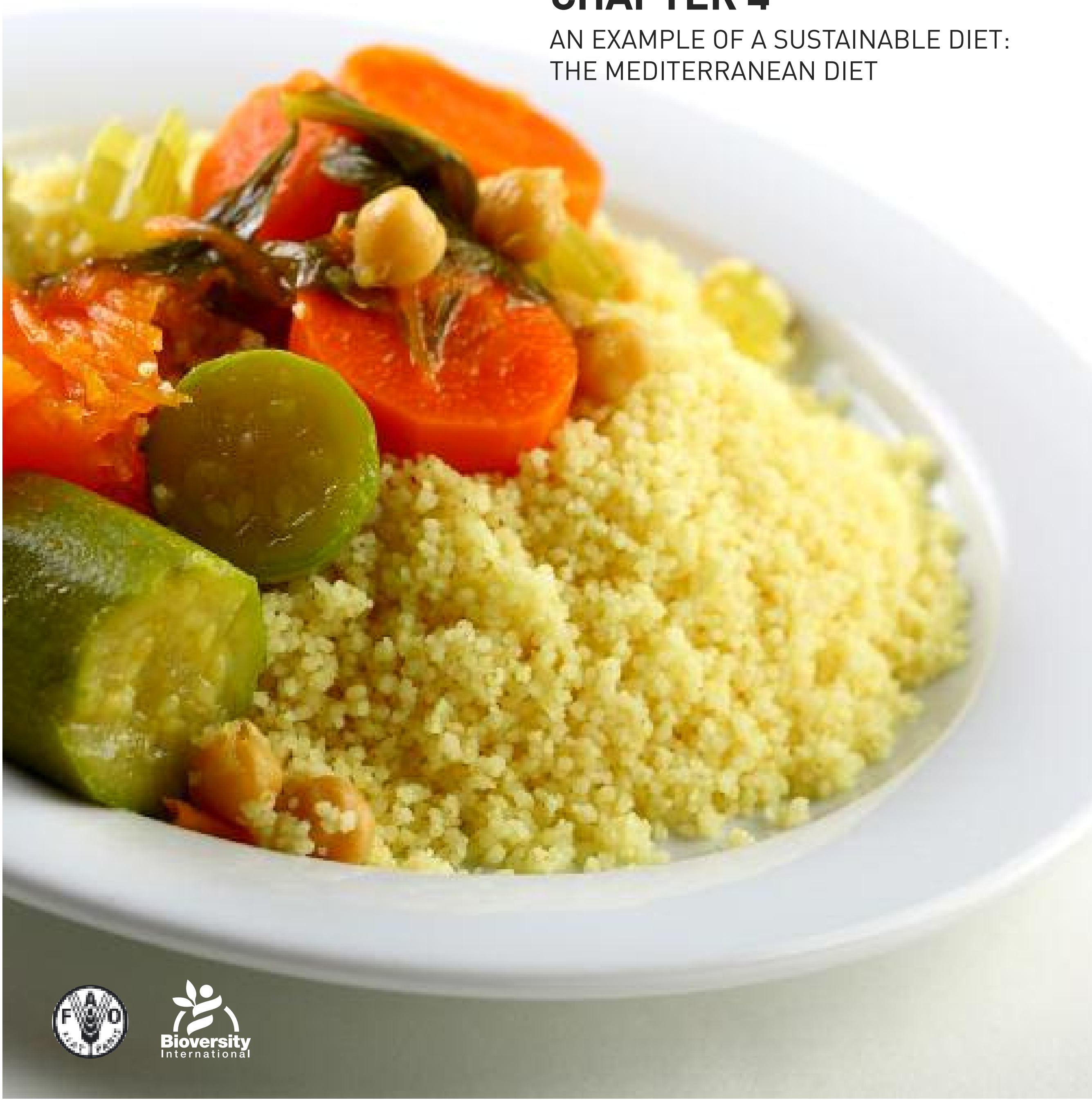
SUSTAINABLE DIETS AND BIODIVERSITY

DIRECTIONS AND SOLUTIONS FOR POLICY, RESEARCH AND ACTION

CHAPTER 4

AN EXAMPLE OF A SUSTAINABLE DIET: THE MEDITERRANEAN DIET



Bioversity International

BIOCULTURAL DIVERSITY AND THE MEDITERRANEAN DIET

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Abstract
The Mediterranean diet constitutes a set of skills, knowledge, practices and traditions ranging from the landscape to the table, including the crops, harvesting, fishing, conservation, processing, preparation and, particularly, consumption of food. The Mediterranean diet is characterized by a nutritional model that has remained constant over time and space, consisting mainly of olive oil, cereals, fresh or dried fruit and vegetables, a moderate amount of fish, dairy and meat, and many condiments and spices, all accompanied by wine or infusions, always respecting the beliefs of each community. However, the Mediterranean diet encompasses more than just food. It promotes social interaction, since communal meals are the cornerstone of social customs and festive events. It has given rise to a considerable body of knowledge, songs, maxims, tales and legends. From 15 to 19 November 2010, the Fifth Session of the Intergovernmental Committee of the Convention will adopt the final decision over the nominations of new elements to be inscribed in the Representative List of the Intangible Cultural Heritage of Humanity.
Between these nominations, there will be the transnational nomination of the Mediterranean diet that already obtained in May 2010 a positive recommendation from the Subsidiary Body of the Committee. This decision of UNESCO will be a milestone in the path of the global recognition of the cultural values of food, agriculture and sustainable diet. The Mediterranean diet emphasizes the development of a relatively new concept: the bio-cultural diversity. This concept encompasses biological diversity at all its levels and cultural diversity in all its manifestations. Biocultural diversity is derived from the countless ways in which humans have interacted with their natural surroundings. Their co-evolution has generated local ecological knowledge and practices: a vital reservoir of experience, methods and skills that help different societies to manage their resources.

1. Not just biodiversity: towards the biocultural diversity
Since the 1980s of the twentieth century the need to protect and preserve biological diversity has been a global priority, becoming a pillar of the United Nations Conference on Environment and Development held in Rio de Janeiro in 1992 when it was agreed a clearer notion of "biodiversity", also developing an integration between biodiversity, climate change and desertification.
At the same time, however, it appeared clear that the biological diversity of ecosystems could not be protected without preserving cultural diversity in that same context at the same time. This awareness is clear from Article 8 of the Convention on Biological Diversity in which the primary objective of the States Parties to the Convention is not only to safeguard the biological diversity of living species, but to "respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities, which refer to traditional lifestyles relevant for the conservation and sustainable use of biological diversity".
Ten years after Rio, even though first in the scientific community, the concept of "biocultural diversity" was born (Maffi, 2001, 2005, 2010).
Integrating biological diversity and cultural diversity is becoming the mantra of the new century, the new commitment of States Parties and of the numerous United Nations conventions.
Since this concept it has been affirmed through different years, several legal instruments were established to protect on the one hand biological diversity in a strict sense (the CBD, for example, but also the FAO International Treaty on Plant Genetic Resources for Food Agriculture in 2001 and the MAB Programme – UNESCO Man and Biosphere), on the other hand cultural diversity (UNESCO, first, with the conventions on cultural heritage and natural material of 1972, the intangible cultural heritage of 2003 on Cultural Diversity of 2005).
Over the years, the need to integrate the various in-

ternational legal instruments of protection in order to preserve the biological and cultural diversity (i.e. the biocultural diversity) emerged.
"The inextricable link between biological and cultural diversity" is for the first time spelled out in the Declaration of Belem, which was adopted by the First International Congress of Ethnobiology in 1988. The discussion around this issue became even more intense at the end of the last century. In 2001, UNESCO unanimously adopted in Paris, during the 31st Session of the General Conference, the Universal Declaration on Cultural Diversity, which, in addition to affirming the fundamental human rights in terms of intellectual, moral and spiritual integration within the concept of cultural diversity, gives some ideas and concepts related to biological diversity.
In 2005, for the first time, the Tokyo Declaration was adopted with the aim of creating a link between cultural diversity of religious or sacred sites protected by UNESCO and the biological richness of those contexts.

In June 2010, in Montreal, many governments, NGOs and associations participated in the International Conference on Cultural and Biological Diversity for Development organized by UNESCO and the CBD, and a Final Declaration was adopted which, after recognizing the need to develop actions so as to preserve biological diversity and cultural diversity, established a ten-year work programme that will, *inter alia*, create a link between the different legal instruments. This declaration (which is actually much more than just a statement) was approved at COP 10 of the Convention on Biological Diversity.

2. A new challenge for world legislators: preserving the biocultural diversity

Speaking of biocultural diversity instead of biodiversity is not just a matter of terminology. It means, in fact, being aware of the close correlation between the loss of cultural and linguistic diversity and loss of biological and genetic diversity, and vice versa (Harmon, 2002). This implies, for anyone who wants to develop a legal discourse, perhaps in order to introduce measures to safeguard or enhance, learning to think in interdisciplinary terms.
This same approach should be used to define the concept of biocultural diversity which includes "diversity of life in all its forms: biological, cultural and linguistic diversity, inter- (and probably co-evolved) within a socio-ecological complex adaptive system".
In order to safeguard the biocultural diversity it is therefore necessary to integrate knowledge from different fields: anthropology, linguistics, ethnobiology, etnoecology, biology, agronomy, ecology and many others (Maffi and Woodley, 2010). But we must, above all, realize that "the diversity of life is not constituted only by the diversity of plant and animal species, habitats and ecosystems on the planet, but also by the diversity of cultures and human languages, these differences do not develop in separate and parallel worlds, but are different manifestations of a single whole and complex relationships between diversity have been developed over time through the cumulative effects of global mutual adaptation – probably coevolutionary nature – between human beings and the local environment" (Maffi, 2010, p. 298).
The starting point that the lawyer must consider is that human beings do not live in an abstract and isolated context but they always have a close relationship with the environment that surrounded them. This environment has always been changed in order to respond to the needs of the human beings; at the same time, they become influenced and shaped by the same environment (Posey, 1999): "This implies that the organization, the vitality and this resilience of human communities are closely linked organization, the vitality and resilience of ecosystems" (Maffi, 2010, p. 298).
In industrialized societies the perception of identity linked to the bond between humans and their environment is getting lost; in indigenous societies, by contrast, the link between the languages, traditions, land and ecosystem is still very strong (Blythe and McKenna Brown, 2004).
Among others, linguistic diversity is, therefore, the representative indicator of cultural diversity (Stepp

et al., 2003). According to data provided by Terralingua, in the world there are from 6 000 to 7 000 different languages, of which 95 percent is the mother tongue of less than one million people. However, linguistic diversity cannot be regarded as the only benchmark. Other factors that relate to the cultural life of a community, such as traditions, folk festivals, events, rituals, social practices, all that intangible cultural heritage referred to in the 2003 UNESCO Convention on World Heritage Intangible Heritage need to be analysed.

3. The world of agriculture and biocultural diversity

The close relationship between biological diversity and cultural diversity is evident especially if you look at global food trends. In other words this relationship can be emphasized as the c.d. agrobiodiversity that can be considered, in itself, an effective index for understanding both the causes and consequences of the loss of biocultural diversity.

According to FAO (1998 data) the plant species used for food production are about 7 000, but today only 30 are under cultivation, and of these, rice, wheat and corn alone cover 50 percent of needs World Food. The loss or abandonment of these crops can be explained by several factors, primarily cultural, in a globalized world, the food seems to be the main victim of the "trend" diet, and it is not just a matter of "appeal". The disappearance of some traditional food is closely related to non-transmission, from parents to children, of the methods of production or storage or handling of food. With a further consequence: the loss of knowledge related to the cultivation of the plant species, which is the prelude to their ultimate demise. The available data are alarming in this respect: just after the Second World War, China, for example, had 10 000 cultivated varieties of wheat, in the 1970s just under 1 000, today about 200. In Mexico, over the past fifty years, 80% of maize varieties, the product symbol of Mexican cuisine, have been lost. In the United States, 95% of the varieties of cabbage, 86% of apples, peas 94%, 81% of tomatoes have disappeared at the same time (Buiatti, 2007, p. 109).

4. The role of UNESCO: 2003 Convention and the Mediterranean diet

UNESCO stands internationally as the only global organization that within its conventions and programmes embraces the concepts of nature and culture, biological and genetic diversity and cultural and linguistic diversity.

Cultural diversity, as it has been mentioned, was, in fact, subject to specific conventions adopted by UNESCO: the Convention on Cultural Heritage in 1972, the Convention on Intangible Cultural Heritage of 2003, the Convention on Cultural Diversity of 2005. Even before the adoption of these international conventions, within UNESCO in 1971 was launched, the Programme MAB – Man and Biosphere, which immediately turned his attention to the protection of biodiversity in the traditional sense and conservation and strategic management of biodiversity.

Founded in the wake of the UNESCO Declaration of Principles of International Cultural Cooperation in 1966, the need to identify and ensure protection measures for the so-called "Intangible Heritage" in its various cultural forms and in the interaction between human activity and both physical and social environment, was clear since 1972, the adoption of the best known UNESCO Convention for the Protection of Cultural Heritage and World Heritage.

Since then, concepts such as folklore, oral expressions, traditional techniques of land management and artistic representations of identity and creativity have been revised several times over several sessions until the adoption, during the 32nd General Conference in 2003, of an ad hoc instrument, the Convention for the Safeguarding of the Intangible Cultural Heritage, signed on 17 October 2003.

The intangible heritage, according to the list provided by Article 2, para. 2, is detectable in 5 areas (oral traditions and expressions, including language as a vehicle of intangible cultural heritage, performing arts, social practices, rituals and festive events; the knowledge and practices concerning nature and universe, traditional craftsmanship). This list does not appear, however, mandatory in nature; especially because of the difficulty of assigning precise classification schemes to the concept of culture, but also because of the intersectoral nature of some oral traditions also when the practices are integrated with food as an integrated system of social relations and shared meanings. Practices related to food are in fact connected to the oral traditions and expressions, to performing arts, to social practices, to some rituals and festivals, to knowledge and practices concerning nature and to the know-how linked to traditional crafts.

Following this approach, in November 2010 on the occasion of the Fifth Session of the Intergovernmental Committee of the 2003 Convention, elements concerning food practices, including the Mediterranean diet were entered for the first time in the Representative List.

In 2008, four countries, namely Italy, Spain, Greece and Morocco, decided to share their own cultural heritage represented by a common way of life and to begin the path of recognizing it as part of the UNESCO Intangible Cultural Heritage of Humanity. The Mediterranean diet constitutes a set of skills, knowledge, practices and traditions ranging from the landscape to the table, including the crops, harvesting, fishing, conservation, processing, preparation and, particularly, consumption of food. The Mediterranean diet is characterized by a nutritional model that has remained constant over time and space, consisting mainly of olive oil, cereals, fresh or dried fruit and vegetables, a moderate amount of fish, dairy and meat, and many condiments and spices, all accompanied by wine or infusions, always respecting the beliefs of each community. However, the Mediterranean diet (from the Greek "diaita", way of life) encompasses more than just food. It promotes social interaction, since communal meals are the cornerstone of social customs and festive events. It has given rise to a considerable body of knowledge, songs, maxims, tales and legends. The system is rooted in respect for the territory and biodiversity, and ensures the conservation and development of traditional activities and crafts linked to fishing and farming in the Mediterranean communities.

The decision to inscribe the Mediterranean Diet in the UNESCO list is a milestone in the path of the global recognition of the cultural values of food, agriculture and sustainable diet. The Mediterranean diet is a unique lifestyle of a particular territory and its sustainability is recognized as a common cultural heritage of Mediterranean communities.

The Mediterranean diet, as an example of sustainable diet, makes clear and evident the link between cultural and biological components, between the environment and human sustainable activities such as traditional agriculture and fishery. The Mediterranean diet emphasizes the development of a relatively new concept: biocultural diversity. This concept encompasses biological diversity at all its levels and cultural diversity in all its manifestations. Biocultural diversity is derived from the countless ways in which humans have interacted with their natural surroundings. Their co-evolution has generated local ecological knowledge and practices: a vital reservoir of experience, methods and skills that help different societies to manage their resources.

This is an example of how, thanks to the so-called "UNESCO system" (Petrillo, Di Bella, Di Palo, 2012), thereby indicating that set of conventions and programmes that protect the tangible and intangible cultural diversity and biological diversity, and to the persistence of local populations, we may now be able to protect and preserve an area in the cultural and biological diversity, in Italy this area is the Cilento.

The National Park of Cilento and Vallo di Diano, in fact, was inscribed in 1997 to UNESCO's World Network of biosphere reserves recognized by the MAB Programme: it is, therefore, recognized as a unique ecosystem, a high concentration of biodiversity. In addition, since 1998 it has been inscribed in the UNESCO World Heritage list being considered by UNESCO as a unique cultural landscape, the result of centuries of human labour and processing of natural resources. In addition, since 2010, the Cilento is one of the four communities identified by the nomination of the Mediterranean diet Intangible Heritage of Humanity: UNESCO has recognized Cilento has handed down traditions and expressions, ancient food practices, cultural diversity, unique and preserved over the centuries. Cilento, thus, represents a unique identification of the concept of biocultural diversity: in this context, in fact, the original characteristics of ecosystems and the knowledge and traditions of local people and their artefacts, are the witnesses of the inextricable link between culture and nature, that go together here, in a close co-evolution.

5. For a new awareness: it is useless to protect biodiversity without preserving cultural diversity

From this picture it is clear that the challenge that the legislators all over the world are facing is to introduce mechanisms to protect, preserve and enhance the set of biological and cultural diversity represented in a community. Unique approaches to this subject will, in the long term, avoid a further loss of biodiversity. In the world, where the beating of a butterfly in China produces an economic tsunami in the United States, it is no longer possible to think and act locally and compartmentalized. We could also start from a fact: in the last 20 years the world has lost so much of its richness in genetic, biological and cultural that if we do not do something to counter this loss in a coordinated and comprehensive way, in another two decades we will be happily doomed to extinction (UNEP, 2010). For example: in 2100 will disappear about 80 percent of the languages spoken today.

But then, who "governs" biocultural diversity? Who has the authority to act to redress the loss in a maybe too much polycentric institutional context too?

The challenge to counter the loss of biocultural diversity collides with the increasingly federal structure of the states, so that we can draw a curve that shows how more fragmented institutional contexts (or "exploded" or "polycentric"), the lower capacity for action to tackle environmental and cultural damage.

The real challenge of the legislative branch is primarily a challenge to themselves, to challenge themsleves and deal with different sciences, trying to find a common language. It is a legal challenge to the traditional object of study, because now lawyers should try to analyse it in a diachronic and interdisciplinary way individual rules and then put them in a different context.

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SUSTAINABILITY OF THE FOOD CHAIN FROM FIELD TO PLATE: THE CASE OF THE MEDITERRANEAN DIET

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Abstract
The Mediterranean diet is considered as a paragon among the world's diets. The reference is the diet of Crete in the late 1960s. Is it provided sustainable?

Various authors have commented on the design of sustainable food. Some emphasize healthy food and alternative agriculture, while others focus on the link between health and welfare, or environmental practices on consumers. For us sustainable food is the one that combines the protection of nutrients, environmental conservation, community development through social aspects.

The traditional Mediterranean diet may be considered as sustainable in part because of (i) a great diversity that ensures food nutritional quality of diet and biodiversity, (ii) a variety of food practices and food preparation techniques, (iii) main foodstuffs demonstrated as beneficial to health as olive oil, fish, fruits and vegetable, pulses, fermented milk, spices, (iv) a strong commitment to culture and traditions, (v) a respect for human nature and seasonality, (vi) a diversity of landscapes that contribute to the well-being, (vii) a diet with low environmental impact due to low consumption of animal products. However, trends in plant breeding on an economic base, intensive modes of production and greenhouse production, higher consumption of meat, industrialization of food, endanger the sustainability of food systems. No analysis of social impact has been achieved. We cannot conclude on this aspect of sustainability, nor on the environmental impact of the food chain.

In conclusion, the Mediterranean diet has numerous virtues. We must ensure that modernity and globalization do not alter its characteristics of sustainability.

Introduction
The Mediterranean diet has enjoyed a high reputation over many years, both for its nutritional quality and its health benefits. The traditional Mediterranean diet of the 1960s is considered a model of nutritional benefits (Padilla, 2008). Its multifunctional nature, encompassing the entire range of ecological, nutritional, economic and social functions, puts food at the heart of the concept of sustainable development.

Sustainable food is a concept that has been developed as a key factor to reduce negative externalities of the global food supply chain. Beyond the preservation of the environment, sustainable food includes also moral and health aspects of eating (ethic and nutrition), satisfaction of consumer expectations, and improved product accessibility at geographic and economic level. Faced with fossil energy exhaustion, soil limited capacity, ecosystem degradation, climate change and global warming, unbalanced diets and population increase, we wonder if the Mediterranean current food system can be considered as sustainable. Is the Mediterranean diet consistent with sustainable development? The aims of this paper are (i) to characterize the different aspects of sustainability of the traditional Mediterranean diet (ii) to analyse what are the principal hot spots of food systems today in the Mediterranean area with regard to sustainability.

