Developing a methodological approach for assessing the sustainability of diets: The Mediterranean diet as a case study

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1. Introduction

Food consumption is variably influenced by a range of factors including food availability, food accessibility and personal food choice. These in turn may be influenced by geography, demography, disposable income, socio-economic status, urbanization, globalization, religion, culture, marketing, and consumer attitude (Kearney, 2010).

Food consumption and production patterns and trends are among the most important drivers of environmental pressures. With rising income and urbanisation dietary patterns are shifting, with pronounced regional and cultural differences, towards consumption patterns higher in animal products, which require more energy, water and land resources (Gerbens-Leenes and Nonhebel, 2005, Lundqvist et al., 2008; Vanham et al., 2013).

The role of eating patterns as important drivers for building sustainable agricultural and food systems has often been neglected by research and policy (Guyomard et al., 2011). Many studies showed that the achievement of substantial reductions in agro-food-related greenhouse gas (GHG) emissions to mitigate climate change must be addressed, not only by how we produce and distribute our food but also by what we eat (Marlow et al., 2009; Garnett, 2013; Macdiarmid et al., 2012; Vieux et al., 2012). Recommendations for lowering energy inputs and GHG emissions from household food consumption include diets with less meat and dairy products, more in-season vegetables and more locally produced and fresh foods (Carlsson-Kanayama and Gonzalez, 2009). There is a growing body of evidence of the non-sustainability of current dietary trends (EC/JRC, 2009; SDC, 2011; INRA/CIRAD, 2011; Guyomard et al., 2011) that together with a growing evidence of the cost of diets on the environment, society and public health nutrition (Haines et al., 2009; O’Kane, 2012) has further raised the attention on the need for a shift towards more sustainable food consumption and production. The word “sustainability” itself requires further clarification and some caution in the use as it covers not only environmental issues but also economic, social, cultural issues (Lang and Barling, 2013), and public health issues (FAO/Bioversity, 2012).

In the early 1980s, the notion of “sustainable diets” was proposed to recommend diets which would be healthier for the environment as well as for consumers (Gussow and Clancy, 1986). With food globalization and the increased industrialization of agricultural systems, and with little attention paid to the sustainability of agro-food ecosystems,
the sustainable diet concept was abandoned for many years. Recently, the interest in sustainable diets has again been raised and, in 2010, through a technical workshop, an online consultation and an international scientific symposium, organized by FAO, in collaboration with Bioversity International, a common scientific position was reached on the definition of “sustainable diets”, taking into consideration the complexity of the sustainability concept applied to diets: “Sustainable diets are 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/Bioversity, 2012).

2. The Mediterranean diet as a sustainable diets’ case study

The Mediterranean diet has been scientifically well-characterized as a healthy dietary pattern. It has also been analyzed in various studies and appreciated for its lower environmental impact (Duchin, 2005; Baroni et al., 2007; EC/JRC, 2009). For these characteristics and because it concerns a vast number of countries, the Mediterranean diet, recognized by UNESCO as an intangible cultural heritage of humanity, has been selected by FAO as its first case study to develop a methodological approach for assessing the sustainability of diets in different agro-ecological zones (FAO/Bioversity, 2012; Lacirignola et al., 2012).

The importance of the Mediterranean diet as an example of a sustainable diet lies not only in its specific foods and nutrients, but also in the methods used to characterize and analyze it and the philosophy of sustainability that is at its core as a lifestyle pattern (Burlingame and Dernini, 2011).

Since the pioneering Seven Countries Study, conducted by Ancel Keys, that established the association of the traditional Mediterranean dietary pattern with a markedly reduced incidence of coronary heart disease mortality (Keys, 1980), the Mediterranean diet has been widely studied and reported to be a model of healthy eating. Greater adherence to the Mediterranean diet has been associated with significant nutrition and health benefits (Willett et al., 1995; Menotti et al., 1999; Serra-Majem et al., 2006; Sofi et al., 2008; Maillot et al., 2011, Estruch et al., 2013). Indeed, numerous recent studies confirmed that good adherence to the traditional Mediterranean Diet is systematically associated with a markedly reduced risk of cardio-vascular events and mortality (Buckland et al., 2008; Trichopoulou et al., 2009; Martinez-González et al., 2009) and with a lower incidence of the metabolic syndrome (Kastorini et al., 2011; Kesse-Guyot et al., 2012).