Material and methods
The definitions of sustainable diets show that they affect various dimensions (agricultural, food, nutritional, environmental, social, cultural, economic) that interact with one another, either inseparably or separately and distinctly. From this point of view, the Mediterranean is the area where more than any other many issues (biodiversity loss, soil erosion, water scarcity etc.) directly or indirectly related to Mediterranean food consumption patterns should be addressed. We have summarized the criteria of sustainable food in Table 1. It is a combination of preservation of the environment, nutrition, and development of the local territory by social and economic aspects all along the food chain, from agriculture to the consumer.

	Environment	Nutrition	Economic	Socio-cultural
Agriculture	Follow sustainable agricultural practices Enhance resilience of production systems Deploy and maintain diversity	Promote diverse food Produce nutritionally dense product	Deploy affordable cultivation practices Promote self reliance through local produce	Maintain traditional agriculture practices and promote local varieties
Food Production	Reduce impact of production, processing, commercialization	Preserve nutrients throughout the food chain	Strengthen local food systems Produce affordable food	Produce culturally acceptable foood
Consumption	Reduce the environmental impact of feeding practices	Promote dietary diversity, food balance and seasonality	Promote access to dietary diversity	Safeguard food traditions and culture Meet local preference & taste

Table 1. The grid of sustainable food system.

From our previous works and experience of the Mediterranean area, we will develop our thinking about each element of sustainability.

Results and discussion

I. Is the traditional Mediterranean food chain linked with the traditional diet sustainable?

Environment: the uniqueness of the Mediterranean area, one of 25 "hot spots" of biodiversity on the planet

The importance of the Mediterranean area as regards crop diversity can be judged by the fact that about one-third of the foodstuff used by humankind comes from the Mediterranean climatic region (Harlan, 1995). The Mediterranean basin was one of the eight centres of cultivated plant origin and diversity identified by Vavilov (1951). He listed over 80 main crops and the most important of these are cereals, pulses, fruit trees and vegetables. There were also many herbs, spice-producing plants, horticultural crops, and ornamentals (Heywood, 1998). Several sociopolitical, agroclimatic, ecological and genetic factors have contributed to this remarkable crop diversity in the Mediterranean (Jana, 1995).

Approximately 30 000 plant species occur, and more than 13 000 species are endemic to the hot spot; yet, many more are being discovered every year (Plantlife International, 2010). The Mediterranean Basin is 1.6% of world land with 10% of known flowering plants and 18.4% of mammal species; 0.7% of the world ocean, with 8–9% of known marine organisms (Sundseth, 2009). The hot spot has roughly the same plant diversity as all of tropical Africa, albeit in a surface area one-fourth the size of sub-Saharan Africa (CEPF, 2010).

There are more plant species in the European Mediterranean region than all the other European bio-geographical regions combined. The Mediterranean forests are diverse and harbour up to 100 different tree species. In the Mediterranean Basin there is huge topographic, climatic and geographic variability giving rise to an astounding array of species and habitat diversity.

A diverse landscape

A large diversity of landscapes was shaped by the practices of agriculture and livestock. This contributes to well-being and environmental protection. Cereal, fruit trees, olive groves, vineyards, horticulture, gardening, were cultivated on small perimeters. Agricultural lands and grasslands occupy 40 percent of the Mediterranean region and vary between large intensive olive or citrus groves to more mixed farming systems (Elloumi and Jouve, 2010). The low intensity and localized nature of thousands of years of subsistence farming activities has had a profound effect on the landscape, creating a complex mosaic of alternating semi-natural habitats rich in wildlife. Vineyards and ancient olive groves are also still a characteristic feature of the Mediterranean landscape. On flatter land and in the plains various forms of sustainable agro-sylvo-pastoral farming systems have evolved that make best use of natural resources (Sundseth, 2009). Ranching is also practiced on the land fallow or wasteland or vast semi-desert lands.

Agriculture practices preserving the environment?

We see the continuation of small-scale family farming (17 million family farms with two-thirds or three-quarters less than 5 ha in Turkey, Morocco, Italy, Greece, for example (Elloumi and Jouve, 2010). They practise traditional agriculture-intensive labour and low use of capital. This agriculture is likely to solve the food crisis, according to Olivier de Schutter, Rapporteur on the right to Food at the UN. It is also an agriculture that preserves the earth, by increasing local productivity, reducing rural poverty, contributing to improved nutrition and facilitating adaptation to climate change.

The richness of Mediterranean agriculture is its diversity of cropping patterns. We distinguish five forms of agriculture in the Mediterranean, especially on the outskirts of towns: (1) An entrepreneurial agriculture, innovative, with high added value. It is an innovative farming vegetable speculative, capital intensive, growing thanks to the availability of capital in the current conditions. (2) An opportunistic agriculture in extension due to the constraints of access to land. It is practiced on large farms consisting of clusters of plots, left short-term leases, usually oral. (3) Family farms in the suburban area specialized in local productions to be sold directly in farmers markets. (4) Agriculture need, practiced by the rural exodus from the city and recently installed, because of economic crises; it tends to perpetuate. (5) Pleasure agriculture: the traditional Mediterranean cultivation has an interest in landscape and identity, such as vineyards and olive trees; they are renewed in European countries where they receive aid from the CAP. The aim of policies related to territory quality (AOC) is to ensure the sustainability of these local productions (Jouve and Padilla, 2007).

Another aspect of land preservation is the commitment to organic farming. Mediterranean organic agriculture is growing, but covers a very small percentage of agricultural land: 4.5% in Italy, between 2 and 3% in Spain and Greece, 6.2% in Slovenia, less than 2% in France, 1.5% in Tunisia and less than 1% in other countries (Plan Bleu, 2006). If organic agriculture does not meet market demand in the North, it does not have a local market in the South. This greatly limits its expansion.

The environmental impact of the diet

Duchin (2005), who studied diets from multiple points of view of sustainability, showed that a Mediterranean diet, which consists mainly of plant-origin foods but not excluding a small proportion of meat and other animal products, is closer to public health recommendations issued by the World Health Organization and has a lower environmental effect than the current average United States diet.

If, for reasons of public health, the plant-based Mediterranean diet is adopted throughout the United States, not only major structural changes would be needed in agriculture, but the farmland dedicated to food would decrease. Indeed, Duchin argues that the typical Mediterranean diet differs from the current dietary recommendations in the United States by including a much lower meat consumption. This choice would also benefit the environment and that food choice is all the more commendable that the environment would benefit too. Among the various diets tested by Duchin, in a global economy model that incorporates Life Cycle Analysis of 30 foods, plant-dominated diet type emerges as the Mediterranean diet, can meet both nutritional and environmental requirements, and for a growing world population while reducing the pressure of food and agricultural systems on the environment.

Nutrition sustainability: few animal products in the diet

The east Mediterranean diet of the early 1960s has interesting qualities for the development of options to create more sustainable, healthy diets. The environmental impacts of animal production vary with the method of production (e.g. extensive grazing, grazing-based production) (MFAF-DK, 2010).

Meat production has a higher environmental impact than fruit and vegetables production. The global livestock sector contributes about 40 percent to global agricultural output. Meat and dairy animals now account for about 20 percent of all terrestrial animal biomass (Steinfeld *et al.*, 2006). According to the Livestock, Environment and Development initiative, the livestock industry is one of the largest contributors to environmental degradation, at local and global scale, contributing to deforestation, air and water pollution, land degradation, loss of topsoil, climate change, the overuse of resources including oil and water, and loss of biodiversity. The use of large industrial monoculture, common for feed crops (e.g. corn and soy), is highly damaging to ecosystems. The initiative concluded that the livestock sector emerges as one of the most significant contributors to the most serious environmental problems. A person existing chiefly on animal protein requires ten times more land to provide adequate food than someone living on vegetable sources of protein (MFAF-DK, 2010) which means a much higher ecological footprint

Type of Food	Area required
Vegetarian food	500 m^2
Dominant vegetarian food	700 m^2
Western diet	4 000 m^2
Mainly meat diet	7 000 m^2

Table 2. Ecological Footprint of different food diets.
Source: FAO.

The Mediterranean variety is major. It helps to meet diverse nutritional needs and to limit the environmental impact

There is growing evidence of the impact of diet on health, including increased risk of obesity, cardiovascular diseases and cancers, and also of its role as a social indicator (Reddy *et al.*, 2009; Hawkesworth *et al.*, 2010). Dietary diversity that characterizes the Mediterranean diet explains the disease prevention related to diet. A study of the index of food variety in several countries has shown that France has a very high rate (90%) compared to the United States (33%). In Morocco, the dietary diversity score was 10.2 for ages 12 to 16 years (Aboussaleh and Ahami, 2009). Other surveys in 2006 for adults (Anzid *et al.*, 2009) also showed high levels of dietary diversity in urban areas only.

Beyond the diversity in terms of different categories of food and in terms of different foods within a category, it should be noted the peculiarity of the Mediterranean diet for the variety of flavours: acid, sweet and sour, salty-sweet, bitter, pungent. The preparation techniques are also very diverse: flavoured, breaded, chopped, into batter, stuffed pastry, salads; the techniques of preservation also: sun-drying, salting, fermentation, vinegar, oil, candied (we find all these technical approaches in the Mune in Lebanon). The diversity can be found also in

cooking techniques: boil, simmer, roast, broil, fry, steam. People eat structured meals taken in a friendly way. Families and friends eat together tapas in Spain, tramessi in Italy, kemia in Tunisia, meze in Lebanon, mézélik in Turkey.
The recommended Mediterranean food pyramid expresses such diversity (Figure 1).

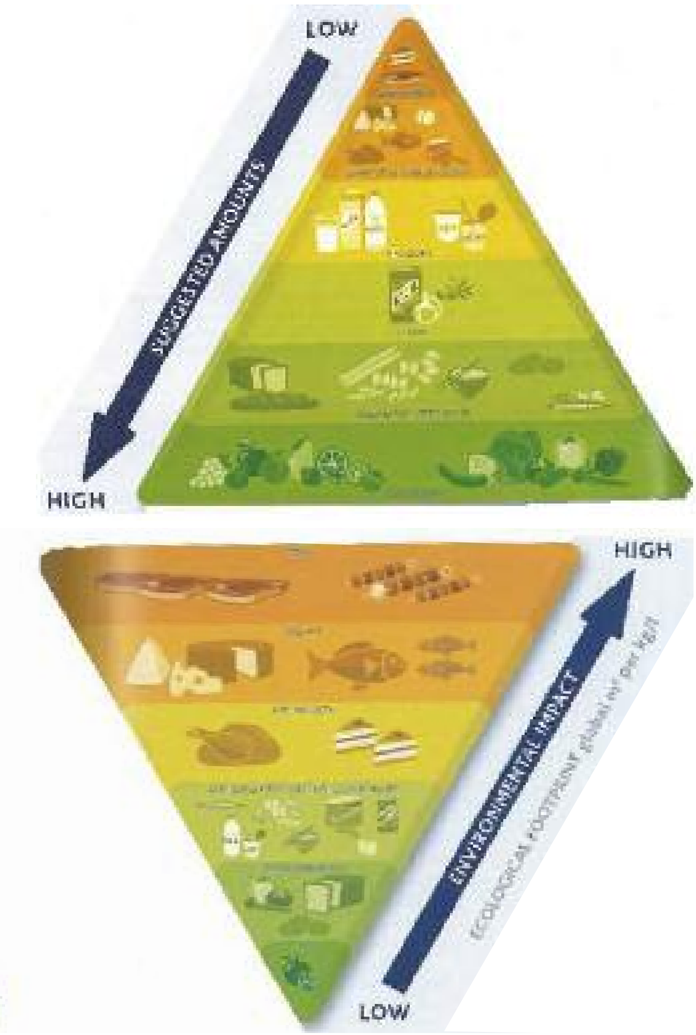

Figure 1. The double pyramid.
Source: Barilla Center, 2010

It not only offers considerable health benefits to individuals but also respects the environment and has less impact. Barilla Center for Food and Nutrition demonstrated that the foods that are recommended to be consumed more frequently, are also those with minor environmental impacts (per kg). In other words, the inverted environmental food pyramid illustrates how the most environmentally-friendly foods also tend to be the healthiest (Barilla Center, 2010). As a matter of fact, the various food groups can be evaluated in terms of their environmental impact. Reclassifying foods no longer in terms of their positive impact on health, but on the basis of their negative effect on the environment, produces an upside-down pyramid which shows the foods with greater environmental impact on the top and those with lower impact on the bottom. When this new environmental pyramid is brought alongside the food pyramid, it creates a food-environmental pyramid called the "Double Pyramid". It shows that foods with higher recommended consumption levels are also the ones with lower environmental impact. This unified model illustrates the connection between two different but highly relevant goals: health and environmental protection. In other words, it shows that if the diet suggested in the traditional food pyramid is followed, not only do people live better (longer and healthier), but there is a decidedly lesser impact – or better, footprint on the environment.

Respect of human nature

Mediterranean people have benefited from the influence of Hippocras about the categorization of food and eating behaviours: hot, cold, wet or dry properties. There is an adaptation to natural conditions in respect of the seasons and a necessary balance among different kinds of products according to the seasons, metabolism and health of individuals.

Social and economy sustainability: strengthen local food systems

Historically, in Europe, the Mediterranean countries have the largest number of initiatives of geographical indications (GI). Locally, they are indicative of a strong connection to the land, the notoriety, the history and the quality of the product. Nearly 80 percent of GIs in the European Union are from Mediterranean countries. France represents alone 20 percent followed by Italy, Portugal, Greece and Spain. In southern countries, this process is beginning in Morocco, Tunisia, Lebanon.

In Mediterranean countries, there is a strong attachment to traditions and culture and food is an integral aspect of human culture. The culinary tradition is still transmitted from mother to daughter, although the cookingprocess is often simplified. Festive occasions around food are common: celebrations, religious rituals. Modern life leads to strong ambivalent practices between acculturation and transmission of a cultural identity. To preserve the Mediterranean food culture, UNESCO has recently recognized the Mediterranean diet as an intangible heritage of humanity (2010) in four countries: Spain, Greece, Italy and Morocco. It will be included in a transnational Mediterranean inventory in preparation.

II. The principal hot spots of food systems today

The risks on biodiversity

Biodiversity is threatened because pollution, overexploitation, natural disasters, invasive alien species, tourism, intensive agriculture. The change in eating habits combined with the pursuit of profitable varieties led to the abandonment of local varieties and cultural degradation of specific products. There is a globalization of the food market with absurd transport costs, an organization of the food chain in function of economic considerations, without taking into account the environmental impact: 30 percent of greenhouse gas emissions are linked to the food in France. Specialization in agriculture and the changing patterns of farming techniques deplete biodiversity and have a negative impact on greenhouse gas emissions. For instance, there are more and more greenhouses in the south of Spain: 40 000 ha of vegetables in Almería, 7 500 ha of strawberry in Huelva. A majority of the workforce is composed of illegal immigrants.

We are in an era of unprecedented threats to biodiversity: 15 out of 24 ecosystems are assessed to be in decline (Steinfeld *et al.*, 2006). The genetic diversification of food crops and animal breeds is diminishing rapidly. At the beginning of the twenty-first century it was estimated that only 10 percent of the variety of crops that had been cultivated in the past were still being farmed, with many local varieties being replaced by a small number of improved non-native varieties (Millstone and Lang, 2008). Only about 30 crop species provide 95 percent of food energy in the world while 7 000 species, that are partly or fully domesticated, have been known to be used in food including many of the so-called underutilized, neglected or minor crops (Williams and Haq, 2002). Humanity depends on ecosystems and their life-sustaining goods and services.

WWF (World Wide Fund for Nature) has listed 32 ecoregions in the Mediterranean hot spot. There are three broad vegetation types: maquis, forests and garrigue (CEPF, 2010). Nowadays, the most widespread vegetation type is the maquis. Many of the endemic and restricted-range plants depend on this habitat; thus, several species are threatened (Tucker and Evans, 1997).

However, whilst small-scale farming is still practised in many parts of the region, the last 50 years have seen a massive change in agricultural practices across large parts of the Mediterranean. Ancient vineyards, orchards and olive groves have been ripped out to make way for industrial-scale fruit or olive plantations and mixed rotational farming has been replaced by intensive monocultures. This has not only caused the loss of wildlife-rich habitats but has also had a major socio-economic impact on large parts of the region as many small-scale farmers have been forced to abandon their land to go and search for jobs elsewhere.

Farming systems

The global changes affecting the Mediterranean region have effects on farming systems and processing of food derived from them. Overall, we can expect a widening of the social and economic divide between industry and family agriculture, namely in the South, because the region is highly dependent on of agricultural imports and therefore subject to the hazards of world agricultural production and its "crisis"; an integration of food to better control price volatility of primary production, while promoting the internationalization of production.

These trends are consistent with the reconstruction of territories: concentration of population in urban and coastal areas; concentration of large farms, competition for use of space between rural and urban areas, and risk of a progressive disqualification of small farming. These changes are associated with the degradation of agro-ecosystems due to climate change, to intensifying production and a devaluation of traditional knowledge, with consequences: a recurring emergence of diseases of various origins, increasing pressure of invasive species, and degradation of biodiversity; stress on crop yields associated with an increase in agricultural water demand coupled with lower ground and underground flows, tensions to share water between uses. In this context of strong pressure on resources (water, land), and increased concentration of population, and environmental degradation, the major health crises, affecting animals or plants, are likely (international trade increasingly important to promote migration of invasive species and pathogens).

Use of water

Modern farming practices through their high demand for pesticides, fertilizers and irrigation water also put excessive pressure on the environment. More than 26 million ha of farmland are now under irrigation in the Mediterranean Basin and in some areas up to 80 percent of the available water is used for irrigation. The exceptionally rapid growth in tourism and urban development in coastal areas combined with the abandonment of small-scale farming practices puts immense pressure on the Mediterranean region's rich biodiversity (Sundseth, 2009).

The Mediterranean population is particularly affected by water scarcity: it represents 60 percent of the population of water-scarce countries in the world with less than 1 000 m^3/inhabitant/year (PlanBlue, 2006). Water demand doubled during the second half of the twentieth century to reach 280 billion m^3 per year for all riparian countries: 64% is for agriculture (82% in southern countries), 13% for tourism. Moreover, the complexity of the food chain increases the use of virtual water. In the Mediterranean region, water resources are limited, fragile and unevenly distributed over space and time where southern rim countries are endowed with only 13 percent of the total resources (Plan Blue, 2006). According to the projections of the Plan Blue baseline scenario and compared to the year 2000, water demands may increase by a further 15 percent by 2025, especially in the southern and eastern countries where an increase of 25 percent is expected. Furthermore, Mariotti *et al.* (2008) predicted by 2070–2099 an average decrease of 20 percent in land surface water availability, with a decrease in soil moisture and river runoff, and a 24 percent increase in the loss of fresh water over the Mediterranean due to precipitation reduction and warming-enhanced evaporation. Thus, improving the water demand management, water saving and rational water use, especially for agriculture, is of paramount importance in the Mediterranean region.

A surge of supermarkets

According to expert estimates, the agro-industrial service model, characterized by mass consumption of industrialized products driven by hyper- and supermarkets, may locate in any region where the average revenue per capita is above US $ 5 000 per head. In 2008, in all Mediterranean countries this limit was reached except in Morocco. For some ten years Mediterranean countries have been facing the development of modern food distribution. If it holds 75 percent of the food market in the north, it remains modest in the south with 5–10 percent, but is growing strongly. In Egypt, it is estimated that around 90–95 percent of the food outlets can be categorized as small grocery stores. The modern retail food service has tripled in five years. In Morocco, like in Tunisia, the modern distribution has duplicated the number of establishments in the last five years. We can count 32 Auchan /Marjane, Metro, Label'Vie, Casino/Asmak Assalam (Chaabi group) in Morocco; 1 Carrefour, 44 super Champion et Bonprix, 1 Géant Casino, 39

Monoprix et Touta, 44 super Magasin Général in Tunisia; and only 1 Carrefour, Blanky/Promy, Cevital in Algéria.

An indicator of each country potential for retail developments is provided by AT Kearney. They classify every year the 30 more promising emerging countries, according to an index based on a set of 25 variables including economic and political risk, retail market attractiveness, retail saturation levels, modern retailing sales area and sales growth. According to the classification for 2010, there were 10 Mediterranean countries ranked in the following places: Tunisia (11), Albania (12), Egypt (13), Morocco (15), Turkey (18), Bulgaria (19), Macedonia (20), Algeria (21), Romania (28) and Bosnia-Herzegovina (29). The problem is that this method of distribution extends distribution channels, massive purchases and sells a wide range of products highly industrialized and not always conducive to health. Thus we are seeing the explosion of soft drinks consumed at any time of the day.