High intake of foods typical of the traditional Mediterranean dietary pattern –e.g. fruit, vegetables, whole grains, olive oil and fish – were also associated with a reduced risk of developing various types of cancers (Bosetti et al., 2009; Vernele et al., 2010).

Despite its benefits, the Mediterranean diet is undergoing an erosion process, which poses important threats to its preservation and transmission as an intangible cultural heritage to future generations (Dernini, 2011). Many countries in the Mediterranean area are drifting away from the Mediterranean diet healthy pattern and current Mediterranean food consumption patterns show a decline in their adherence to the Mediterranean diet (IOTF, 2005; Alexandratos, 2006; Garcia-Closas et al., 2006; Belahsen, Rguibi, 2006; da Silva et al., 2009; Vareiro et al., 2009).

The Mediterranean area is passing through a “nutritional transition” in which, in the Southern and Eastern Mediterranean countries, problems of under-nutrition coexist with overweight, obesity and food-related chronic diseases (Table 1).

The decline of the adherence to the MD entails two major concerns: an increase in the consumption of lipids (e.g. meat, dairy products, etc.) (Figure 1) and a decrease in the consumption of complex carbohydrates (e.g. cereals and legumes) (Maillot et al., 2011).

Changes of diets and consumption patterns in the Mediterranean region are the result of population growth (Plan Bleu, 2012), globalisation (Florensa and Aragall, 2012; González Turmo, 2012; Padilla, 2008) and urbanization (Florensa and Aragall, 2012). According to UN-EP/MAP (2005), the Mediterranean agricultural and rural Table 1 - Obesity, overweight and malnutrition (undernourishment) in selected Mediterranean countries.

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Albania</td>
<td>54.4</td>
<td>21.3</td>
<td>-</td>
</tr>
<tr>
<td>Algeria</td>
<td>45.5</td>
<td>16.0</td>
<td>&lt;5</td>
</tr>
<tr>
<td>Egypt</td>
<td>67.9</td>
<td>33.1</td>
<td>&lt;5</td>
</tr>
<tr>
<td>Iraq</td>
<td>62.3</td>
<td>27.0</td>
<td>26.0</td>
</tr>
<tr>
<td>Israel</td>
<td>60.9</td>
<td>26.2</td>
<td>-</td>
</tr>
<tr>
<td>Jordan</td>
<td>64.1</td>
<td>30.0</td>
<td>&lt;5</td>
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<tr>
<td>Lebanon</td>
<td>61.8</td>
<td>27.4</td>
<td>&lt;5</td>
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<tr>
<td>Libya</td>
<td>61.9</td>
<td>27.8</td>
<td>&lt;5</td>
</tr>
<tr>
<td>Morocco</td>
<td>46.8</td>
<td>16.4</td>
<td>5.5</td>
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<tr>
<td>Syria</td>
<td>61.2</td>
<td>27.1</td>
<td>&lt;5</td>
</tr>
<tr>
<td>Tunisia</td>
<td>53.7</td>
<td>22.3</td>
<td>&lt;5</td>
</tr>
<tr>
<td>Turkey</td>
<td>61.9</td>
<td>27.8</td>
<td>&lt;5</td>
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models, including the Mediterranean dietary model, are under increasing threat from the predominance of imported consumption patterns (Figure 2). Taking into consideration the erosion of the healthy Mediterranean diet pattern all around the Mediterranean area, in 2009 and 2010, a new revised Mediterranean diet pyramid was developed through a participative process (Bach-Faig et al., 2011; Dernini et al., 2012) (Figure 3). The concepts of seasonality, fresh and locally grown products, culinary activities, biodiversity, traditional, local and eco-friendly products, of variety of colours for fruit and vegetables were introduced along with main meals, conviviality and physical activity. The concept of frugality and moderation was emphasized because of the major public health challenge of overweight and obesity. This revised Mediterranean Diet pyramid was conceived as a simplified main frame in order to be adapted to the different country specific variations related to the various geographical, socio-economic and cultural contexts of the contemporary Mediterranean lifestyle. It was aimed at better popularizing its applicability for present daily lifestyle, without leaving out the different cultural and religious traditions and different national identities present in the Mediterranean area. Main foods included in the common food basket are: an abundance of olive oil and olives, fruit, vegetables, cereals (mostly unrefined), legumes, nuts and fish, moderate amounts of dairy products (preferably cheese and yoghurt) and low quantities of meat and meat products. Wine in moderation was considered acceptable when it does not contradict religious or social norms.