A Food Quality Index of food in regression

Based on the recommendations of the National Research Council, the American Health Association, and the latest proposals of the joint committee of FAO / WHO (2003), we see that the Food Quality Index is decreasing in the main Mediterranean countries.

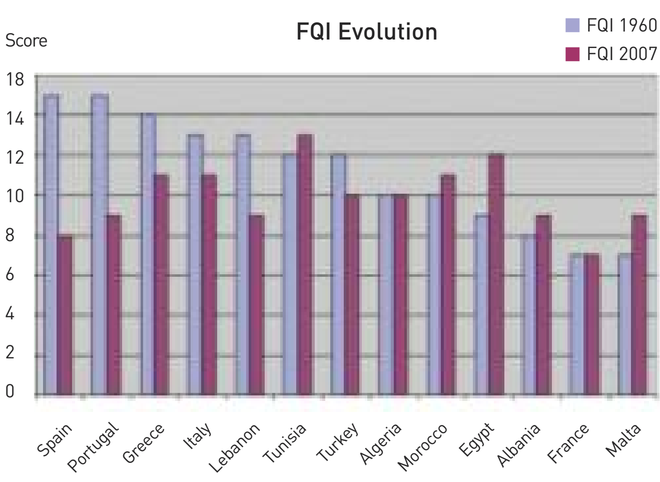

Figure 2. FQI evolution within the Mediterranean countries (1960-2007).
Source: Based on FAO data.

Major concerns relate to the aggravation of saturated fat (meat, dairy and industrial foods), a very sharp increase in sugars (sodas, cookies, desserts), a reduced consumption of starches (bread, potatoes), and micronutrient deficiencies.

The mirror of the new eating behaviours is the increasing overweight and obesity. The main causes are: the lifestyle, the type and frequency of physical activity, the type and quality of food consumed and time spent on food related activities (shopping, cooking, etc.).

A negative balance of the total ecological footprint in the Mediterranean region

With modern diets and food consumption patterns there is a trend to have a greater flow of food commodities over long distances, and highly processed and packaged foods that contribute to increased emissions of greenhouse gases and non-renewable resources depletion. Alteration of the ecosystem occurs if an area's ecological footprint exceeds its biocapacity. Balance of the total ecological footprint in the Mediterranean is shown in Figure 4 based on data of the global footprint network for the year 2007. The results put in evidence an ecological deficit in the Mediterranean region and an alteration of the ecosystem is therefore occurring. The ecological deficit is more pronounced in the Balkans and northern Mediterranean even if they have a higher biocapacity with respect to North Africa and the Near East.

Conclusions

The grid of sustainable diet: what should be done?

For the immediate future, we recommend a better synergy between environmental and health education to obtain agreement for a dietary change for the general public. A lot of researchers explained the health benefits that a plant-based diet would have on health and environment, and this knowledge could be translated into information campaigns. Further research is needed to understand barriers and why changes in diets have not been a main issue on the climate agenda until now. It is there-

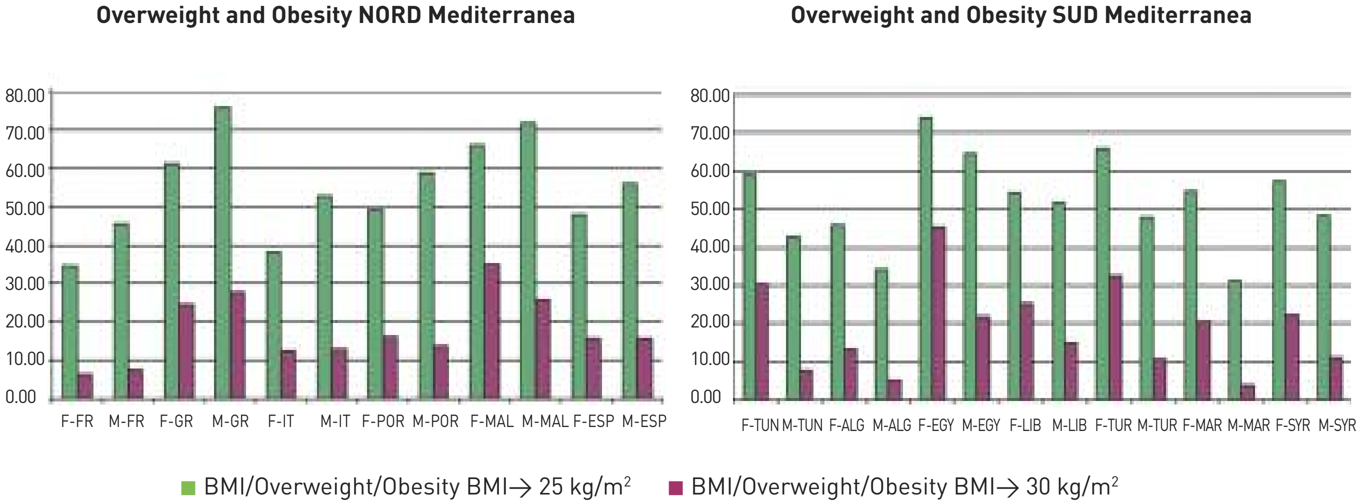

Figure 3. Overweight and obesity in Mediterranean countries.
Source: WHO, 2009.

fore necessary to act urgently to implement a strategy that promotes the use of the concept of "sustainable diets" in different contexts worldwide, in industrialized as well as developing countries.

The Mediterranean diet was proven as good for health; it has nutritional virtues, diversity, seasonality, freshness, culture, skills. The south Mediterranean countries should avoid reproducing a Western pattern of which we perceive the limits today and should incorporate sustainable development goals into their policies Our objective is not to cultivate the past, but to become aware of abuses of food systems in the Mediterranean. Traditional knowledge and experience are wiped out in the name of modernity. Don't we have to learn from our past to ensure a sustainable modernity? It is still possible to build our future on the triad of traditional food, food industry and sustainable development including nutrition, environment and biodiversity.

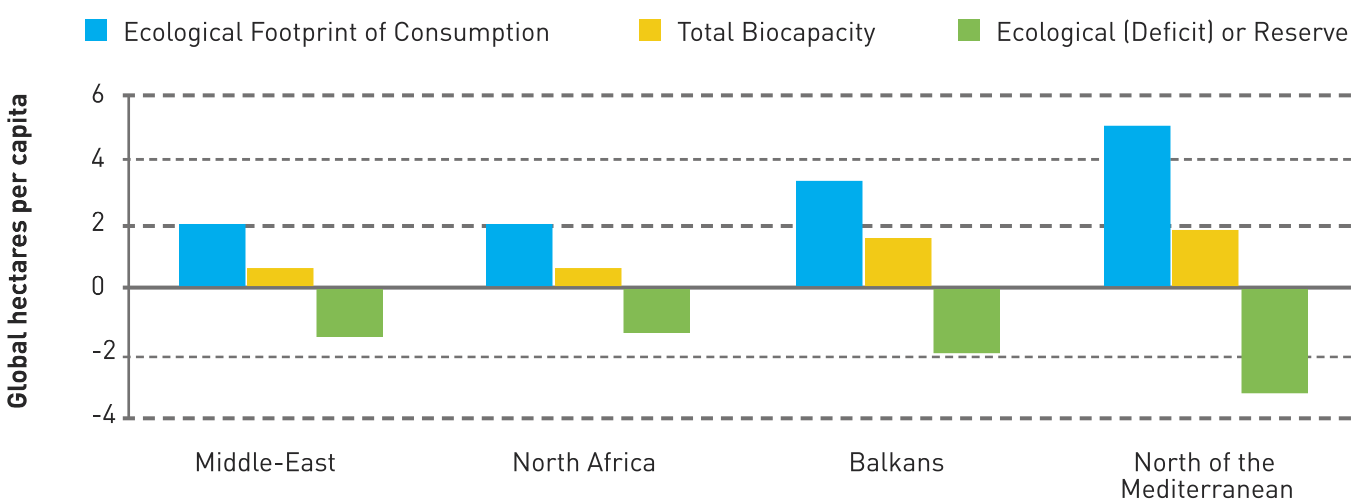

Figure 4. Balance of the total ecological footprint in the Mediterranean region.
Source: Global footprint network, 2007.

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BIODIVERSITY AND LOCAL FOOD PRODUCTS IN ITALY

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Abstract
The role of biodiversity for food quality and healthy status is well recognized. The question is whether environmental changes could affect the composition and bioavailability of bioactive and other food components and in what way the production of local and traditional foods in the various Italian countries can be improved by applying advanced technologies. The great progress in technological processes (advanced technologies, innovative food equipment manufacturers), agricultural practices (food production, transport and processing) and so the changes in lifestyle led to take attention towards both local foods and functional foods as principal elements for improving food product quality and in the meantime supporting local agrobiodiversity. The main aim of this research is to identify the many different local and traditional foods in Italy, their production methods, domestic cooking and the environmental factors that may affect food quality addressing towards a healthy status. Our study has been focused on quantification of bioactive molecules (vitamins, polyphenols, carotenoids) and evaluation of ferric-reducing antioxidant power (FRAP) of selected foodstuffs, representing Italian agricultural ecotypes. FRAP value, measured on Aprica's cherries, was 18.55 mmolkg-1 (SD 1.91) and vitamin C concentration was 0.22 gkg-1 (SD 0.76). Wild strawberries presented more efficiency in the total value then literature data 62.85 mmolkg-1 (SD 3.32). In the selected agricultural ecotypes of carrots, α-carotene and β-carotene reached highest values. The antioxidant levels and their bioactivity could indicate a better potential for health for the artisan niches improving their quality and biodiversity.
The conservation and valorization of local/traditional products could increase the adoption of more sustainable agricultural systems together with the adoption of practices more respective of the environments and the natural habitats.

Introduction
The great progress in technological processes (advanced technologies, innovative food equipment manufacturers), agricultural practices (food production, transport and processing) and so the changes in lifestyle led to take attention towards both local foods and functional foods as principal elements for improving food product quality and in the meantime supporting local agrobiodiversity. Quality should be identified as valorization of traditional agricultural patrimony, peculiarity of cultivation and uniqueness of typical products. The high quality food products have significant nutritive and excellent biological properties and so they have a crucial role in the productive process and the manufacturing system in the agro-alimentary industry. Nowadays, several researches emphasize benefits that accrue to the small-scale producer and to the consumer, due to the linkage between food quality and agricultural biodiversity.
The artisan niches production, founded on quality and agricultural biodiversity and intended for local and regional use, seems to meet requirements of consumers about safety and genuineness. The local small production (niche) represents a system based on support of agricultural ecotypes cultivated by techniques based on the historical and cultural tradition of a specific territory and occurring only in their native place. Through buying locally grown produce, consumers could give their support to local producers as well as helping to revitalize rural economies. Our study represents a step within a research programme aiming to improve the valorization of different agricultural ecotypes as artisan niches, in particular their nutritional and health value. The geography influences the variation in crop growth and so the nutrient/micronutrient content varies considerably by species, genotype and ecotype and by the range of crop management practices employed. The environmental and agricultural specification could contribute to further valorization of local agricultural products by adding market value to a specific basket of products, and then can be a tool for the promotion of local products and varieties in the frame of sustainable rural development, with the adoption of practices more respective of the environments and

the natural habitats. It will be clear that local and traditional foods play an important role in the food pattern of many population groups in several countries. Their nutritional quality and safety are essential elements in dealing with those foods. Over the last 15 years, several researchers have shifted towards quality that is related to antioxidants that are active in preventing widespread human diseases. Much epidemiological and experimental evidence has shown the correlation between diet and degenerative diseases in humans such as cancer and cardiovascular disease (1,2,3,4). The contents of antioxidant substances, mainly phenolic compounds, carotenoids, tocopherol and ascorbic acid have been determined in many species of fruits, vegetables, herbs, cereals, sprouts and seeds (5,6). Particular attention is given to fruits, as rich sources of phenolic compounds. Changes in antioxidant composition of the selected vegetables were linked to agricultural practices and environmental factors. The potential antioxidant effects and the high phytochemical content represent an essential tool for obtaining high quality and healthy products.

The main aim of this research was to investigate the antioxidant properties and bioactive molecules contents of selected local and traditional foods in Italy, their production methods, domestic cooking and the environmental factors that may affect food quality addressing towards a healthy status. In addition the bioactivity of polyphenolic extracts obtained from cultivated and wild chicory in human epithelial colorectal adenocarcinoma cell (caco-2) models were studied.

Material and methods

Selected foodstuffs. The foods, selected to represent Italian agricultural ecotypes, were taken from different regions of Italy: strawberry, cherry "Aprìca" from Lombardia; potato "Rotzo", raspberry "Cansiglio" from Veneto; potato "Val Belbo", pear "Madernassa" from Piemonte; apple "Limoncelle", purple carrots "Fucino" from Abruzzo; chicory, strawberry "Mara des Bois" from Calabria; chicory and plums from Lazio (Table 1).

Table 1. Selected local Italian agricultural ecotypes.

Species	Ecotypes	Origin
Fragaria vesca	strawberry	Lombardia
Prunus padus	cherry	Lombardia
Solanum tuberosum	potato	Veneto
Rubus idaeus	raspberry	Veneto
Solanum tuberosum	potato Val Belbo	Piemonte
Pyrus communis	pear Madernassa	Piemonte
Malus domestica	apple Limoncella	Abruzzo
Daucus carota	purple carrot	Abruzzo
Chicorium intybus	chicory	Calabria, Lazio
Fragaria ananassa	strawberry " Mara des Bois"	Calabria
Prunus domestica	plum	Lazio

We have analysed some of these products cooked because our aim was to study the food as it used to be consumed. Chicory, potatoes and carrots are used also as cooked vegetables. In addition, for potatoes, we analysed potatoes cultivated following two types of cultural practices, organic and integrated, in the same region.

Chemicals and standards. The organic solvents used for the separation of carotenoids, ascorbic acid and polyphenols were of HPLC grade and purchased from Carlo Erba, Milan, Italy. Other organic solvents and chemicals used in the extraction procedures were of analytical grade (Sigma). Standard regression lines pure were purchased from Sigma.

Sample preparation. A representative sample from each treatment was homogenized in a Waring blender for 1 minute. Two replicates were prepared from each sample. Aliquots of the samples were stored at -80°C until the polyphenols, carotenoids, vitamin C analysis were conducted.

Methodologies. The total antioxidant activity was measured by ferric-reducing antioxidant power as proposed by Benzie and Strain (8). The obtained supernatants were combined and used directly for assay (9). The absorbance was recorded through the use a Tecan Sunrise® plate reader spectrophotometer. Total ascorbic acid (AA+DHAA) was extracted and quantified by HPLC system according to the method of Margolis *et al.* (10), with some modifications (11). Chromatographic separation was carried on a 250 x 4.6 mm Capcell Pak NH2 column (Shiseido, Tokyo, Japan), using ESA series HPLC, equipped an eight-channel coulometric electrode array detector and an ESA coularray operating software that control the equipment and perform data processing (ESA, Chemsford, MA, USA). Phenolics were hydrolyzed to obtain total free forms, and extracted as described by Hertog *et al.* (12). Quantitative analysis was performed using an ESA series (MODEL 580) of HPLC solvent delivery module, an ESA 5600 eight-channel coulometric electrode array detector and an ESA coularray operating software that control the equipment and perform data processing (ESA, Chemsford, MA, USA).

Carotenoids were determined as described by Sharpless *et al.* (13). The extracts were analysed by a Perkin-Elmer ISS 200 series HPLC system. The eluents were methanol/acetonitrile/tetrahydrofuran (50:45:5). The peaks were detected with a variable spectrophotometric detector (Perkin-Elmer LC-95, Norwalk, CO, USA) connected to a personal computer Pe Nelson mod 1020 (Perkin-Elmer). The detection wavelengths was 450 nm for carotenoids (14).

MTT test to evaluate cytotoxicity of phenolic chicory extracts on Caco-2 cells was used. The MTT colorimetric assay determines the ability of viable cells to convert a soluble tetrazolium salt (MTT) into an insoluble formazan precipitate. The ability of cells to reduce MTT provides an indication of mitochondrial integrity and activity which, in turn, may be interpreted as a measure of viability and/or cell number. The assay has therefore been adapted for use with cultures of exponentially growing cells such as the human epithelial colorectal adenocarcinoma cells. Determination of their ability to reduce MTT to the formazan product after exposure to test compounds, enables the relative toxicity of test chemicals to be assessed.

Statistics

Data are given as the mean and standard deviation (SD). Statistical analysis was performed using student's t-test.

Results and discussion

Our study has been focused on quantification of bioactive molecules (vitamins, polyphenols, carotenoids) and on evaluation of antioxidant power of local selected foodstuffs (Table 1). It is important not only levels of phytochemicals in foodstuffs, but the contribution of foodstuffs to dietary intake (7). Detailed consumption data for fruit and vegetables in Italy are in Table 2.

Table 2. The contribution of selected foodstuffs to dietary intake.

	Total			Northwest			Northeast			Centre			South and islands		
Food	Average	SD	% cons.[a]	Average	SD	% cons.[a]	Average	SD	% cons.	Average	SD	% cons.[a]	Average	SD	% cons.[a]
Raw carrots	9.24	16.45	53.08	12.36	19.17	50.09	12.50	18.64	66.11	6.62	14.72	49.37	6.26	12.12	50.85
Potatoes	38.59	38.58	78.01	34.51	35.74	73.48	35.21	35.67	75.63	41.18	41.42	78.84	42.51	40.21	82.84
Vegetables	19.91	32.63	47.62	19.05	30.80	46.10	15.69	29.84	45.38	24.05	34.52	54.91	20.47	34.14	45.75
Apples	52.88	73.82	60.67	62.59	82.33	62.74	58.04	82.82	66.39	45.27	59.47	60.71	46.05	66.95	55.64
Pears	16.87	34.13	30.69	18.09	35.86	29.81	12.28	29.46	25.77	16.19	31.94	30.73	18.75	35.96	34.16
Cherries	3.88	16.08	8.95	1.71	10.40	5.37	1.73	9.91	4.20	5.12	19.03	11.08	6.25	20.11	13.45
Strawberries	3.51	14.00	10.72	3.93	16.55	10.92	3.71	16.28	8.96	3.66	11.84	12.59	2.94	11.05	10.36
Berries	0.61	6.28	1.77	0.26	2.28	1.91	0.31	3.16	1.12	0.14	1.79	0.76	1.39	10.37	2.63

[a] % of people who consumed food in study week.
Data from A. Turrini, A. Saba, D. Perrone, E. Cialfa and A. D'Amicis, Food consumption patterns in Italy: the INN-CA Study 1994-1996. European Journal of Clinical Nutrition 55:571-588 (2001), adapted by Aida Turrini.

In an accurate evaluation of the total antioxidant capacity, the antioxidant properties of single molecules present in a single product, but also the synergic effects of interactions between the different bioactive compounds may be considered. In addition, we have studied the relative contributions of vitamin C and phenolic compounds to the antioxidant potential of fruits and vegetables. In Table 3, the FRAP values have been shown and have been compared to values derived from literature data (9, 15).
The antioxidant capacity often could be linearly correlated with the phenolic content. So we have evaluated the content of most representative molecules in every selected product (Table 4) and we have related it to literature data (16,17, 18, 19, 20).

Fruits
Apple polyphenols have been widely observed; cinnamic acid derivatives, flavonols and anthocyanins, compounds with strong antioxidant activity, have been found mainly in cortex and in skin (21). The FRAP values for apple with peel was 7.65 mmolkg-1 (SD 0.49) and for apple without peel was 4.15 mmolkg-1 (SD 0.07). In particular, the contribution of lipophilic fraction was more than hydrophilic fraction for both apple with peel and apple without peel. According to our results, the value of the total antioxidant power, obtained for apples, should be due to contribution of flavonoids such as quercetin, epicatechin and procyanidin B(2) rather than vitamin C. In addition we have calculated that the percentage

Table 3. Ferric-reducing antioxidant power (FRAP) of selected food extracts.

Region	Food	Mean total (mmol kg^{-1})	SD	Literature data
Abruzzo	Raw carrot	0.93	0.12	1.06[c]
	Cooked carrot	0.8	0.02	
	Apple with peel	7.65	0.49	7.4[c]
	Apple without peel	4.15	0.07	3.23[c]
Calabria	Chicory	20.36	0.08	
	Strawberry (cultivated)	17.79	0.43	22.74[c]
Lazio	Chicory (cultivated)	4.61	0.38	
	Chicory (wild)	7.33	0.36	
	Plums (cultivated)	9.80	0.89	
	Plums (wild)	83.86	14.73	
Lombardia	Strawberry (wild)	62.85	3.23	28.00[c]
	Cherry	18.55	1.91	8.10[c]
Piemonte	Pear with peel	2.9	0.28	5.00[c]
	Pear without peel	1.35	0.07	
	Raw potato[a]	2.6	0	3.67[c]
	Cooked potato[a]	3.95	0.21	
	Raw potato[b]	2.6	0.14	3.67[c]
	Cooked potato[b]	4.4	0.71	
Veneto	Raw potato Rotzo	3.05	0.64	3.67[c]
	Cooked potato Rotzo	4.3	0.14	
	Raspberry	57.7	6.2	43.03[c]

[a] Organic cultivation.
[b] Integrated cultivation.
[c] Data from Pellegrini *et al.* Mol Nutr Food Res 50:1030 – 1038 (2006).
[d] Data from Khanizadeh *et al.* JFAE 5: 61-66 (2007).

Table 4. More representative bioactive molecules of selected local food extract.

Region	Food	Target molecule	Mean (mg kg^{-1})	SD	Literature data mean (mg kg^{-1})
Abruzzo	Raw carrot	α-carotene	47.88	9.28	26.60[a]
		β-carotene	116.83	3.97	85.21[a]
	Cooked carrot	α-carotene	30.63	3.56	28.38[a]
		β-carotene	81.09	7.50	88.31[a]
Calabria	Chicory	chlorogenic acid	24.1	2.31	
	Strawberry (cultivated)	coumaric acid	12.4	0.2	7–27 [b]
		quercetin	31	0.04	22.0-57.11[c]
		kaempferol	15.6	0.59	4.72-21.8[c]
Lazio	Chicory (cultivated)	vitamin C	4.43	0.69	
	Chicory (wild)	vitamin C	9.21	0.95	
Lazio	Plums (cultivated)	β-carotene	5.28	1.02	
		vitamin C	34.09	4.37	30-100[f]
	Plums (wild)	β-carotene	7.54	1.11	
		vitamin C	56.09	2.69	30-100[f]
Lombardia	Strawberry (wild)	coumaric acid	8	0.31	7–27 [b]
		quercetin	24.6	0.45	22.0-57.11[c]
		kaempferol	33.8	0.97	4.72-21.8[c]
	Cherry	vitamin C	229.2	0.76	184[d]
Veneto	Raspberry	vitamin C	222.1	1.34	152.9[e]

[a] Data from Hart and Scott, Food Chemistry 54 (1):101–111(1995).
[b] Data from Prior, *et al.* J. Agric Food Chem 46: 2686–2693 (1998).
[c] Data from Cordenunsi *et al.* J Agric Food Chem 50:2581–2586 (2002).
[d] Data from Jacob *et al.* J Nutr 133: 1826–1829 (2003).
[e] Data from Oregon Raspberry and Blackberry Commission.
[f] Data from GIL *et al.* J. Agric. Food Chem., 50: 4976–4982 (2002).

of decreasing from apple with peel to apple without peel was 46 percent. For example, in the study of Chinnici *et al.* (22), a strong divergence between the flavonol values obtained for apple peels and pulp was noticed: quercitrin (94.00 mgkg-1 (SD 36.00) of fresh wt peels to 7.76 mgkg-1 (SD 1.95) of fresh/wt pools), reynoutrin (48.9 mgkg-1 (SD 16.20) of fresh wt peels to 1.98 mgkg-1 (SD 0.50) fresh/wt pools), avicularin (110.00 mgkg-1 (SD 32.90) of fresh/wt peels to 2.27 mgkg-1 (SD 0.46 fresh/wt pools).

For Aprica's cherries, the FRAP value 18.55 mmolkg-1 (SD 1.91) was higher than the literature data (16). In addition the contribution to value of lipophilic fraction and hydrophilic fraction were respectively 8.69 mmolkg-1 (SD 1.12) and 9.87 mmolkg-1 (SD 0.81).

For Aprica's cherries vitamin C concentration reached 0.22 g kg-1 (SD 0.76). The activities of phenoloxidase and ascorbic acid oxidase enzymes during storage contributed to the total content of ascorbic acid (23). Relevant levels of anthocyanins and ascorbic acid (AA) were found in the juice produced from blackcurrants, elderberries, sour cherries (24). Therefore, it is interesting to compare the vitamin C content to the values found for total antioxidant capacity. The percentage contribution of AA to the total antioxidant capacity (FRAP value) was 14 percent. TAC of cherry should be tightly correlated to vitamin C content.

Wild strawberries presented more efficiency in the

FRAP value than literature data 62.85 mmolkg-1 (SD 3.32), while for cultivated strawberries 17.79 mmolkg-1 (SD 0.43) (Table 3), FRAP values are less than literature data (9). Recent studies have shown the correlation between the phenolic constituents and antioxidative (25) and anticarcinogenic (26) properties of berries, as strawberries and berries of the genus Vaccinium. p-Coumaric acid derivatives, ellagic acid, quercetin 3-O-glycoside, and kaempferol 3-O-glycoside were detected (27,28,29). The occurrence of p-coumaroylglucose, quercetin 3-glucoside, quercetin 3-glucuronide, kaempferol 3-glucoside, and kaempferol 3-glucuronide was reported in strawberries and ellagic acid was also described as an important phenolic constituent of this fruit (30). These bioactive molecules were selected for their proposed health promoting effects as antioxidants and anticarcinogens (31). Compared to literature data, wild strawberries (from Lombardia) show an antioxidant power higher and p-Coumaric, quercetin and kaempferol content, too. So, the high content of bioactive molecules and the high antioxidant power value demonstrated as strawberries of "Aprìca" should be seen as ecotype representing a quality cultivation. Moreover, in the study of Häkkinen (32), varietal differences were observed in the contents of flavonols and phenolic acids among six strawberry and four blueberry cultivars studied. Scalzo *et al.* (33), analysing both wild and cultivated strawberries, as indicated by the Trolox Equivalent Antioxidant Capacity (TEAC), found antioxidant activities of wild strawberries higher than cultivated strawberries (34). From elucidation of specific flavonol glycosides in cranberry, quercetin-3-arabinoside was found in both furanose and pyranose forms in cranberry (35). Strawberries contain high levels of antioxidants. Phenolic phytochemicals probably play a large role than previously thought in total antioxidant activity (36).

Wild plums (from Lazio) showed significantly higher FRAP value (83.36±14.73 mmol kg-1) than cultivated ones (9.08±0.89 mmol kg-1). In recent years antioxidant activity and the content of total phenolic compounds of several plum cultivars have been investigated in order to suggest plum varieties rich in antioxidants, which may possibly exert beneficial effects on human health. Gil *et al*. (2002) have found close correlations between antioxidant capacities and both the anthocyanins and total phenolics content (37).

The contributions of phenolic compounds to antioxidant activity were much higher than those of vitamin C and carotenoids. In Table 4 observed β-carotene content was 7.54 mg kg-1 (SD 1.11) and 5.2 mg kg-1 (SD 1.02) in wild and cultivated plums respectively, while ascorbic acid content was 56.96 mg kg-1 (SD 2.69) and 34.09 mg kg-1 (SD 4.37) respectively for wild and cultivated plums.

From our data reported in Table 3, FRAP value for pear with peel was 2.90 mmolkg-1 (SD 0.28) and for pear without peel was 1.35 mmolkg-1 (SD 0.07). In addition we have calculated that the percentage of decreasing from pear with peel to pear without is 53 percent. Leontowicz *et al*. observed a strong divergence between pear skin and pear pulp (38). In fact, in several studies, the antioxidant levels were found to be higher in the skin than in the pulp. Finally, the main phenolics found in pear are leucocyanidin, catechin, epicatechin, chlorogenic acid, quercitrin and quercetin (39). The total antioxidant activity expressed as FRAP value was found to be 57.70 mmol/kg (SD 6.20); in particular, the contribution to value of lipophilic fraction and hydrophilic fraction were respectively 43.00 mmol/kg (SD 7.55) and 14.64 mmol/kg (SD 1.36). The high contribution to antioxidant activity is attributed to higher content of total phenolics, flavonoids, and anthocyanins in red raspberry fruits (40). Vitamin C contributes only 4.3 percent of the total antioxidant activity (41).

Vegetables

Comparing the results obtained in this work with those found in literature, no differences for antioxidant capacity were recorded in raw and cooked carrots (8). The percentage of decreasing was found to be 14 percent. Carotenoids are the main representative antioxidant molecules of this vegetable: β-carotene (60–80%), α-carotene (10–40%), lutein (1–5%) and the other minor carotenoids (0.1–1%)(42). α-carotene and β-carotene levels decreased after boiling: the percentages of decreasing were found to be 0.36% and 0.31% for α-carotene and for β-carotene respectively. In these agricultural ecotypes α-carotene and β-carotene values are higher than those shown in literature data (17). In addition β-carotene values were higher than α-carotene for both raw and cooked carrots (43).

Chicory represents a main source of micronutrients: in fact, it easily grows year-round, due to its ability to resist to high temperatures. It should be an interesting and cheap source of antioxidant phenolic extracts. The chicory (from Calabria) FRAP value observed was higher 20.36 mmolkg-1 (SD 0.08), than the value 6.72 mmolkg-1 reported in literature and the observed value in chicory from Lazio (4.43 and 9.21 mmolkg-1 respectively for wild and cultivated chicory): this could suggest a better benefit power for the human health. The results obtained indicate that chicory could be a remarkable source of antioxidants (44). The main representative compound of chicory was found to be the chlorogenic acid 24.1 mg kg-1 (SD 2.31). To improve the quality of chicory ecotypes, the phenolic content and composition of different chicory varieties have been previously investigated considering the influence of variety, processing and storage on this composition (45). In addition differences between the way of cooking were observed in chicory from Lazio (Figure 1):

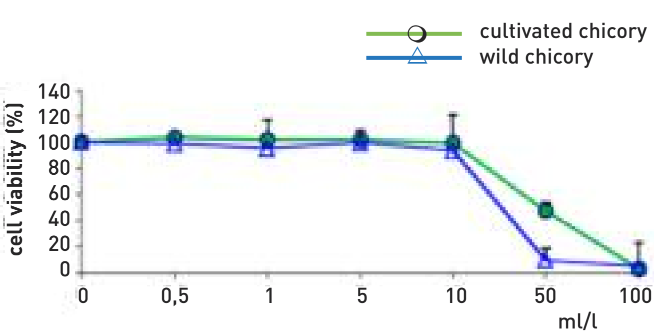

Figure 1. Effect of cultivated and wild chicory extracts on CaCo-2 viability.

lutein and β-carotene values were significant higher in pan-fried product than fresh product (P←0.02 and P←0.05 respectively) for cultivated chicory, while significantly higher values of β-carotene were observed in boiled wild chicory than wild fresh (P←0.05) and lutein was significantly higher in wild fresh than wild pan-fried chicory (P←0.02). This could be due to the greater extractability of carotenoids after cooking, while their their low contribution to total antioxidant capacity is enhanced by higher values of TAC in both wild and cultivated fresh chicory.

In potatoes, a slight increase in the FRAP values was observed after cooking. The percentage range of increasing was found to be 41–70 percent. Indeed the increase of reducing power may be correlated to release of glucosydes from food matrix after cooking (Table 3). After cooking, potato varieties differ in antioxidant values from each other, while antioxidant levels do not change in fresh potatoes. The very low values of antioxidant activity were found in watery vegetables such as potato, marrow and cucumber. In addition, the chemical components of the potato and interactions occurring during cooking, influenced the quality of potatoes and the texture of the cooked tubers (46). No remarkable differences were found in antioxidant activity between the several varieties of potatoes.

Bioactivity test

Regarding potential bioactivities, the chicory extracts seem to cause a high cytotoxicity in human epithelial colorectal adenocarcinoma cells (caco-2) by reducing cell viability to values lower than 10 percent. The results indicate that the polyphenolic extract of wild chicory possesses a marked cytotoxicity compared to cultivated chicory reducing cell viability lower than 10 percent using 50 ml/l of the extract (Figure 2).

Conclusion

Our findings show that local products have a distinctive and unique nutritional value. Their antioxidant

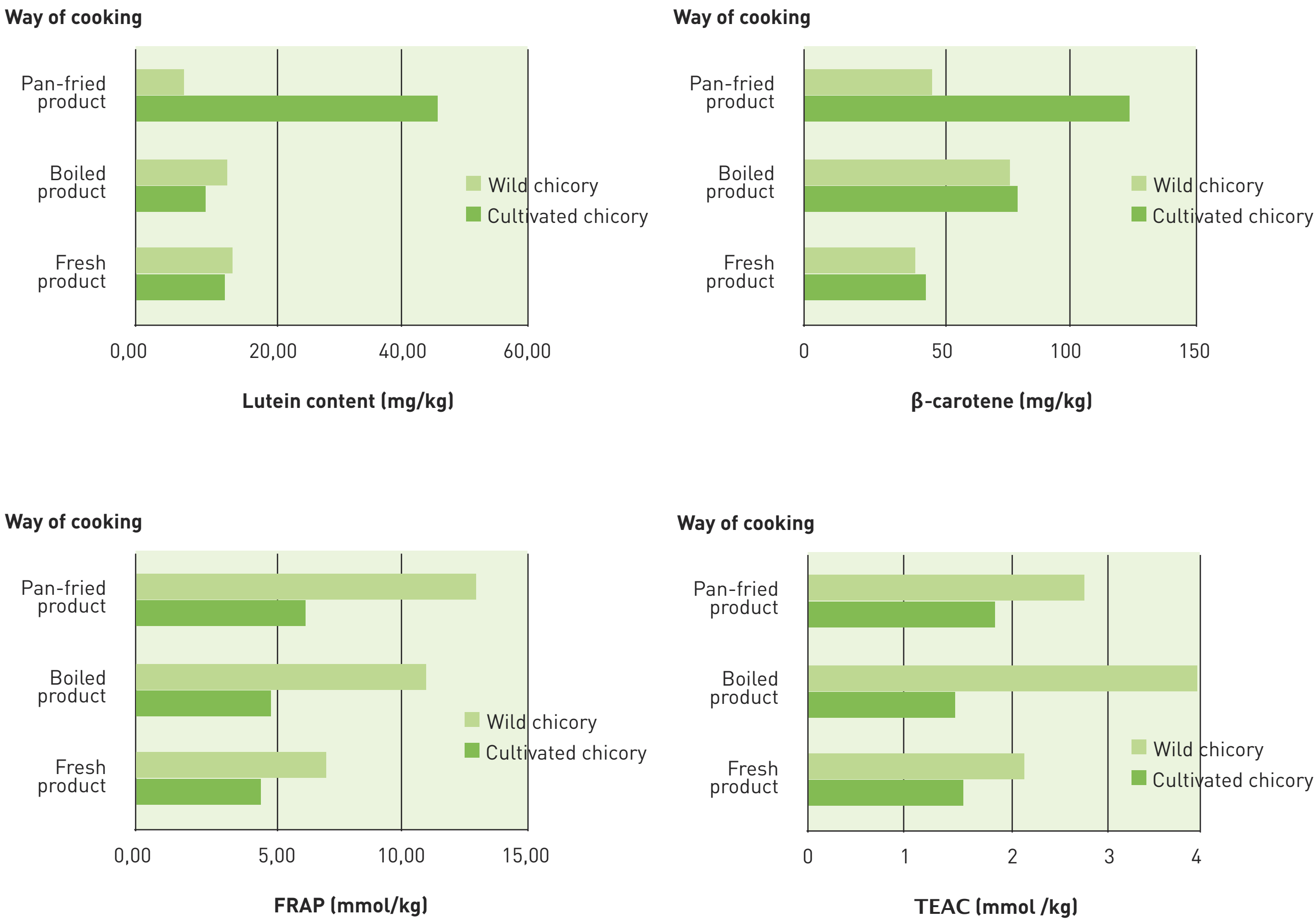

Figure 2. Effect of way of cooking on bioactive molecules and total antioxidant capacity in cultivated and wild chicory from Lazio.

levels and their bioactivity could indicate a better potential for health. Several antioxidant capacities for Valtellina typical foodstuffs appear to have higher values compared to literature data. A strong difference has been obtained for cherries of "Aprìca". Chicory (from Calabria and Lazio) represents an important source of micronutrients, that give to this vegetable a resistance to cold temperatures, consenting growth of the plant during all year. It needs to be underlined that wild chicory appears to have higher phytochemicals and its extracts seem to exert cytotoxicity in human epithelial colorectal adenocarcinoma cell (caco-2) and so promoting good health and preventing or modulating diseases.

Our data highlight the direct linkages between biophysical attributes of location and agricultural potential to improve crop growth models. On this basis the typical local production mostly in terms of quality and safety of the products should become a base for maintaining a correct nutritional plane. In addition, the conservation and valorization of local/traditional products could increase the adoption of more sustainable agricultural systems together with the adoption of practices more respective of the environments and the natural habitats.

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ORGANIC FARMING: SUSTAINABILITY, BIODIVERSITY AND DIETS

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Abstract

The current agrofood system is one of the most responsible for the ecosystem degradation, in particular, the biodiversity loss. Moreover, it has proved to be unable to addres hunger and malnutrition. Biodiversity in the food systems is absolutely crucial for both a sustainable food production and food security. Diets based on different food species promote health by addressing the problem of micronutrient and vitamin deficiencies. Therefore, it seems that the transition towards sustainable forms of agriculture cannot be deferred further.

The organic food production is seen having the potential to contribute substantially to the global food supply and reduce the environmental impact of the conventional agriculture.

This paper summarizes the evidence present in the scientific literature on these subjects and offers insights into the links between organic food production, sustainability, biodiversity and healthy diets.

Introduction

The current globalized food system is one of the most responsible for the ecosystem degradation. Agriculture alone contributes about 13 percent to the global human-induced greenhouse gas emissions, but this rate increases ranging from 17 to 32 percent if the indirect emissions (fertilizers production and distribution, farm operations, land conversion to agriculture) are included (Bellarby *et al.*, 2008). Therefore, the so-called "industrial agriculture" based on the adoption of large-scale farming systems, on the massive use of fertilizers, that needs high energy inputs to have high yields and to maintain a constant level of production, is widely considered no longer sustainable. Overall, if one takes into account that it failed to address hunger and malnutrition.

Currently, it is widely accepted that facing the dual challenge of achieving food security and reducing the environmental impact of food production, it is necessary to take steps of transition towards sustainable forms of agriculture (Hoffmann, 2011).

Organic farming and sustainability

Interest in organic production has grown appreciably over the last few decades in the world (Willer and Kilcher, 2011). According to EC Reg. No. 834/2007, organic production is defined as: "…an overall system of farm management and food production that combines the best environmental practices, a high level of biodiversity, the preservation of natural resources, the application of high animal welfare standards and a production method in line with the preferences of certain consumers for products produced using natural substances and processes".

Organic management practices exclude such conventional inputs as synthetic pesticides and fertilizers, instead putting the emphasis on building up the soil with compost additions and animal and green manures, controlling pests naturally, rotating crops and diversifying crops and livestock.

Organic agriculture is generally considered as having a lower environmental impact than conventional agriculture. According to Hoffmann (2011), a conversion to organic agriculture could significantly reduce the greenhouse gas (GHG) emissions (reduction of the use of industrial nitrogen-fertilizer and of the soil-based N2O emissions). However, an examination of the scientific literature demonstrates that the lower environmental impact of organic agriculture is true for many foods but not for all, and not for all the classes of environmental impact. (Foster *et al.*, 2006). An energy analysis carried out at the Rodale Institute showed a 33 percent reduction in fossil-fuel use for organic farming systems in comparison with the equivalent conventional ones (Pimentel, 2005). Fewer energy input requirements have been observed for the organic production of wheat, beef, sheep and pork meat, oil seed rape, milk (Foster *et al.*, 2006; Williams *et al.*, 2006); whereas the energy inputs were higher for organic poultry meat and eggs. No difference was observed, instead, between organic and conventional potato production (Foster *et al.*, 2006).

In terms of land use, organic production generally requires substantially more farmland than the conventional one (Cederberg and Mattsson, 2000; Foster *et al.*, 2006).

On the other hand, organic agriculture has a significant ability to sequester large amounts of atmospheric carbon into the soil (Hepperly *et al.*, 2007), thus contributing to counteracting greenhouse gases. Therefore, carbon sequestration of organic farming is crucial in assessing the environmental impact (Niggli *et al.*, 2008).

Leaching of nutrients, nitrogen in particular, is responsible for much of the environmental damage caused to many ecosystems by intensive agriculture (Hansen *et al.*, 2001). In organic production only organic fertilizers can be used to supply the soil with nitrogen. From the scientific literature, the nitrogen leaching in organic farming results lower than that occurring in conventional agriculture (Knudsen *et al.*, 2006; Hansen *et al.*, 2001). However, nitrogen leaching depends not only on the type of fertilizer used, but also on the management practices (Knudsen *et al.*, 2006). In fact, the mineralization of organic fertilizers is slow and problems with the supply of nitrogen can occur, particularly when the demands of the plants are high (Kelderer *et al.*, 2008).