The Mediterranean diet, through its new revised pyramidal repre-
sentation, shows that it not only offers considerable health benefits but also respects the environment.

3. A methodological approach for assessing the sustainability of diets in the Mediterranean area

The definition of sustainable diets agreed upon in 2010 (FAO/Bioversity, 2012) provided a starting point to identify the main thematic areas to be considered in order to assess the sustainability of diets. To the three dimensions of sustainability, economic, social and environmental, were added nutrition and health as the very objective of a sustainable diet, and also culture, key to characterize diets and their relations with food, society, economy and environment. Four main thematic areas were accordingly identified: 1) nutrition and health; 2) environment (including agro-biodiversity); 3) economy; and 4) society and culture (FAO, 2010). Through a participatory process, conducted in 2011 and 2012 by CIHEAM MAI-Bari and FAO, in collaboration with ENEA, CNR, INRAN, CIISCAM, Bioversity International, WWF-Italy, within these four main thematic areas, a first list of potential sustainability indicators was compiled (Table 2) and the following steps were identified to develop a methodological approach for assessing the sustainability of diets in the Mediterranean area (Lacirignola et al., 2012):

- Identify priority sustainability challenges, within the four proposed thematic areas (nutrition and health; environment including agro-biodiversity; economy; society and culture);
- Identify the most appropriate indicators and available data resources to monitor the identified sustainability priority challenges.

For nutrition and health indicators
- Choose Mediterranean countries to apply the revised Mediterranean diet (MD) pyramid (Bach-Faig et al., 2011), to be adapted to each country, as a comparison framework for current country food consumption patterns;
- Assess food consumption patterns in selected countries by using available food consumption surveys and food balance sheets/supply utilization accounts;
- Calculate country-specific consumption patterns and trends, in terms of dietary energy, protein, fat, and selected micronutrients;
- Assess these consumption patterns for their adherence to the revised MD pyramid (Bach-Faig et al., 2011);
- Calculate a value/score using the data gathered for each indicator;
- Combine all scores into a scale and analyse trends over relevant time series. Assess from this set of indicators/scores the relationship between current dietary patterns, adherence to the MD pattern and the sustainability of food consumption and production at country level;
- Changes/trends will indicate whether a country is moving towards, or away from, nutrition and health sustainability.

For environmental, socio-cultural and economic indicators
- Identify for each selected country where the food comes from (locally produced and/or imported) by using recent and historic agricultural statistical databases (e.g., FAOSTAT and CountrySTAT);
- Calculate a value/score using the data gathered for each indicator;
- Combine all scores into a scale and analyse trends in the sustainability of the diet over time. Assess from this set of indicators/scores the relationship between current dietary patterns, adherence to the MD pattern and sustainability of food consumption and production at country level. This set of scores/indicators provides a framework for assessing the relationship between the MD, sustainable diets and sustainable development;
- Changes in national-level indicators will indicate whether a country is moving towards, or away from, environmental, socio-cultural and economic sustainability.

For all diet sustainability dimensions
- Assess the overall (nutrition and health; environmental; economic; socio-cultural) sustainability of diet and food consumption patterns in each Mediterranean country;
- Develop a framework for country-based guidelines and

![Figure 3 - The new Mediterranean diet pyramid.](Bach-Faig et al., 2011).
The Mediterranean area could be described as passing through a “nutritional transition” in which problems of under-nutrition coexist with overweight, obesity and food-related chronic diseases resulting in a “nutritionally vulnerable area” which is not to provide an exhaustive amount of information for each item, but to provide a reference point and guidance for country teams and national stakeholders.

### 3.1. Identification of the challenges for the sustainability of diets and food consumption patterns in the Mediterranean area

Recent reports, with trends and projections for the Mediterranean area (e.g. UNEP/MAP/Plan Bleu, 2011, 2008; FAO, 2012a) were taken into consideration to identify priority challenges for the sustainability of diets and food consumption patterns in the Mediterranean. They concern all the above mentioned thematic areas and include, but are not limited to:

- Nutrition and health: malnutrition and degree of adherence to the Mediterranean diet pattern;
- Economy: population growth, urbanization, food prices, and food losses and waste;
- Environment: water scarcity, climate change and biodiversity loss;
- Socio-cultural factors: homogenization of lifestyles and erosion of the Mediterranean diet cultural heritage.