The lower yields generally observed in the organic crop production are ascribed to the limited availability of nitrogen in the organic systems (Doltra *et al.,* 2011). By an efficient and careful management of the nutrient supply to the plants, it is possible to counterbalance the negative effects on the yields (Doltra *et al.*, 2011; Crews and Peoples, 2004; Hansen *et al.*, 2001; Pang and Letey, 2000). Mader *et al.* (2002) reported a reduction of only 20 percent of the yield of grain crops in organic systems, although the fertilizer input was reduced by 34–53 percent. Pimentel *et al.* (2005) reported yields in organic maize and soybean comparable to those of conventional production, suggesting that organic crop production can be competitive with conventional faming.

Organic farming and biodiversity

Agricultural biodiversity (agrobiodiversity) is fundamental to agricultural production, food security and environment conservation. Agrobiodiversity, in fact, includes a wide variety of species and genetic resources and also the ways in which the farmers can exploit them to produce and manage crops, land, water, insects and biota (Thrupp, 2000). Agricultural biodiversity, moreover, provides ecosystem services on farm, such as pollination, fertility enhancement, insect and disease management. Over the last 40 years the model and patterns of industrial agriculture have caused serious degradation of natural resources and, in particular, biodiversity: loss of plant genetic resources, livestock, insect and soil organisms. The erosion of biodiversity is manifested both within farming systems and off farms, in natural habitats.

A principal objective of organic farming is to maintain, to enhance the natural fertility of the soil. Organic farming systems which involve the use of catch crops, the recycling of crop residues, the use of organic fertilizers and perennial crops, are assumed to promote higher levels of organic matter and biological activity in the soil (number and variety of soil organisms). Microorganisms, like bacteria or fungi, play a central role in maintaining the fertility of the soil through the decomposition of organic matter. Several studies have demonstrated an increase in the biodiversity, biological activity and fertility in the soil managed by organic systems (Bengtsson *et al.*, 2005; Pimentel *et al.*, 2005; Mader *et al.*, 2002). Moreover, in organic farms it has been observed a higher diversity and abundance of birds, pollinator, insect and herbaceous plants (Holzschuh *et al.*, 2008; Rundlöf *et al.*, 2008a; Rundlöf *et al.*, 2008b; Holzschuh *et al.*, 2007) than in conventional ones.

However, Gabriel *et al.* (2010) have demonstrated that within a farm biodiversity is influenced by both management within the farm and management of surrounding farms, thus highlighting the crucial role of the landscape. Belfrage *et al.* (2005) compared diversity and abundance of birds, butterflies, bumblebees and herbaceous plants between organic and conventional farms of different sizes. They found more bird species, butterflies, herbaceous plant species, and bumblebees on the small farms compared to the large farms. The largest differences were found between the small organic and large conventional farms. However, differences were also noted between small and large organic farms: This study introduces the aspect of the farm size as a co-factor contributing to the higher biodiversity in organic farms, and the small size farms seem to behave better in terms of biodiversity than the larger ones.

Clearly, the farm size per se does not affect biodiversity. However, it is possible to state that the biodiversity results are affected by the different farm regimes and management practices that different farm sizes require.

Organic farming and sustainable diets

Fruit and vegetables contain health-related compounds, such as vitamins, dietetic fibre, antioxidants (ascorbic acid, phenolic compounds, carotenoids) whose consumption can positively contribute to human health by reducing the risk of cardiovascular and degenerative diseases (Béliveau and Gingras, 2007; Bazzano *et al.*, 2002; Ness and Powles, 1997). For these reasons, the dietary patterns grounded on scientific evidence encourage the consumption of fruit and vegetables and suggest to reduce the frequency of the consumption of meat. One of the most known dietary patterns is the so-called "Mediterranean diet", that recently has been recognized by UNESCO as an intangible heritage of humanity. The Mediterranean diet promotes the consumption of plant products typical of the countries of the Mediterranean Basin such as olive oil, cereals, legumes, fruit and vegetables.

It has been demonstrated that encouraging individuals to consume less meat and more plant-based foods may be also a measure to increase the sustainability and reduce the environmental costs of food production systems. In fact, the production of animal food has a higher global warming potential (GWP) than that of plant food (Moresi and Valentini, 2010; Duchin, 2005; Carlsson-Kanyama *et al.*, 2003; Rejinders and Soret, 2003) and needs higher arable surface than plant food production (Brandão, 2008). From a comparison between different dietary patterns combined with different production systems it resulted that: i) within the same method of production, a greater consumption of animal products translates to a greater impact on the environment; ii) within the same dietary pattern, conventional production methods have a greater environmental impact than organic methods (Baroni *et al.*, 2006).

On the whole, the evidence seems to support the opportunity of educating people, mainly in western countries, to shift their eating habits towards the increase of direct consumption of plant foods to protect their own health and the environment.

Consumer awareness of the environmental impact of the food system has increased in recent decades, thus leading to an expansion of the organic food sector (Willer and Kilcher, 2011). Consumers purchasing organic food demonstrate to have an attitude towards health (Tjärnemo and Ekelund, 2004), environment quality, food safety (Loureiro *et al.*, 2001), ethical values (animal rights) (Honkanen *et al.*, 2006). It has been suggested the existence of a potential relation between organic food and vegetarianism. The ecological motivations underlying organic food choice and vegetarian diet choice are quite similar (Honkanen *et al.*, 2006).

Consumer studies have shown that among the multiple reasons for organic preference, the belief that the organic foods are healthier than the conventional ones is one of the most important (Shepherd *et al.*, 2005). A number of studies have been published during the last two decades comparing the nutritional quality of conventionally and organically produced fruit and vegetables. It is known that crop management can affect the composition of plant material (Bourn and Prescott, 2002). Different theories have been put forward to describe the mechanisms on which the organic production system could affect the nutritional value and the content of health-related compounds (Brandt and Molgaard, 2001). However, the research on this aspect is not conclusive and only some trends have been individuated: a higher content of vitamin C, dry matter, phosphorus, titratable acidity, phenols (antioxidant) and less of nitrates in organic fruit and vegetables in comparison with conventional ones (Lairon, 2009; Bourn and Prescott, 2002; Brandt and Molgaard, 2001). The interpretation of the results of the investigations published in the scientific literature is difficult, because of methodological differences related to cultivar selection, growing conditions, sampling and analytical methods.

Most of these studies fail in describing the field experiment design and represent only one seasonal harvest. In a recently published systematic review, in which the authors adopted a series of criteria to select the comparative studies conducted over the past 50 years, only a higher content of phosphorus and values of titratable acidity in the organic products were confirmed (Dangour *et al.*, 2009). This shows that further research is needed on this subject before conclusively stating if differences exist in the nutritional quality between organically and conventionally grown fruit and vegetables.

In the decade 1999–2009 the organic agricultural land has increased from 11 million to 37.2 million ha. Australia, Argentina, the United States, China and Brazil are the countries with the most organic agricultural land. However, if the share of the organic agricultural land out of the total agricultural land is considered, small countries such as Falkland, Liechtenstein, Austria, Switzerland hold the first positions in the world. The countries with the largest numbers of organic producers are India, Uganda, Mexico, Ethiopia, Tanzania. In these countries the average farm size is low, and the conversion to organic agriculture could represent a quite easy option to the small farmers, because they are used to producing more or less "organic", with little or no application of chemical inputs.

The role of small-size farms is fundamental in preserving and enhancing biodiversity. Worldwide small farmers are those who generally practise high-diversity agriculture, both in terms of cultivated crops and varieties of a single crop. This practice is necessary also to increase food security, because it provides more options to cope with pests and diseases. Generally, the small farmers cultivate local varieties of a crop, because well adapted to local conditions and able to resist or tolerate the typical diseases of the crop.

Promoting this high diversity of crops and varieties has doubtless positive effects on human health. Fruit and vegetables have a fundamental role in diet, because they are the main natural sources of micronutrients, dietary fibre, bioactive compounds. Many factors can affect the nutritional content of horticultural crops, including climate, geography, soil, fertilization, but the differences between varieties are often by far more relevant. Interestingly, the nutrient content of the less-known cultivars and wild varieties has often resulted higher than that of the widely-cultivated cultivars, thus suggesting the need of compositional researches to characterize these products and providing data useful for their protection and use (Lutaladio *et al.*, 2010). The market where small farmers can sell their products is different from that of the large-size farms.

These latter select the crop and varieties to cultivate in a way to match the standards fixed and the amount demanded by the organized distribution chains. Instead, the final destination of the products from small-size farms is mainly represented by the local markets or the so-called short food supply chain, such as farmers' markets or other forms of direct selling from the producer to the consumer. These short supply chains are gaining more and more interest among consumers in western countries, thus creating a new relationship between agricultural and urban worlds. The organic small farms often find the commercial outlet for their products in this kind of market (Böhnert and Nill, 2006).

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MEDITERRANEAN DIET: AN INTEGRATED VIEW

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Abstract

Malnutrition, in its two contradictory aspects concerning undernutrition and unbalanced overnutrition, is becoming one of the main threats to the worldwide population. This calls for a radical change on how food is daily produced, thought and managed. New food behaviours are to be developed, proposed and disseminated in order to actively combat both hunger and the growing phenomenon of obesity in the framework of sustainable food systems. In this context, the Mediterranean diet represents a very effective model of sustainable diet. Characterized by a healthy nutritional model, rich in olive oil, whole grains, fish, fruits and vegetables and (a little) wine, the Mediterranean diets are based on respect for the territory and on activities performed by local communities including crop harvesting, fishing, conservation, processing, preparation and consumption of food. One of the main peculiarities of the Mediterranean diets is the relevance of biodiversity. The Mediterranean Basin has a high heterogeneity of cultures and a high biodiversity. Epidemiological studies have drawn attention to certain traditional Mediterranean diets which present a high variety of plant- and animal-derived foods that favour better nutritional conditions. Scientific investigation on this kind of diet and more generally on sustainable food systems and diet requires a new holistic vision of research and innovation, based on a pro-active and very participative approach involving stakeholders. This also requires to strongly support independent and transparent research and innovation, open to the public and not subject to economic speculation in order to appropriately respond to the big worldwide questions about the food.

1. Introduction

Food security represents a multifaceted issue gripping the world, intimately linked to the big challenges humanity faces in the coming years. Proper food production and supply as well as correct and balanced diets for all are crucial and closely associated to a new ecological vision of development based on sustainability principles. Malnutrition, in its two contradictory aspects concerning undernutrition and unbalanced overnutrition, is dramatically rising, becoming one of the main threats to the worldwide population. Often coexisting in the same geographical area, it is the result of different food habits, among different social status and between old and new generations. The World Health Organization refers that 35 million of the 43 million overweight children live in developing countries, mainly in Asia but the fastest growth rates are registering in Africa (De Onis *et al.*, 2010). The contradiction more shocking is that, at the same time, hungry and undernourished are rising worldwide. According to the recent estimate of the UN Food and Agriculture Organization (FAO, 2009; UNEP, 2009), between 1990 and 2000, the number of people that live with insufficient food has increased by 34 million only in sub-Saharan Africa. In this way, food insecurity and undernourishment are now present in different countries in the world as well as conditions of overweight and obesity and vitamin and mineral deficiencies. It should be noted that, over the past two decades, food trade liberalization policy has generated dramatic implications for health, facilitating the "nutrition transition" towards unsustainable models (Kearney, 2010). Going back in the time, it should also highlight that the so-called "green revolution", while helping to reduce world hunger, has also produced significant negative impacts on the environment. The productivity of the main agriculture crops increased up to 4–5 times (Conway, 1997; Tilman *et al.*, 2002; Pimentel and Pimentel, 2008), but the consequences were very high on soil (Shiva, 2002), biodiversity, energy input use (Pimentel and Pimentel, 2008), water use (Molden, 2007), negatively impacting, among others, traditional rural livelihoods, indigenous and local cultures, accelerating indebtedness among millions of farmers and separating them from lands that have historically fed communities and families. In more recent years, the fluctuations and increases in oil and commodities prices have increased food insecurity and inequalities, with a progressive lack of access to land or to agricultural resources. Meanwhile, the actual intensive production system is also increasing alienation of peoples from nature and the historical, cultural and natural connection of farmers. Finally, it is to consider that, over the next decades, the world's population is expected to grow from 6.8 billion in 2008 (medium estimates) to 8.3 billion by 2030, and to 9.2 billion by 2050 (UNEP, 2009). The question is how to feed a growing population in a world having less soil, less water and energy. The answer can only be found in a sustainable model of production and distribution and in an appropriate public policy that makes it possible. This includes prioritizing the procurement of public goods in public spending; investing in knowledge providing adequate support to research and innovation; fostering forms of social organization that encourage partnerships, including farmer field schools and farmers' movements innovation networks; sustaining empowering women and creating a macro-economic enabling to connect sustainable farms to fair markets (UN, 2010). All the above considerations call for a radical change on how food is daily produced, thought and managed (Worldwatch Institute, 2011). New dietary behaviours are to be developed, proposed and disseminated (Nestlè, 2006; Pollan, 2010) in order to actively combat both hunger and the growing phenomenon of obesity. At the same time, it is to strongly emphasize the indissoluble linkage between ecosystems protection and fairness issues in the world. Environmental justice necessarily requires social equity and respect to the human rights among all the social groups and societies, from present and future generations. The most political act we do on a daily basis is choosing what to eat.

2. Towards sustainable food systems

The whole food chain has to be considered for moving to a real sustainable food system, starting from primary producer for arriving to the final consumer, assuring any health precaution in each step. The intimate connection among food, health and sustainable development has been well formulated by the American Public Health Association in a major policy statement (American Public Health Aassociation, 2007). Similarly, the American Dietetic Association, in its position statement, encourages environmentally responsible practices for supporting ecological sustainability of the food system (American Dietetic Association, 2007). A "sustainable food system" is "one that provides healthy food to meet current food needs while maintaining healthy ecosystems that can also provide food for generations to come with minimal negative impact to the environment. A sustainable food system also encourages local production and distribution infrastructures and makes nutritious food available, accessible, and affordable to all. Further, it is humane and just, protecting farmers and other workers, consumers, and communities" (American Public Health Association, 2007).

In this regard, it has to be remarked the convergence of the "food security" concept with that of "sustainable food system", proposed by the Sustainable Development Commission (SDC) of the United Kingdom Government that suggested a new definition of food security in terms of "genuinely sustainable food systems where the core goal is to feed everyone sustainably, equitably and healthily; which addresses needs for availability, affordability and accessibility; which is diverse, ecologically-sound and resilient; which builds the capabilities and skills necessary for future generations" (Sustainable Development Commission, 2009). Within the framework of a sustainable food system, sustainable diets assume a central role. According to FAO, sustainable diets are defined as "those diets with low environmental impacts which contribute to food and nutrition security and to healthy life for present and future generations.

Sustainable diets are protective and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable; nutritionally adequate, safe and healthy; while optimizing natural and human resources" (FAO, 2010). Closely linked to the mentioned issues, the cultural aspects of food are highly significant. Unfortunately, food systems and related diet are facing a process of cultural homogenization and standardization. For years, indeed, conservation of different traditional cultures and knowledge were not enough considered in public policies.

Mainly in urban places, people rarely know cultural and environmental meaning of what they eat and do not usually think about the food chain and how food is produced and prepared. On the contrary, it should be affirmed that eating cannot be relegated to the mere act of taking food but it also represents the way that populations spread their selves through the environment (Murrieta *et al.*, 1999). In other words, it has to be recognized the close connection of food with space and time with a proper specific identity.

Sustainable diet calls also for following healthy lifestyle and reassigning to the food its close linkage with seasonality. Local ways of livelihood have been viewed as possible solutions, like using local production, spreading regional culinary cultures and traditions, supporting traditional trades (e.g. fishermen, shepherds, butchers, sausage makers, bakers) and encouraging people in re-dignifying the act of eating. In a global perspective, this represents a valid contribution to face the challenge of food security. It is indeed not thinkable ensuring global access to food without supporting peoples in choosing their own production and farming systems.

For a world with environmental and social justice, one should foster the capacity of governance in basal communities, leading to assert the importance of "food sovereignty" defined as the right of peoples and sovereign states to democratically determine their own agricultural and food policies (International Assessment of Agricultural Knowledge, Science and Technology for Development, 2008).

Another aspect to be considered is the occasion of conviviality connected with the eating act. Conviviality is described as being synonymous with empathy "which alone can establish knowledge of other minds" (Polanyi, 1958), sharing of a certain kind of food and/or drink, reinforcing the positive feeling of togetherness on which the community's awareness of its identity is based (Schechter, 2004).

The mentioned very interconnected considerations need to be assembled and recomposed in a well-ordered coherent way, for defining and implementing suitable policies addressed to support sustainable food systems. Similarly, effective sustainable food systems and diet models are useful for transposing in practice the above conceptual schemes.

3. The global value of the Mediterranean diet model

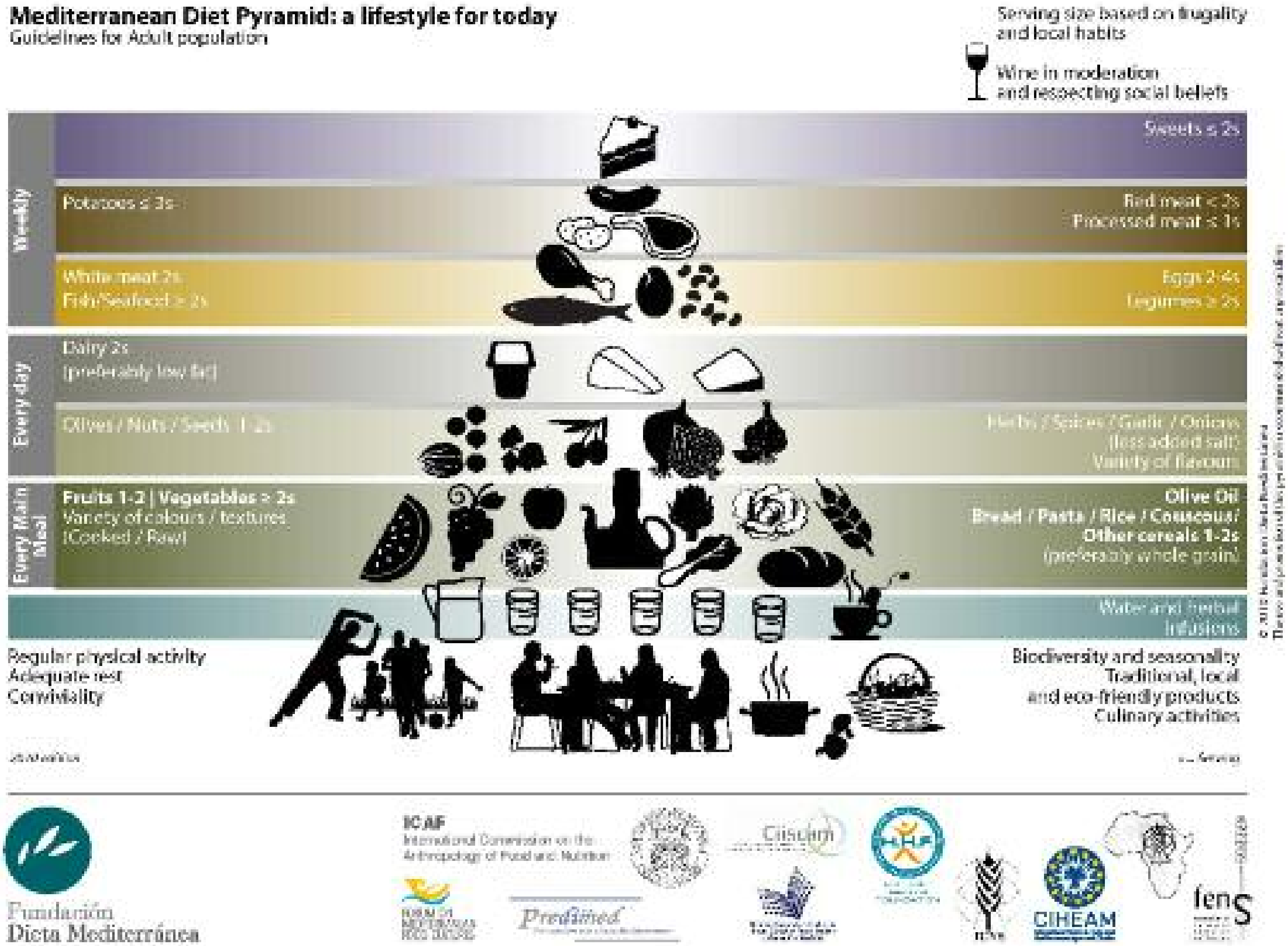
3.1 General remarks

UNESCO inscribed in 2010 the Mediterranean diet on the Representative List of the Intangible Cultural Heritage of Humanity, being recognized the importance of maintaining the healthy aspects, the good practices and traditions related to this diet as well as its peculiar cultural diversity in the face of growing globalization. This helps intercultural dialogue, and encourages mutual respect for other ways of life, taking into account that the importance of intangible cultural heritage lies in the wealth of knowledge and skills that is transmitted through it from one generation to the next.

The reason why the Mediterranean diet can be actually considered as a very effective model is that it proposes a food system scheme based on sustainability, collecting the mentioned aspects and able to contribute in pursuing real food security.

The system is characterized by a healthy nutritional model, which consists mainly of olive oil, cereals, fruit, fresh or dried, and vegetables, moderate amounts of fish, dairy products and meat, whole

Figure 1. Mediterranean Diet Pyramid



grains, many condiments and spices accompanied by wine or teas, always respecting the traditions of each community (Figure 1).

These are common characteristics, but there are many different Mediterranean diets. A famous cookbook, "Eat well and stay well" by Ancel and Margaret Keys makes it known to the United States which is exported to Europe and worldwide (Keys and Keys, 1959). Prof. Keys, after a long-term study in seven countries concluded that we should cut down drastically on saturated fat and meat and turn to vegetable oils and fresh fruit and vegetables instead in order to have lower rates of heart disease, diabetes and depression. His fortune in the second half of the twentieth century is explained by the gastronomic tourism and the development of olive cultivation and production in California and Australia. It is the effect of habits, tastes, knowledge that is confronting scramble and recompose transposed (Capatti *et al.*, 2003). The Mediterranean diets are based on the respect for the territory and biodiversity (Figures 2, 3 and 4) and on activities performed by local communities including crop harvesting, fishing, conservation, processing, preparation and consumption of food, following traditional recipes and the way and context of eating them (Serra-Majem *et al.*, 2006). They promote social interaction by communal meals and emphasize the relevant position of women that play an important role in transmitting expertise and traditional gestures as well as

Figure 2. Secular olive cultivation in Mallorca Island (Spain). Photo by Migliorini.

Figure 3. Organic cultivation of old varieties of common wheat. Photo by Migliorini.

Figure 4. *Vitis vinifera* (Zibibbo cv.) cultivated in Pantelleria Island. Photo by Carimi.

in safeguarding ancient techniques. For confirming its global value, it is also to consider that Mediterranean does not represent only a geographic dimension but a build-up of knowledge that trace historical human events. In this context at European and global level, Italy appears as an ideal reference country for the sustainable diet model because of its production of high quality and typical in all regions, its climate, the richness and diversity of its ecosystems, the type and variety of its products, its large agro-food and gastronomic traditions.

3.2 The crucial role of biodiversity conservation

During the past decade the concept of biodiversity has passed from the sphere of academic authorities to the growing attention of public opinion that considers its defence as an important issue for sustainable development. A promising approach for dealing with this theme, is to identify "biodiversity hot spots", or areas featuring exceptional concentrations of endemic species and experiencing exceptional loss of habitat. One key hot spot, the Mediterranean Basin, should be considered as a hyper-hot candidate for conservation support in light of its exceptional total (13 000) of endemic plants (Myers *et al.*, 2000). There is growing attention to the implications of cultivated biodiversity loss, affecting the livelihoods of resource-poor farmers and threatening the future prospective of agricultural developments (Tripp and van der Heide, 1996). The replacement of traditional landraces of major crops with modern cultivars had practically been completed when, in the 1970s, the green revolution in the developing world started (van de Wouw *et al.*, 2009). It is estimated that over 7 000 plant species used for food can be found across the world (Bioversity International, 2009). Harlan (1975) assesses around 360 cultivated crops and several thousand species are also collected in their wild habitats for food, fibre or medicine. However, the human diet is based on very few crops. In fact, about 20 crops play a major role in human nutrition; cereals (wheat, maize, rice, barley, sorghum and millet, Table 1), root and tuber crops (cassava, potatoes, yams and sweet potatoes) are the main starch component of the human diet (Vigouroux *et al.*, 2011).

Table 1. Land used to grow the main cereal crops in 2008. The area is based on data from FAOSTAT 2010

Crop(s)	Cultivated land in millions of hectares
Wheat	224
Maize	161
Rice, paddy	159
Barley	57
Sorghum	45
Millet	37

In addition to conventional strategies addressing the conservation and use of plant genetic resources, farmer-participatory plant breeding is flanked today (Tripp and van der Heide, 1996). Recent studies on farmer-participatory plant breeding indicate that decentralized participatory plant breeding is important to increase and stabilize productivity and maintain genetic diversity as each pocket area is occupied by the best and different genotypes. In regions characterized by high genetic diversity, landraces often evolve through crossing with wild relatives, and farmers play an important role in selecting and adapting new genotypes (Tripp and van der Heide, 1996). Farmers should be encouraged to diversify and not all select the same cultivars and species, while breeders need to guarantee that farmers can choose from a wide range of locally adapted genotypes with a different genetic base (van de Wouw *et al.*, 2009). Conservation and sustainable use of genetic resources is strategic to meet the future demand of farmers and consumers. Maintenance and survey of traditional germplasm typical of the different regions as well as its wild or semi-domesticated relatives can be of strategic impor-

Table 2. Examples of nutrient composition within varieties (per 100 g edible portion, raw).

Species	Protein (g)	Fibre (g)	Iron (mg)	Vitamin C (mg)	Beta-carotene (mcg)
Rice	5.6–14.6		0.7–6.4		
Cassava	0.7–6.4	0.9–1.5	0.9–2.5	25–34	←5–790
Potato	1.4–2.9	1–2.29	0.3–2.7	6.4–36.9	1–7.7
Sweet potato	1.3–2.1	0.7–3.9	0.6–14	2.4–35	100–23 100
Taro	1.1–3	2.1–3.8	0.6–3.6	0–15	5–2 040
Breadfruit	0.7–3.8	0.9	0.29–1.4	21–34.4	8–940
Eggplant		9–19		50–129	
Mango	0.3–1.0	1.3–3.8	0.4–2.8	22–110	20–4 320
Banana			0.1–1.6	2.5–17.5	←1–8 500
Pandanus			0.4	5–10	14–902
GAC					6 180–13 720
Apricot	0.8–1.4	1.7–2.5	0.3–0.85	3.5–16.5	200–6 939 (beta-carotene equivalent)

Source: Burlingame *et al.*, 2009.

tance to ensure a gene pool useful for future breeding programmes. Moreover, recent studies show that there is great variability in nutrient content among varieties (Table 2), demonstrating significant nutritional differences (Burlingame *et al.*, 2009). Transition from traditional to intensive farming, in addition to recent phenomena of degradation, fragmentation and loss of habitat, pollution, wildfires, non-sustainable exploitation of natural resources and climate changes, involved genetic erosion both in cultivated and wild taxa. The Council Regulation (EC) N° 870/2004 promotes *ex situ* and *in situ* conservation of genetic resources in agriculture, including forest species, as well as the use of for a long time ignored and therefore underutilized varieties. Thus, there is an urgent need to identify priority wild species and areas for conservation and to develop integrated *in situ* and *ex situ* preservation strategies, to ensure that the rich genetic diversity of crop wild relatives is protected and the biodiversity loss is halted. The Mediterranean Basin has a high heterogeneity of cultures and a high biodiversity. Epidemiological studies have drawn attention to certain traditional Mediterranean diets. However, wild gathered food species, which are an important, but fast disappearing element of these diets, so far have been largely neglected in scientific studies (Leonti *et al.*, 2006). Wild harvested plant foods include: roots and other underground parts; shoots and leafy greens; berries and other fleshy fruits; grains, nuts and seeds; and mushrooms, lichens, algae and other species (Turner *et al.*, 2011). The use of non-cultivated leaves in Mediterranean cuisine is inextricably embedded with cultural concepts describing the traditional management of natural resources and the spatial organization of the natural/cultural landscape (Pieroni *et al.*, 2005). Better conservation and use of wild food plants will be crucial to help farmers adapt to current and upcoming challenges. In the light of these considerations, the traditional use of non-cultivated food plants may represent a valuable supplementary food source for present and future generations, and thus preservation of knowledge of plant identities and uses is of major concern (Pasta *et al.*, 2011).

3.3 The importance of research and innovation

The above-cited food-related problems call for very intensive, global dimensioned and well targeted research and innovation actions. They play a fundamental role to generate new knowledge and effectively face the main obstacles in a prospect of well balanced, healthy and sustainable food systems worldwide. In this context, "social innovation" has to be recognized "as an important new field which should be nurtured" (European Commission, 2010). Results derived from research and innovation are, in a framework of sustainability, key factors for a fair growth that is, at the same time, able to combine the conservation of natural resources, public welfare and social equity. Putting more importance in dealing with social issues by research and innovation is clearly supported in the recent issued Green paper "From Challenges to Opportunities: Towards a Common Strategic Framework for EU Research and Innovation Funding" (European Commission, 2011), in which it is evidenced that the Europe 2020 strategy calls for future EU funding programmes to focus more on societal challenges. A multi- and interdisciplinary approach is also needed, involving all the actors including academic and scientific institutions, public authorities, farmers, different economic operators and citizens, focusing on the grand challenges, going beyond the current rigid thematic setting (Lund Declaration, 2009). The investigation area of sustainable food systems and diet needs to overcome disciplinary barriers and requires a new vision of research and innovation, based on a proactive stakeholders involvement. This also requires supporting independent and transparent research and innovation processes, open to the public and not subject to economic speculation. Therefore, public research in this field should assume a central role in order to appropriately respond to big worldwide questions in a very balanced manner according to the general public interest. The systemic nature of the Mediterranean diet model represents its hallmark. Consequently, research in this field cannot be limited to separate study of individual elements but calls for investigating, as well as on single "objects" (food composition, quality, safety, ...), also on the relationships between "objects" (food and environment, food and culture, food and culinary tradition, food and territorial specificities, ...). This leads to innovative research, that should devote greater emphasis to system interactions and comparisons. This is a pillar of the methodological approach that has to be pursued. Moreover, this generates a change in the way of looking at research. The researchers have to deal with multiple objectives that, in addition, are not solely traced back to traditional criteria with productivity and efficiency. Similarly, the related research results allow consumers to have the opportunity to choose food with awareness, not depending on a short-term economic assessment. They are motivated, not only by the protection of health and that of their loved ones, but also by ecological reasons as well as ethical and social solidarity considerations. The guiding principle should be the sustainability in its fullest meaning, which implies long-term research, which can combine with the immediate needs "practice" of farmers and traditional culture with those of a better understanding of natural biological processes that underlie each agro-ecosystem. Such an approach can only be founded in increasing knowledge and ability to critically analyse the world around us, which is also the foundation for scientific research. This concept is directed towards research and innovation which involves, beyond the traditional agricultural science and in a very comprehensive manner, different investigation areas, including modeling, sustainability and complexity sciences, system engineering, managing sciences, economic and social sciences. The difference – compared to conventional research – is in how to mix and combine the various skills in a holistic, interdisciplinary and very participative approach directly involving farmers that have to regain the importance that has been progressively removed from them.

4. Conclusions

One of the main global threats in the next years is the transition to unsustainable diets that are occurring in different developing countries, leading them to adopt diet habits mainly existing in the richer countries and based on energy-dense foods. This leads to the emergence, also in those countries, of an increase in diet-related diseases, that are coexistent with still present problems of undernutrition that urgently call for being faced effectively within the framework of food security (Alexandratos, 2006). At the same time, climate changes and other worldwide environmental issues have to be dealt with, through efficient international cooperation. In this context, proper food production and supply as well as correct and balanced diets for all, closely associated to a new ecological vision of development based on sustainability principles are crucial. The adoption of sustainable food systems and diets in their broadest and comprehensive meaning should be the right way to go. They should include a revision of the current development model and related food trade liberalization policies. Sustainable food policies should consider, in a coherent manner, both agriculture and the health sector, as well as new challenges represented by ageing, globalization and urbanization, with the aim to ultimately benefit agriculture, human health and the environment. To be really effective, these policies should be more locally based, self-reliant food economies in which sustainable food production, processing, distribution and consumption are integrated to enhance economic, environmental and social health (Kearney, 2010). Apart from the need to better assemble and recompose the conceptual aspects connected to sustainable food systems and diets, their transposition in practice through helpful and replicable models is essential. The Mediterranean diets, for their intrinsic characteristics can represent valid models to address the main issues concerning the sustainable food system worldwide.

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FOOD AND ENERGY: A SUSTAINABLE APPROACH

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Abstract
The question of food production implies social, ethical, economic and environmental aspects that in recent times have become increasingly important and relevant. The global food production heavily relies on fossil resources, among which the most important is oil. Up to now, the modern food system has been based on the assumption of an unrestricted availability of low-cost fossil resources. Moreover, its expansion contributes to global warming due to the emission of greenhouse gases.
From an energy efficiency standpoint, the modern food system is the least effective industrial system: it consumes more energy than it produces. A study on the environmental impact of the products and services used in the EU-25 has evidenced how the food and drink, tobacco and narcotics are collectively responsible for 22–31 percent of the global warming. Recently, owing to problems linked to the food system sustainability, it was considered how changes in lifestyles could influence greenhouse gas emissions. Consumer choices could play a leading role. Dietary choices could give their contribution not only to health, but also to the sustainability of the agricultural system. In recent years, some indicators were developed in order to evaluate the environmental performance of food production systems like food miles and Life-Cycle Assessment (LCA) of the food supply chain. The challenge is to develop and exploit the tools necessary to better understand the sustainability of food chains, optimize sustainable primary production and identify consumer attitudes towards sustainable food production. In this context, the Mediterranean diet would represent a key resource for sustainable development around the Mediterranean Basin and worldwide. The diet is grounded in respect for the environment and biodiversity, and ensures the preservation and development of traditional activities and crafts related to the fishing and farming communities.

The energy issue
The continuing world population growth, rapid economic development (even if interspersed with periods of stagnation and recession) and – above all – the request of emerging countries to benefit from the economic boost, inevitably imply the need for greater energy requirements. Global food production heavily relies on fossil resources, among which the most important is oil. As a consequence, every threat to the regular supply of oil is a threat to food security, that is to the availability of and access to safe food, adequate for a nutrient diet. Our modern agro-industrial food system is comparable to the other industrial systems for its complex structure and the amount of energy used. Furthermore, it can also be considered as part of the same industrial economic system which is traditionally thought to operate like a bubble floating in the space, benefiting from an unlimited supply of natural resources, bolstering economic activities and pouring waste in the environment. The environment is therefore the only one to pay, in the form of waste, the environmental costs of the entire economic system.
Up to now, the modern food system has been based on the assumption of an unrestricted availability of low-cost fossil resources. Moreover, its expansion contributes to global warming due to the emission of greenhouse gases. As Herman E. Daly has asserted for a long time, modern economies must be considered as subsystems of larger ecosystems and have to function within those constraints. That is to say, modern economies must be able to manage limited resources and create sustainable development at the same time. The entire food system uses energy, both directly and indirectly, and depends on fossil resources: chemical industry products, mainly fertilizers and pesticides, farming machines and their fuel, energy for water supply and its distribution, for the transport of agricultural products, for their transformation and packaging and, finally, for the distribution to the final consumers. In the last century, in the western countries, the progress of genetics, mechanics and chemistry (the green revolution) as well as the low cost of energy, have determined the development of the food system, ensuring copious and good quality food production.

In the last 50 years, the global production of cereals tripled (from 631 million tonnes in 1950 to 2 029 million tonnes in 2004) and the current situation forces us to pay attention to the adoption of sustainable agricultural practices and natural resources (energy, climate, water, soil and biodiversity).

The energy efficiency of the food system

From an energy efficiency standpoint, the modern food system is one of the least effective industrial systems: it consumes more energy than it produces. One indicator of the unsustainability of the modern food system is the Sustainability Index (SI), the ratio of energy inputs (the energy required to produce a food divided by the energy content of a food product, evaluated in calories).

In the last century (1910–2010), this indicator has increased from close to 1 for traditional pre-industrial societies at the beginning of the last century to a value close to 9 in the 1970s, to arrive, today, to a value equal to, and sometimes higher than 100.

The food system and global warming

A study on the environmental impact of the products and services used in the EU-25 (cited in Moresi and Valentini, 2010) has evidenced how the food and drink, tobacco and narcotics are collectively responsible for 22–31 percent of global warming. Among these products, meat and meat products have the largest environmental impact of the total consumption, their estimated contribution to global warming (GWP[1]) being close to 12%, 24% of Eutrophication Potential (EP[2]) and 10% of Photochemical Ozone creation potentials (PCOP[3]). Dairy products contribute some 5% to GWP, some 10% to EP and some 4% to PCOP. Cereal products (bread, pasta, flours) contribute some more 1% to GWP and PCOP, and close to 9% to EP. Finally, fruits and vegetables (including frozen ones) give a contribution close to 2% to GWP, EP and PCOP.

Consumer choices

Consumer choices could play a leading role. In 1986, J. Gussow and K. Clancy introduced the term "sustainable diet": dietary choices could give their contribution not only to health, but also to the sustainability of the agricultural system. Their studies showed the strong link that exists between dietary choices and land use and conservation, water management and energy resources. Recently, owing to problems linked to the food system sustainability, it was considered how changes in lifestyles could influence greenhouse gas emissions. In the United Kingdom, it has been calculated that the CO2e emissions per capita due to dairy products and meats consumption equal 2 194 kg CO2e, whereas those due to vegetable products consumption (cereals, fruits and vegetables) correspond to 450 kg CO2e. A diet with a 30% decrease in animal products and a 15% increase in vegetables would allow a reduction of emissions of 590 kg CO2e per capita per year. This reduction would be equivalent to a total decrease of 5% of the global emissions per capita, equal to 10.3 Mg CO2e expected in 2008. Dietary choices aimed at reducing CO2e emissions must however be formulated guaranteeing nutritionally balanced menus.

Sustainability indicators

In recent years, some indicators were developed in

[1] Global warming potential (GWP) is a measure of how much a given mass of greenhouse gas is estimated to contribute to global warming. The global warming potential is calculated in carbon dioxide equivalents (CO2-Eq.). This means that the greenhouse potential of an emission is given in relation to CO2. Since the residence time of the gases in the atmosphere is incorporated into the calculation, a time range for the assessment must also be specified. A period of 100 years is customary.

[2] Eutrophication Potential (EP): Eutrophication is the enrichment of nutrients in a certain place. Eutrophication can be aquatic or terrestrial. Air pollutants, waste water and fertilization in agriculture all contribute to eutrophication. The eutrophication potential is calculated in phosphate equivalents (PO4-Eq).

[3] Photochemical Ozone creation Potential (PCOP): photochemical ozone creation potential (POCP) is measured in ethylene-equivalents (C2H4-Eq.). Despite playing a protective role in the stratosphere, at ground-level ozone is classified as a damaging trace gas. Photochemical ozone production in the troposphere, also known as summer smog, is suspected to damage vegetation and material. High concentrations of ozone are toxic to humans.

order to evaluate the environmental performance of food production systems. In the 1990s, Tim Lang (Professor of Food Policy, City University, London) coined the term "food miles". Food miles is a term that refers to the distance that a food item travels from the place where it is produced to the place where it is eaten. The idea behind food miles was to highlight the hidden ecological, social and economic consequences of food production to consumers in a simple way. In recent years, food miles have increased very rapidly. Between 1978 and 2002, the amount of food trucked increased by 23 percent. And the distance for each trip increased by over 50 percent. In 2002, food transport accounted for an estimated 30 billion vehicle kilometres. The original idea behind the food miles concept was that the distance that farm produce travelled before consumption was a good indicator of the amount of CO2 that had been emitted.

That idea has been seriously challenged, because transport accounts for only a very small proportion of the CO2 emissions from farm produce. In some cases, carbon emissions are much lower for items produced in tropical countries rather than in temperate countries. In other cases, emissions are much lower when they come from the most efficient source. Considering these limits, it seems more appropriate to consider how food is produced and with what kind of energy. A suitable strategy is the Life-Cycle Assessment (LCA) of the food supply chain. LCA is a methodology used for analysing and assessing the environmental impacts of a material, product or service throughout its entire life cycle, from the extraction of raw materials and their processing, through manufacturing, transport, use and final disposal: an analysis from cradle to grave. Recently, Life-Cycle Assessments have been utilized to evaluate and improve the environmental performance of food production systems. In order to find the possible directions to sustainable food production and consumption, LCA has been applied for more than 15 years to agricultural and food systems, identifying their environmental impacts throughout their life cycle and supporting environmental decision-making. A variety of databases and methodological approaches have been outlined over this period to support the applications of LCA to food systems. LCA results have been used in the development of eco-labelling criteria with the aim of informing consumers of the environmental characteristics of products. However, most analyses are limited to case studies of either a single food or a limited set of items. The challenge is to develop and exploit the tools necessary to better understand the sustainability of food chains, optimize sustainable primary production and identify consumer attitudes towards sustainable food production.