#### 3.1.1. Nutrition and health: malnutrition and decline of the adherence to the Mediterranean diet pattern

Recent surveys are pointing out that many countries in the Mediterranean area are drifting away from the Mediterranean diet healthy pattern and current Mediterranean food consumption patterns show a decline in their adherence to the Mediterranean diet (IOTF, 2005; Alexandratos, 2006; Garcia-Closas et al., 2006; Belahsen and Rguibi, 2006; da Silva et al., 2009; Vareiro et al., 2009). The Mediterranean area could be described as passing through a “nutritional transition” in which problems of under-nutrition coexist with overweight, obesity and food-related chronic diseases (WHO, 2011; CIHEAM, 2008).

#### 3.1.2. Economy: population growth, urbanization, food prices, and food losses and waste

Population growth in the Mediterranean Basin is marked by a widening gap between the northern and southern shores: in the North, the growth rate is levelling off and the population is ageing, whereas the population in the South is increasing rapidly and steadily. Today, 25% of the Mediterranean population is under 15 years of age and 25% of the 15 to 24-year olds are unemployed (Plan Bleu, 2012). For the Mediterranean area, the globalisation of the economic field is introducing changes in the distribution and availability of food products (imports, commercial innovation, transformation of retail sales) while changes in lifestyles and food habits are simultaneously being introduced as a result of this transition from tradition to modernity (Florensa and Aragall, 2012).

Within the globalization process, the pressure from the agro-food market has forced the abandonment of some crops, long established livestock farming techniques and traditional crafts. It has imposed new networks and sales systems, and modified consumption habits. This impact entails losses in the knowledge and practices that have contributed historically to the identity of the Mediterranean peoples and have configured a rich and complex food universe in the Mediterranean area (González Turmo, 2012).

Price increase and volatility has a strong impact on the poor and on food importing countries, especially where diets are less diversified. It also risks modifying diets, especially of the poorest as they tend to shift to cheaper, less preferred, and, often, poorer quality foods (HLPE, 2011).

The distribution of food losses and waste along the food chain vary between regions. Relatively speaking, losses in the first part of the food chain, which are due to poor harvesting techniques, lack of transport and poor storage in combination with climate conditions, are more important in developing countries (Lundqvist et al., 2008), where 40% of food losses occur at the post-harvest and processing level while in industrialised countries more than 40% of the losses occur at the retail and consumer level, i.e. food is wasted (FAO, 2011). Reducing in the entire Mediterranean area the amount of food wasted throughout the food chain (i.e. from farm to fork) would help improve food security and nutrition (FAO, 2011).

#### 3.1.3. Environment: water scarcity, climate change and biodiversity loss

Water scarcity is the most critical development problem in the Mediterranean area and the single most important factor in limiting agricultural growth (UNEP/MAP/Plan Bleu, 2008). According to the 4th IPCC report (IPCC, 2007), the Mediterranean is one of the regions of the world in which global warming will impact the more environment and human activities (UNEP/MAP/Plan Bleu, 2008). Climate change is likely to affect agriculture and food security in the Region primarily through changes in temperature, precipitation, extreme climatic events and sea level rise (Skuras, Psaltopoulos, 2012). The main pressures on these ecosystems and their biodiversity come...
3.1.4 Socio-cultural factors: homogenization of lifestyles and erosion of the Mediterranean diet cultural heritage

Changes in intergenerational relations and gender relations, the role of women in society and interrelations with the rest of the world (tourism and migrations) are having main effects on Mediterranean lifestyles with a trend to the westernization of food consumption patterns in the Mediterranean area. These changes are influenced to a large extent by: urbanization, organization of working time, growing participation of women in economic life, fewer household members, fewer generations living together, desocialization, collective environment (Padilla, 2008).

3.2. Identification of potential indicators

To select the most effective indicators, the following criteria were considered: 1. Relevant to the question being asked i.e. the indicator should be the best indicator currently available to answer the question; 2. Understandable i.e. clear, simple and unambiguous; 3. Graphically representable; 4. Readily interpretable i.e. clear which direction the indicator should develop to lead to greater sustainability; 5. Relevant in most Mediterranean countries i.e. not restricted to an issue which is limited to a few countries; 6. Monitorable i.e. based on data that is readily available, or could be made available at reasonable cost-benefit ratio and with regularity within the time frame of policy cycle (i.e. updated each year and within maximum four year time delay); 7. Reliable and consistent i.e. data collection and analysis methodologies should preferably be consistent from country to country and at the very least be consistent within a given country from year to year; 8. Representative i.e. can be taken to represent current food consumption and production trends (Watson et al., 2010).