Mediterranean diet

The Mediterranean diet is an example of sustainable food production. It is a dietary pattern that can combine taste and health, environmental protection, biodiversity protection and consumption of local and seasonal products. The concept of a Mediterranean diet was developed for the first time in 1939, by Lorenzo Piroddi, a nutritionist who understood the connection between diet and diabetes, bulimia and obesity, as confirmed by the studies conducted by Ancel Keys and his school afterwards. The main features of the Mediterranean diet are:

- a high intake of vegetables, legumes, fruits, nuts and cereals, mostly wholemeal;
- the prevalence of the use of olive oil, compared with a modest intake of saturated fats;
- a moderate intake of fish, also as a function of distance from the sea;
- a regular but limited intake of dairy products (mainly in the form of yogurt and cheese);
- a moderate consumption of meat and poultry;
- a moderate intake of ethanol and active ingredients such as resveratrol, mainly in the form of wine consumed during meals.

"The Mediterranean Diet is a set of skills, knowledge, practices and traditions that range from landscape to the table, including crops, harvesting, fishing, preservation, processing, preparation and, in particular, the consumption of food. [...]. However, the Mediterranean diet (from the Greek diaita, or lifestyle) is more than just a set of foods. It promotes social interaction, because the common meal is the basis of social customs and festivities shared by a given community, and resulted in a considerable body of knowledge, songs, maxims, tales and legends. The Diet is grounded in respect for the environment and biodiversity, and ensures the preservation and development of traditional activities and crafts related to the fishing and farming communities of the Mediterranean ". For these reasons, related to both nutritional and social, cultural and environmental aspects, on 17 November 2010 in Kenya, the Mediterranean diet was declared part of the intangible heritage of humanity by the Intergovernmental Committee of the Convention on intangible heritage of humanity of UNESCO. The characteristics of the diet can be graphically represented by the food pyramid, whose first version was drawn in 1992 by the United States Department of Agriculture. The food pyramid shows in a concise and effective way how to adopt a healthy and balanced type of diet. As part of Expo 2015, having the theme "Feeding the Planet, Energy for Life", among the project proposals is a proposal on the Mediterranean diet. The Expo will be an extraordinary international context in which to recognize and promote the Mediterranean diet as a key resource for sustainable development around the Mediterranean Basin and worldwide. The ability to inspire through food a sense of continuity and identity for local people may represent, now and even more in the future, a factor of sustainable growth.

Conclusions

The current production of food in our society is extremely complex. This complexity has led to a gradual loss of knowledge and awareness on how the food that every day we put on our tables is produced and prepared. The question of food production implies social, ethical, economic and environmental aspects that in recent times have become increasingly important and relevant. Food, especially in a country like Italy, must regain its importance not only nutritionally but also socially. Significantly in this context is the consumer behaviour and the virtuous changes that it can promote in the food system. The inclusion of the Mediterranean diet into the intangible heritage of humankind by UNESCO and the project application on the Mediterranean diet as part of Expo 2015 are clear indications of a different way of looking at food production and nutrition. All of the above must be linked to the need to feed an increasing world population. The global governance could achieve the necessary objectives: 1. increase international trade in order to balance the surplus production in OECD, former Soviet and South American countries with Asian and African deficits; 2. increase agricultural production, adopting technological and organizational progresses that promote sustainability; 3. change consumption patterns, starting from developed countries, aiming at a consumption of about 2 000 kilocalories per day (of which only 500 kilocalories derived from animals) and reducing waste (presently, 800 kilocalories per day go in the garbage); 4. reduce the bioaccumulation of toxic substances within food matrices, through a mapping of the major sources of pollution. If international policies to promote better nutrition are successful, rich countries will experience reduced diseases from overweight and a diet that is more environmentally sustainable. If governments manage to agree on a stable trading system to compensate the deficit and the surplus food production in the different parts of the world, a structural problem of social injustices on the planet will be healed, reducing now evident social tensions. If science and technology once again do their job, the quantity and quality of food production will make a leap forward. Everyone should do his part and then the world of tomorrow will be fairer and more virtuous than that of today in terms of food security.

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DOUBLE PYRAMID: HEALTHY FOOD FOR PEOPLE AND SUSTAINABLE FOR THE PLANET

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Abstract

Man has long been aware that correct nutrition is essential to health. Development and modernization have made available to an increasing number of people a varied and abundant supply of foods.

Without a proper cultural foundation or clear nutritional guidelines that can be applied and easily followed on a daily basis, individuals risk following unbalanced – if not actually incorrect – eating habits. Proof of this is the recent, prolific spread of pathologies caused by overeating and accompanying reduction in physical activity (including obesity, diabetes and cardiovascular disease) in all age brackets of the population, including children and young people.

The Mediterranean diet, recognized by UNESCO in 2010 as an "Intangible Cultural Heritage" and internationally recognized as a complete and balanced diet pattern, proves to be a sustainable model for the environment.

The Barilla Center for Food & Nutrition is offering the Food Pyramid in a double version, positioning foods not only following the criteria nutritional science has long recommended on the basis of their positive impact on health, but also in terms of their impact on the environment. The result is a "Double Pyramid": the familiar Food Pyramid and an environmental Food Pyramid. The latter, placed alongside the Food Pyramid, is shown upside-down: foods with higher environmental impact are at the top and those with reduced impact are at the bottom. From this "Double Pyramid" it can be seen that those foods with higher recommended consumption levels, are also those with lower environmental impact. Contrarily, those foods with lower recommended consumption levels are also those with higher environmental impact. In other words, this newly-elaborated version of the Food Pyramid illustrates, in a unified model, the connection between two different but highly-relevant goals: health and environmental protection.

The Environmental Pyramid was constructed on the basis of the environmental impact associated with each food estimated on the basis of the Life Cycle Assessment (LCA), an objective method for evaluating energy and environmental impact for a given process (whether an activity or product). More specifically, process assessment underscores the extent to which the main environmental impacts are seen in the generation of greenhouse gas (Carbon Footprint), consumption of water resources (Water Footprint) and Ecological Footprint "land use". In order to provide a more complete and effective communications tool, only the Ecological Footprint was used as a reference index in creating the Environmental Pyramid.

This work, far from being conclusive, aims to encourage the publication of further studies on the measurement of environmental impacts of food, which will be considered in future editions of this document.

In this sense the most innovative element of the updated Double Pyramid is represented by its coherence with the needs of those who are still growing. Since food needs during the age of development differ from those of adults, it was decided to design a specific nutritional pyramid. The same approach used to design the "adult version" of the pyramid was employed to realize the "Double Pyramid for those who are still growing" and its environmental impact has been calculated according to the same criteria.

The objective is to increase the coverage of statistical data and examine the influence that may have some factors, such as, for example, geographical origin or food preservation.

Finally the technical aspects, data and considerations are highly summarized in order to provide proper scientific information and conclusions. The technical document, on the contrary, is for "experts only" and presents detailed data and elaborations

1. The Food Pyramid model

The Pyramid was created using the most current nutrition research to represent a healthy, traditional

Mediterranean diet. It was based on the dietary traditions of Crete, Greece and southern Italy in the 1960s at a time when the rates of chronic disease among populations there were among the lowest in the world. From the first "Seven Countries Study" to the current days, many other studies have analysed the characteristics and the relationships between dietary habits adopted and the onset of chronic disease. Starting in the 1990s, there has also developed a line of study into the relationship between diet and longevity. In general, what emerges is that the adoption of a Mediterranean, or similar, diet, provides a protective factor against the most widespread chronic diseases. In other words, high consumption of vegetables, legumes, fruits and nuts, olive oil and grains (which in the past were prevalently wholemeal); moderate consumption of fish and dairy products (especially cheese and yoghurt) and wine; low consumption of red meat, white meat and saturated fatty acids. The interest of the scientific and medical community in the Mediterranean diet is still extremely active, and, in fact, the current specialist literature often publishes information about the relationship between Mediterranean-style dietary habits and the impact on human health. The beneficial aspects of the Mediterranean diet are backed by increasing evidence in terms of both prevention and clinical improvement regarding specific pathology areas. These publications present the results of clinical or epidemiological research in which adherence to the Mediterranean diet translates into measurable benefits in numerous areas of human health, which include, for example, cardiovascular disease, metabolic conditions, neurological or psychiatric pathologies (e.g. Alzheimer's), respiratory disease or allergies, female and male sexual disorders (e.g. erectile dysfunction) and certain oncological

FOOD PYRAMID

pathologies. In terms of this last point, of particular interest are the recent conclusions of a broad-ranging EPIC European study which examined 485 044 adults over the course of nine years; EPIC showed that increased adherence to the Mediterranean diet is connected to a significant reduction (-33%) in the risk of developing gastric cancer. Finally, it is interesting to note that the scientific literature demonstrates a positive impact of the Mediterranean diet across all age brackets, starting from pre-natal to childhood, adulthood and old age.

Its adoption is especially pronounced in the more educated segments of the population (not Europe only) which, moreover, it perceived consistency with the current sociocultural trends, such as attention to the welfare, the fight against obesity, the promotion of typical products, the search for natural products and natural attention to environmental protection.

The value of the Food Pyramid is twofold: first it is an excellent summary of the main knowledge gained from studies on medicine and nutrition, essential for anyone who pays attention to their health, second it is a powerful tool for consumer education, thanks also to its effective graphic form and its undoubted simplicity, it plays an important promotional role for the benefit of all those foods (fruits and vegetables in particular) that are almost always "unbranded" and not advertised by manufacturers.

2. The environmental impact of food production and Double Pyramids

The estimated environmental impact for each single food item was calculated on the basis of the information and public data which was measured through the Life Cycle Assessment (LCA): an objective assessment methodology to detect energy and environmental loads in a process (either an activity or a service). This kind of assessment includes the analysis of the whole value chain, starting from growing or extraction practices, raw material processing, manufacturing, packaging, transportation, distribution, use, re-use, recycling and final disposal. On the one hand, the LCA approach has the advantage of offering a fairly objective and complete assessment of the system; on the other hand, the disadvantage lies in a difficult transmission of the resulting complex outcome.

Synthetic indicators are then used to fully understand this outcome. These indicators are meant to preserve the scientific basis of the analysis as much as possible; they are selected according to the kind of system analysed and must simply and correctly represent the relations with the main environmental categories. The process analysis, more specifically and focusing our attention on food production, highlights the main environmental loads: greenhouse gas generation, the use of water resources and the ability to regenerate local resources. According to this input, and considering this work's aim to provide valid results in an initial analysis, the following environmental indicators were chosen:

- **Carbon Footprint**, representing and identifying greenhouse gas emissions responsible for climate change: measured through the CO2 equivalent. By "Carbon Footprint" is meant the impact associated with a product (or service) in terms of emission of carbon dioxide equivalent (CO2-equiv), calculated throughout the entire life cycle of the system under examination. It is a new term utilized to indicate the so called Global Warming Potential (GWP) and, therefore, the potential greenhouse effect of a system calculated using the LCA – Life Cycle Assessment method.

In calculating the Carbon Footprint are always taken into consideration the emissions of all greenhouse gases, which are then converted into CO2 equivalent using the international parameters set by the Intergovernmental Panel on Climate Change (IPCC), a body operating under the aegis of the United Nations. Correctly calculating the Carbon Footprint of a good or service must necessarily take into account all the phases of the supply chain starting with the extraction of the raw materials up through disposal of the waste generated by the system on the basis of LCA methodology. Clearly, this requires the creation of a "working model" that can fully represent the supply chain in order to take into account all aspects which actually contribute to the formation of the GWP.

- **Water Footprint** or virtual water content, measures the use of water resources in terms of volume (expressed in m3) of water consumed and/or polluted by the entire chain – from production to direct consumption of goods/services.

The indicator is closely linked to the concept of virtual water (virtual water), theorized in 1993 by Professor John Anthony Allan of King's College London School of Oriental and African Studies, which indicates the volume of freshwater consumed to produce a product (a commodity, good or service) by summing all phases of the production chain. The term "virtual" refers to the fact that the vast majority of water used to produce the product is not physically contained in the same product, but has been consumed during its entire life cycle.
The methodology used for the measurement of the indicator was developed by the Water Footprint Network (www.waterfootprint.org), a non-profit organization of reference that operates at international level to standardize the calculation and use of this impact indicator. According to the protocol published in a version updated in 2011, the Water Footprint of a system is the sum of three specific components both

Component	Description
Green water	Volume of rainwater evapotranspired from the ground and cultivated vegetation.
Blue water	Volume of freshwater, which originated from surface or groundwater sources, used throughout the entire chain under observation that is not repleneshed into the basin or origin. This footprint includes both irrigation and process water consumption.
Grey water	Voume of polluted water associated with the production of goods or services measured as the amount of water (theoretically) required to dilute the pollutants to a degree as to ensure the quality of the water.

geographically and in terms of time and which corresponds to a different impact on the environment. When looking at the details of agrifood chains, the most characteristic item, but also the most complex to evaluate, is the green water component given its close ties to the local climatic conditions and species cultivated as well as its productive yield. This component is particularly important for agricultural cultivations (it encompasses plant transpiration and other forms of evaporation). The following formula is used to calculate green water:

$$\text{Green water}\left[\frac{l}{kg}\right] = \frac{ET0\,(mm) * Kc * 10}{\text{yeld}\left[\frac{t}{ha}\right]}$$

where:

- ET0 is a factor that represents the volume of rainwater and depends on local climatic characteristics;
- Kc depends on the plant species cultivated;
- Yield depends on the crop cultivated and climatic conditions of the cultivation area.

As one might easily suppose, the value of green water of a product can vary greatly both from region to region and from year to year, as much depends on the value of ET0. The availability of public databases and tools, made available by FAO (Food and Agriculture Organization of the United Nations), allows simple retrieval of the necessary factors for the calculation of this contribution.
The blue water component is represented by both the quantity of water used during industrial production and that consumed for irrigation in the agricultural phase.
Lastly, the evaluation of the grey water component takes into account both the characteristics of water released from the system and the natural conditions of the receiving body in which it is released.

- **Ecological Footprint**, measuring the quantity of biologically productive land (or sea) needed to provide resources and absorb the emissions produced

by a manufacturing system: measured in m2 or global hectares.
The Ecological Footprint is an indicator used to estimate the impact on the environment of a given population due to its consumption; it quantifies the total area of terrestrial and aquatic ecosystems required to provide in a sustainable manner all the resources utilized and to absorb (once again in a sustainable way) all the emissions produced. The Ecological Footprint measures the quantity of biologically productive land and water required to both provide the resources consumed and absorb the waste produced.

The calculation methodology is identified by the Global Footprint Network and includes the following components in the calculation:

- Energy Land, represents the forest area required to absorb the carbon dioxide produced by fossil fuel burning and power for the production of that good;
- Cropland, represents the area of cultivated land necessary for the production of food and other non-edible resources of plant origin (cereals, fruit, vegetables, tobacco, cotton etc.);
- Grazing Land, represents the area required to produce food and non-edible resources of animal origin (meat, milk, wool etc.);
- Forest Land, represents the land, either cultivated or wild,utilized for the production of wood-based products;
- Built-up Land, represents the land occupied for the construction of roads, homes and other infrastructures;
- Fishing Ground, represents the marine and fre shwater surface area required for fisheries.

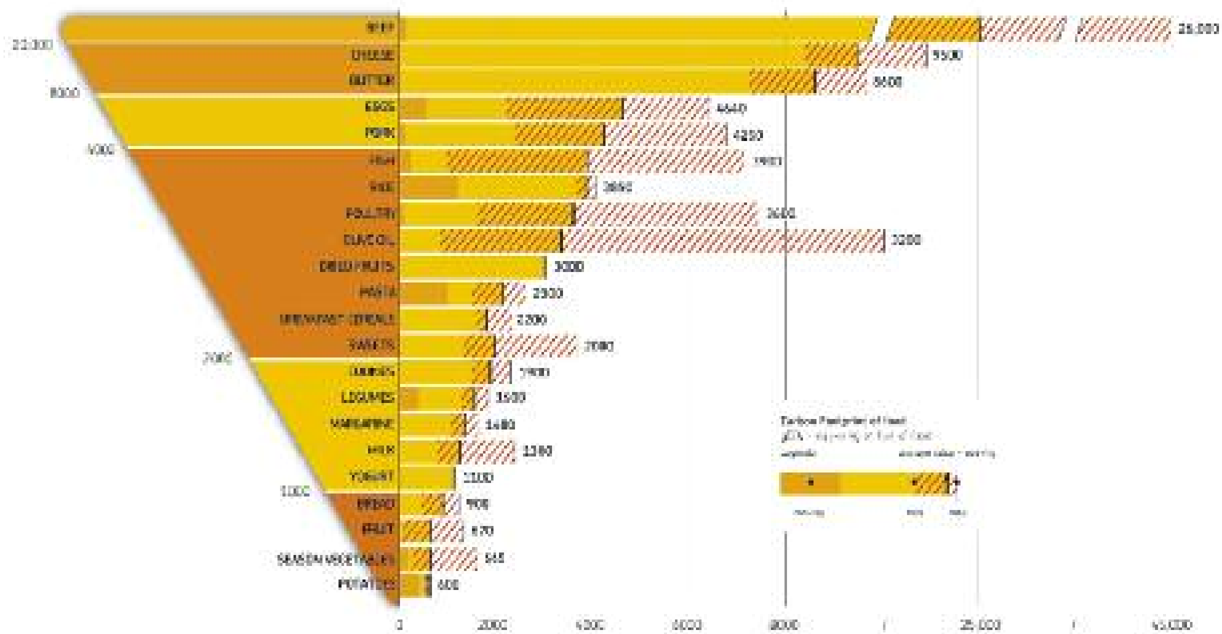
The Ecological Footprint is thus a composite indicator which, through conversion and specific equivalences, measures the various ways in which environmental resources are utilized through a single unit of measure, the global hectare (gha).

Global Footprint Network

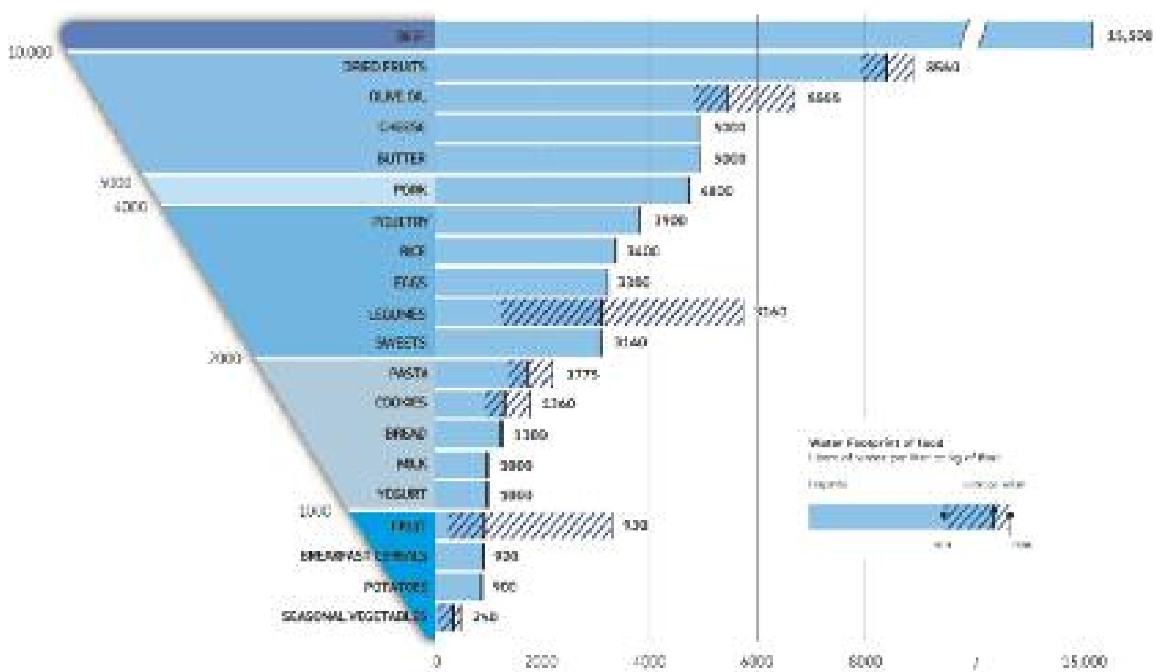
In 2004 Mathis Wackernagel and his associates founded the Global Footprint Network, a network of research istitutes, scientists and users of this indicator which aims to further improve its calculation method and bring it to higher standards, while at the same time guarantee enhanced scientific “robustness” for the indicator as well as promoting its spread.
Together with the Living Planet Index it represents one of the two indicators throught which, on a two-years basis, the WWF in collaboration with the Global Footprint Network and the Zoological Society of London, assesses the conservation status of the planet: the results are presented in the Living Plant Report.

It is, nevertheless, important to notice that the impacts this research takes into consideration are not just the ones generated by a food production chain; they can be the most relevant ones in terms of real impact and communication. Even though the environmental pyramid has been represented through the ecological footprint, for synthetic reasons the food environmental impact was measured by water and carbon footprint indicators, to avoid partial and sometimes misleading ideas of the phenomena. The pyramids concerning the three environmental impact indicators and the Environmental Pyramid are displayed below.

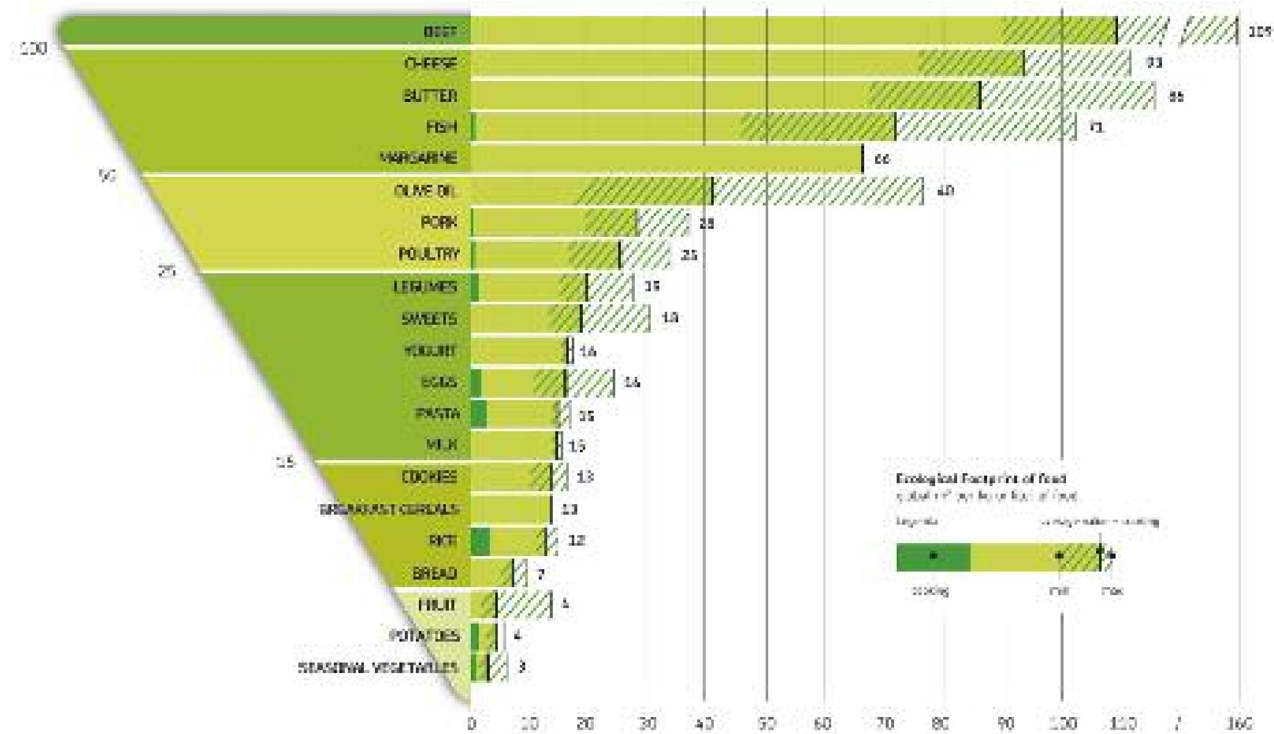
Carbon Footprint impact



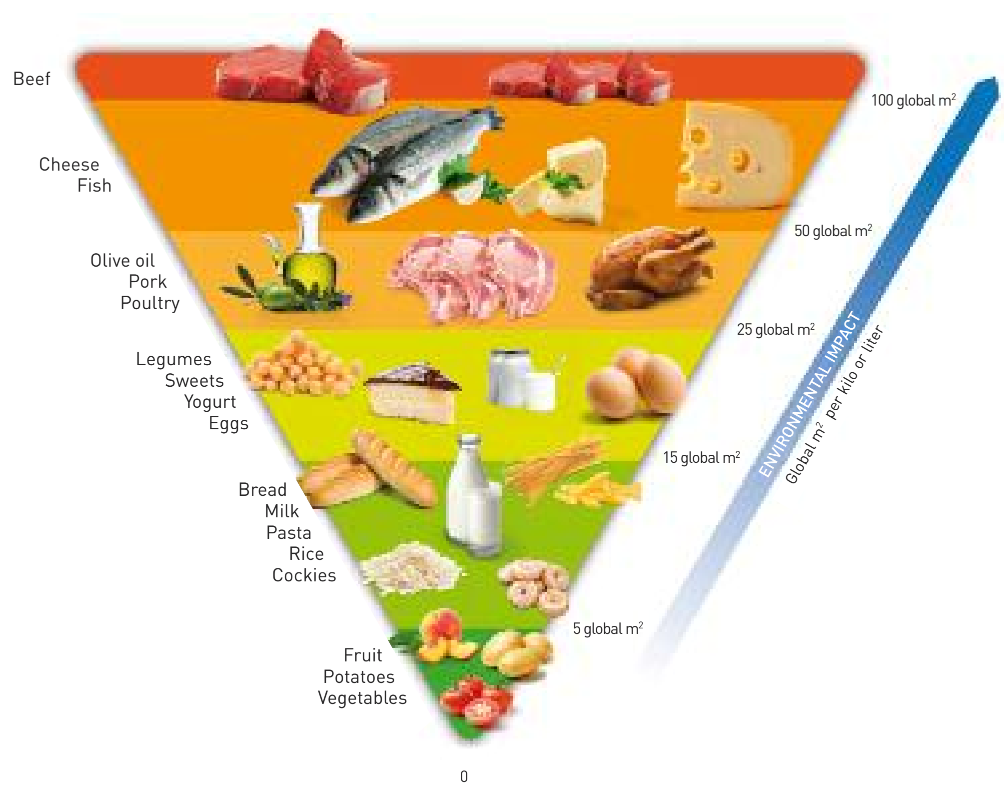
Water Footprint or virtual water content



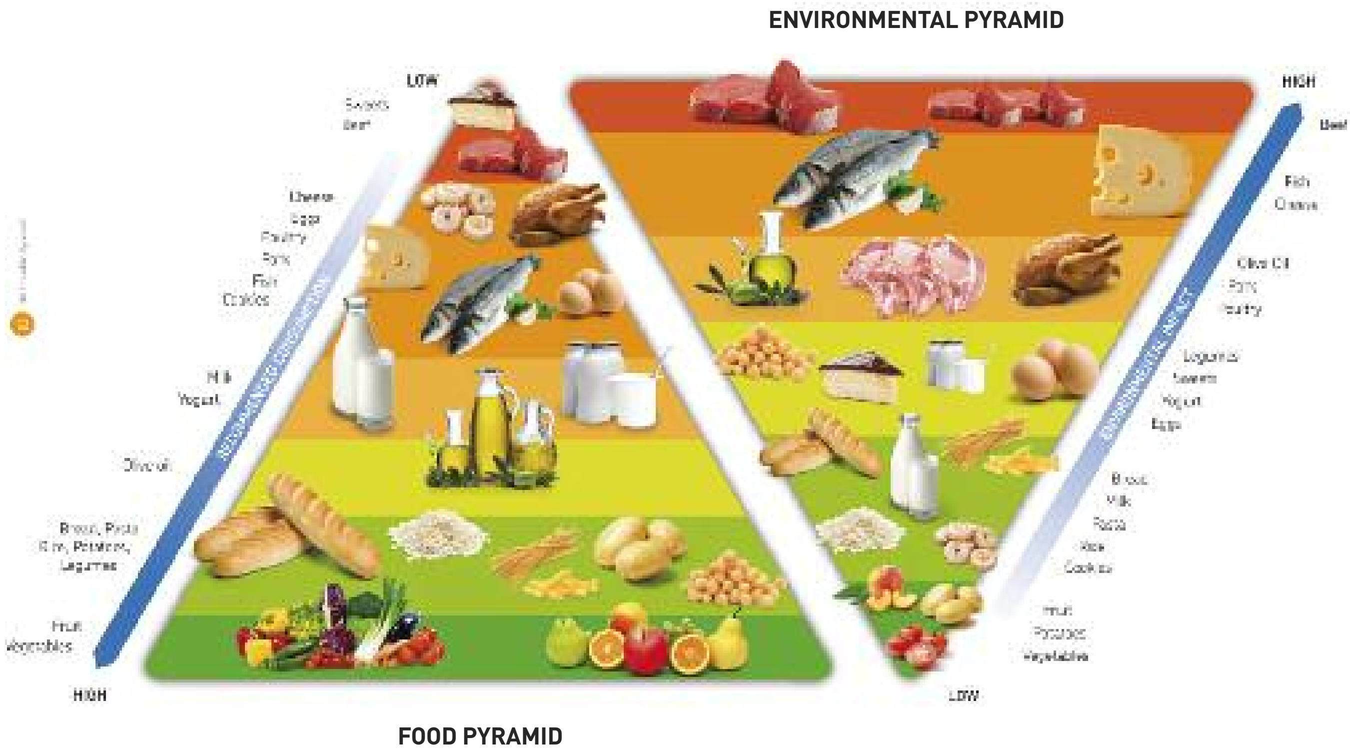
Ecological Footprint



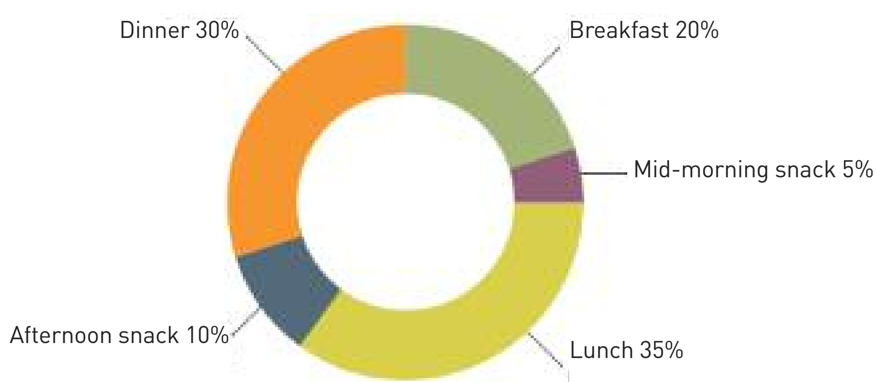
The BCFN environmental pyramid. Its layout is based on the re-classification of the foods' environmental impact, represented through their ecological footprints.



The Double Food-Environmental Pyramid is obtained by comparing the two pyramids (one in its correct position and the other one upside down). It is clear that, in general, the more recommended foods have a lower impact on the environment as well. Conversely, foods which are recommended for a lower consumption are also the ones that have the greatest impact on the environment.In practice, two different but equally relevant goals – people's health and environmental protection – fit into one single food model.

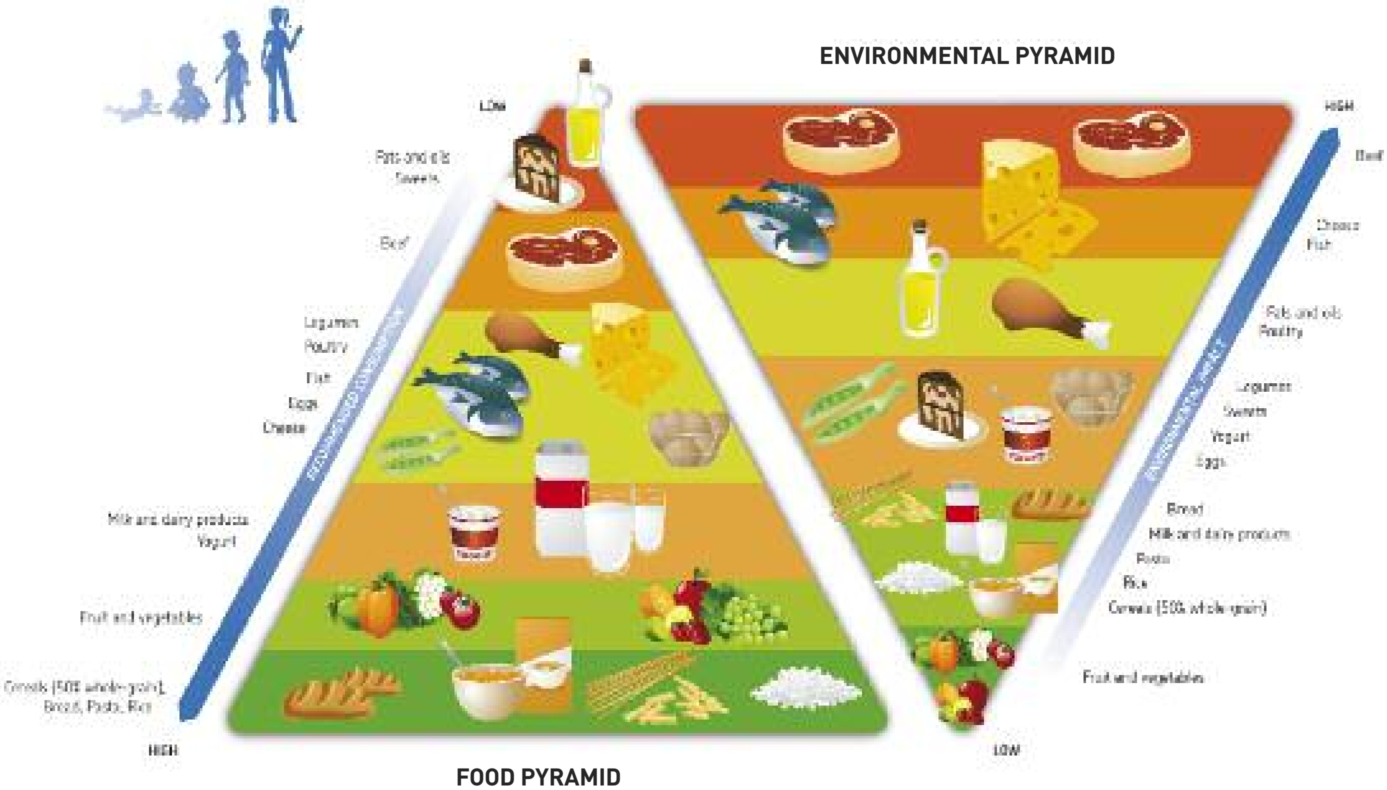


In the same way it has been developed the same concept for children and adolescents: if the main connections are changed between macro- and micronutrient intake and proper development at different stages of growth in an average diet which is adequate for meeting the requirements identified by pediatricians and nutritionists, it is possible to achieve the definition of a weekly composition of food eaten by children and adolescents that – as a whole – is both correct and balanced, in terms of type of food ingested and the distribution of daily calories.



Source The European House-Ambrosetti elaboration of data from the Italian Society of Human Nutrition

As in the case of adults, the diet of children and adolescents, too, should be based mainly on plant foods, particularly the various cereals, especially wholegrains, which are very important for their fibre content and protective components, and fruits and vegetables. Slightly above, we find milk and dairy products, preferably low-fat versions, as well as meat and fish; while higher up we get to products with a higher fat and sugar content, for which we suggest a relatively low frequency of consumption. The necessary intake of unsaturated fats should be covered by fish and dried fruit, preferably by using vegetable oils for condiments. The combination of an environmental and a nutritional pyramid for children has allowed us to create the BCFN Double Pyramid, dedicated to those who are growing.



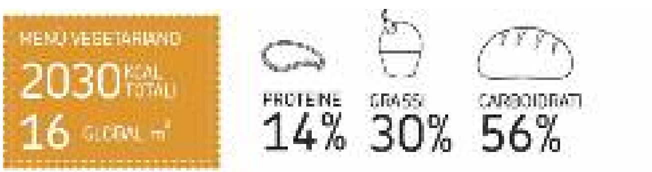
3. The impact of dietary habits

Using the ecological footprint – the indicator that was used for the Double Pyramid – as a point of reference, this chapter examines how the eating habits of people have an environmental impact. Significant reductions can be achieved both by changing eating habits (as demonstrated by some examples of menus) and by reducing waste.

According to recent statistics published by the Global Footprint Network (GFN), a citizen who lives in a country with a high income, in order to maintain the desired level of well-being, requires an ecological area of about 6.1 gha (1gha is approximately 170 square feet total per day), more than twice the global average (2.7 gha). Analysing the data in its components, one finds that food consumption is the first entry in terms of impact, with a significant Ecological Footprint totaling around 30–40 percent, which corresponds to about 1.8/2.4 gha per year. Referring to the average consumption (2.1 gha) and the reported daily impact, one can assume that every individual needs approximately 60 square meters to meet their global needs for food. The estimate takes into account the fact that, on average, a citizen who lives in a high-income country follows a diet of 2 650 kcal per day, considering the consumption of both food and drink, including food waste (unfortunately, a very common phenomenon). As an example, we can also

cite the case of the average Italian citizen, 42 square global metres exploited for food compared to 137 total, and that of a citizen of London with a global impact of 75 square metres out of 180. At this point, it is interesting to see to what extent the eating habits of individuals affect the Ecological Footprint.
In order to estimate the extent to which the food choices of individuals affect the Ecological Footprint, two different daily menus were analysed: both are balanced from anutritional point of view, both in terms of calories and nutrients (proteins, fats and carbohydrates), but in the first one, the protein is of plant origin ("vegetarian menu"), while in the second, it is mainly of animal origin ("meat menu"). The meat menu has an environmental impact that is two and a half times higher than the vegetarian one: 42 square global metres compared to 16; that is, a difference of at least 26, which represents a very significant share in the daily impact of an individual. Based on this data, we can hypothesize what the reduction of environmental impact of an individual might be if he or she simply changes eating habits.

Composition of a vegetarian menu and its environmental impact



Colazione	Spuntino	Pranzo
1 Porzione di frutta (200 gr) 4 Fette biscottate **1 global m²**	1 Vasetto di yogurt magro 1 Frutto **3 global m²**	1 Porzione pasta con finocchietto 1 Porzione di sformato di zucca e porri **4 global m²**

Spuntino	Cena
1 Vasetto di yogurt magro 1 Pacchetto di cracker non salati **1 global m²**	1 Porzione di verdure fagiolini (200 gr) e patate (400 gr) al vapore con scaglie di grana (40 gr) **7 global m²**

Composition of a meat menu and its environmental impact

Colazione	Spuntino	Pranzo
1 Tazza di latte parz. scremato 4 Biscotti **3 global m²**	1 Porzione di frutta (200 gr) **1 global m²**	1 Porzione di pizza Margherita Ortaggi misti crudi **16 global m²**

Spuntino	Cena
1 Vasetto di yogurt magro **2 global m²**	1 Porzione di minestra pasta e piselli 1 Bistecca di carne bovina alla griglia (150 gr) 1 Fetta di pane **20 global m²**

Fonte: BCFN, 2011

Variations in the ecological footprint depending on food choicesimpact

DIETA SETTIMANALE	IMPATTO SETTIMANALE [GLOBAL m2]	IMPATTO SETTIMANALE [GLOBAL m2]
7 VOLTE MENÙ DI CARNE	294	42
5 VOLTE MENÙ VEGETARIANO + 2 VOLTE MENÙ DI CARNE	164	23
7 VOLTE MENÙ VEGETARIANO	116	16

Fonte: elaborazione BCFN sulla base dei dati dell'Ecological Footprint Network.

Taking the example of a week's worth of food, we can hypothesize having three different diets on the basis of how many times a vegetarian menu is eaten and how many times the menu is based on meat: limiting animal protein to just twice a week, in line with the recommendations of nutritionists, you can "save" up to 20 square global meters per day.

Conclusions and suggestions for further research

The present study represents a further step in the investigation of the relationships between people's eating habits and food environmental impact. The analysis of main publicly available data lets us make some considerations about the impact on soil use (ecological footprint), water consumption (water footprint) and greenhouse gas emissions (carbon footprint) of foodstuffs included in the traditional food pyramid.

Indicators have been chosen in order to achieve the right balance between simplicity of the message to communicate and scientific rigour.

The most interesting result that emerges from the model is the strong correlation between environmental impact of foodstuffs and their nutritional characteristics. Specifically, it turns out that the foodstuffs of which we suggest a moderate consumption are also those that have a greater impact in terms of soil use, water consumption, and CO2 emissions. And vice versa.

In the future, in addition to the enlargement of the sample, that will enable the investigation of a higher number of product categories, two further limitations of the research have to be addressed. (a) the lack of references both to seasonality issues (considering that the environmental impact increases consistently when foodstuffs are consumed out of season) and (b) to logistics needed for transportation, with particular reference to the food cold chain. Therefore, further research by BFNC, that will be published in the third edition of the paper, will take into account data relative to the geographical variable in terms of both food production (i.e. origin) and place of consumption.

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