In the identification process of the sustainability indicators, consideration was given to the set of indicators provided by the UK Department for Environment, Food and Rural Affairs for enabling and encouraging people to eat a healthy, sustainable diet (DEFRA, 2009). Using the above mentioned criteria as well as the wide range of diverging criteria (UN, 2007), a preliminary list of indicators for assessing the sustainability of Mediterranean dietary patterns was proposed (Table 2).

4. Conclusions

The assessment of the sustainability of dietary patterns is a critical development issue to counteract the emerging triple burden of undernutrition, overnutrition and micronutrient deficiencies in the Mediterranean region, particularly in Southern and Eastern countries. The abandonment of the healthy Mediterranean diet pattern and the emergence of new lifestyles associated with socioeconomic changes pose important threats for this intangible heritage as well as for the sustainability of Mediterranean food systems.

### Table 2 - Proposed indicators for assessing the sustainability of the Mediterranean food consumption patterns.

<table>
<thead>
<tr>
<th>Thematic area</th>
<th>Proposed indicators</th>
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| A. Nutrition and health| A1. Diet-related morbidity/mortality  
A2. Fruit and vegetable consumption/intake  
A3. Vegetable/animal protein consumption ratio  
A4. Dietary energy supply/intakes  
A5. Dietary diversity score  
A6. Dietary energy density score  
A7. Nutrient density/quality score  
A8. Food biodiversity composition and consumption  
A9. Nutritional anthropometry  
A10. Physical activity prevalence |
| B. Environment         | B1. Water footprint  
B2. Carbon footprint  
B3. Nitrogen footprint  
B4. Biodiversity |
| C. Economy             | C1. Food consumer price index (FCPI): cereals, fruit, vegetables, fish and meat  
C2. Cost of living index (COLI) related to food expenditures: cereals, fruit, vegetables, fish and meat  
C3. Distribution of household expenditure per groups: food  
C4. Food self-sufficiency: cereals, fruit and vegetables  
C5. Intermediate consumption in the agricultural sector: nitrogen fertilizers  
C6. Food losses and waste |
| D. Society and culture | D1. Proportion of meals consumed outside home  
D2. Proportion of already prepared meals  
D3. Consumption of traditional products (e.g. proportion of product under PDO or similar recognized traditional foods)  
D4. Proportion of mass media initiatives dedicated to the knowledge of food background cultural value |

Source: Lacirignola et al., 2012.
The Mediterranean diet results from a highly diversified heritage, which makes diverse in various countries. Food traditions vary from country to country in the Mediterranean area and as a consequence it is necessary to take into consideration different local realities with specific environmental, economic, social and cultural traits.

Diets are at the intersection of extremely diverse scientific disciplines. They are both the result and the driver of food systems. As such they have to be looked at simultaneously from diverse points of view. This requires huge amount of data, agreed methodologies and analytical tools, some of which do not currently exist in Mediterranean area. It requires also looking at dietary patterns not only from a nutritional point of view but also from environmental, economic, social and cultural perspectives, within a food system approach, to be further identified and developed.

The methodological approach presented in this paper requires to be tested and further refined in a group of selected Mediterranean countries. By considering together the various sustainability dimensions and their complex interactions, in the context of the Mediterranean area under investigation, it will also require to work together across disciplines to develop and strengthen studies of diets and food consumption patterns.

The multidisciplinary methodological approach described in this paper aims to facilitate dialogue among members of the scientific community on the sustainability of the diets in the Mediterranean area. The development of the priority 5 “Food consumption patterns: diet, environment, society, economy and health” of the Feeding Knowledge project (www.feedingknowledge.net) within the frame of 2015 Milan Universal Exposition, provides a great opportunity for a “Euro-Med pilot sustainability laboratory” to enhance the transition towards more sustainable food systems in the Mediterranean area. Such a transition requires a further development of holistic approaches within different spheres and arenas of agriculture, nutrition, health, economy, environment, biodiversity, climate change, society, culture, and lifestyle.

The methodological approach outlined in this paper aims to be useful to design policies for cross-sectoral policy instruments allowing the improvement of the sustainability of the diets and food systems in the Mediterranean area, which represents an important area of reflection and action for governments and international organisations concerned about socio-economic and environmental impacts of unsustainable agro-food practices (CIHEAM, 2012).

This methodological approach will be also useful for a similar work to characterize sustainable diets in other agro-ecological zones and among different cultural groups around the world, including the most vulnerable in terms of food security and nutrition.

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