

# Achievement of sustainable development goals through the Mediterranean diet

M.C. MEDORI<sup>1</sup>, K. DONATO<sup>2,3</sup>, L. STUPPIA<sup>4,5</sup>, T. BECCARI<sup>6</sup>, M. DUNDAR<sup>7</sup>, R.S. MARKS<sup>8,9</sup>, S. MICHELINI<sup>10</sup>, E. BORGHETTI<sup>11</sup>, C. ZUCCATO<sup>11</sup>, L. SEPPILLI<sup>12</sup>, H. ELSANGAK<sup>13</sup>, G. SOZANSKI<sup>14</sup>, D. MALACARNE<sup>1</sup>, M. BERTELLI<sup>1,2,3</sup>

<sup>1</sup>MAGI'S LAB, Rovereto, Trento, Italy

<sup>2</sup>MAGI EUREGIO, Bolzano, Italy

<sup>3</sup>MAGISNAT, Atlanta Tech Park, Peachtree Corners, GA, USA

<sup>4</sup>Center for Advanced Studies and Technology, G. d'Annunzio University, Chieti, Italy

<sup>5</sup>Department of Psychological Health and Territorial Sciences, School of Medicine and Health Sciences, G. d'Annunzio University, Chieti, Italy

<sup>6</sup>Department of Pharmaceutical Sciences, University of Perugia, Perugia, Italy

<sup>7</sup>Department of Medical Genetics, School of Medicine, Erciyes University, Kayseri, Turkey

<sup>8</sup>Avram and Stella Goldstein-Goren Department of Biotechnology Engineering, Ben Gurion University of the Negev, Beer Sheva, Israel

<sup>9</sup>The Ilse Katz Center for Nanoscale Science and Technology, Ben Gurion University of the Negev, Beer Sheva, Israel

<sup>10</sup>Vascular Diagnostics and Rehabilitation Service, Marino Hospital, ASL Roma 6, Marino, Italy

<sup>11</sup>AERSAFE srl, Rovereto, Trento, Italy

<sup>12</sup>Camillo Cavour Foundation, Turin, Italy

<sup>13</sup>Life University, Marietta, GA, USA

<sup>14</sup>Alliance for Health Promotion (A4HP) - in Official Relations with the World Health Organization (WHO), Geneva, Switzerland

**Abstract.** – The prosperity of our planet relies on the cardinal concept of sustainable development. The dietary choices of humans play a pivotal role in creating a peaceful and contented world. In this context, the Mediterranean diet (MD) has emerged as a valuable approach to accomplishing such progress, wherein the rights of all living beings are equally honored. This review aims to analyze the significance of a plant-based diet, particularly the Mediterranean diet, in attaining sustainable development goals. A comprehensive search of the literature was conducted to gather the most reliable and published scientific evidence from books and papers. Within this research endeavor, specific Sustainable Development Goals (SDGs) are individually addressed in relation to the adoption of the Mediterranean diet as a foundational nutritional paradigm. Our research findings underscore the immense importance of the MD and advocate for its worldwide implementation to accomplish sustainable development objectives. The MD emerges as the most suitable dietary option for fostering sustainability and tranquility in our world. It is crucial to prioritize the global implementation of the MD to genuinely achieve sustainable development.

## Key Words:

Mediterranean diet, Sustainable food systems, Sustainable diet, Sustainable development goals, SDGs, Non-communicable disease, NCDs.

## Introduction

Sustainable development refers to the placid growth of the world that promotes prosperity while maintaining an equilibrium between humanity and the ecosystem without compromising the potentiality of future generations to meet their own requirements. However, holistic development is hampered by a myriad of factors, including irresponsible distribution of human resources, unemployment, limited educational opportunities, inequitable nutrition, unhealthy aging, prevalence of non-communicable disease (NCDs), lack of knowledge about agricultural methods and innovations, and lack of collaboration among relevant stakeholders. Therefore, it was crucial to surmount these global challenges for the transition to sustainability<sup>1</sup>.

With the intent of unleashing a better and harmonious world, the United Nations set out to establish a global strategy and a set of 17 interrelated universal objectives known as SDGs, that are envisioned to be achieved by 2030<sup>2</sup>. The Agenda 2030 sustained that the target of ending poverty must coincide with robust economic advancement, ecological prosperity, and effective governance scaffold, along with the fair distribution of resources while handling climatic changes and ensuring environmental protection<sup>3</sup>.

In this context, SDG2 aims to eliminate hunger and ensures adequate nutrition, which holds intrinsic value in accomplishing other sustainable development goals. Good health and wellbeing (SDG3) are vital in improving dietary choices and maintaining a balance between malnourishment (nutritional deficiencies) and over-nourishment, as demonstrated in obesity and diabetes<sup>4</sup>.

Factors influencing food choices vary significantly from region to region, but they all have a significant impact on how people consume their food. From geography to demographics, disposable income, and socio-economic status, there are many variables that can shape

our decisions about what we eat. Urbanization plays an increasingly important role in shaping global diet patterns as cities expand and populations become more concentrated in urban areas with access to a wider variety of foods than rural areas can offer. Globalization has also had a huge impact on the way people choose their food, making food from different cultures accessible across borders at a relatively low cost compared to traditional local food<sup>5</sup>.

Sustainable food systems are those that constitute a healthy diet that is not only beneficial for humans of all socio-economic profiles but also for the environment. Mediterranean nutrition offers a compelling framework to effectively achieve the ambitious targets of sustainable food systems set forth by the Agenda 2030. This nutrition model, recognized as “Intangible Heritage of Humanity” by UNESCO, is a way towards eradicating hunger and nurturing healthy nations, along with the preservation of the environment and natural resources. Furthermore, the Mediterranean diet (MD) is also helpful in preventing non-communicable diseases<sup>6</sup> and can be embraced for sustainable development (Figure 1).

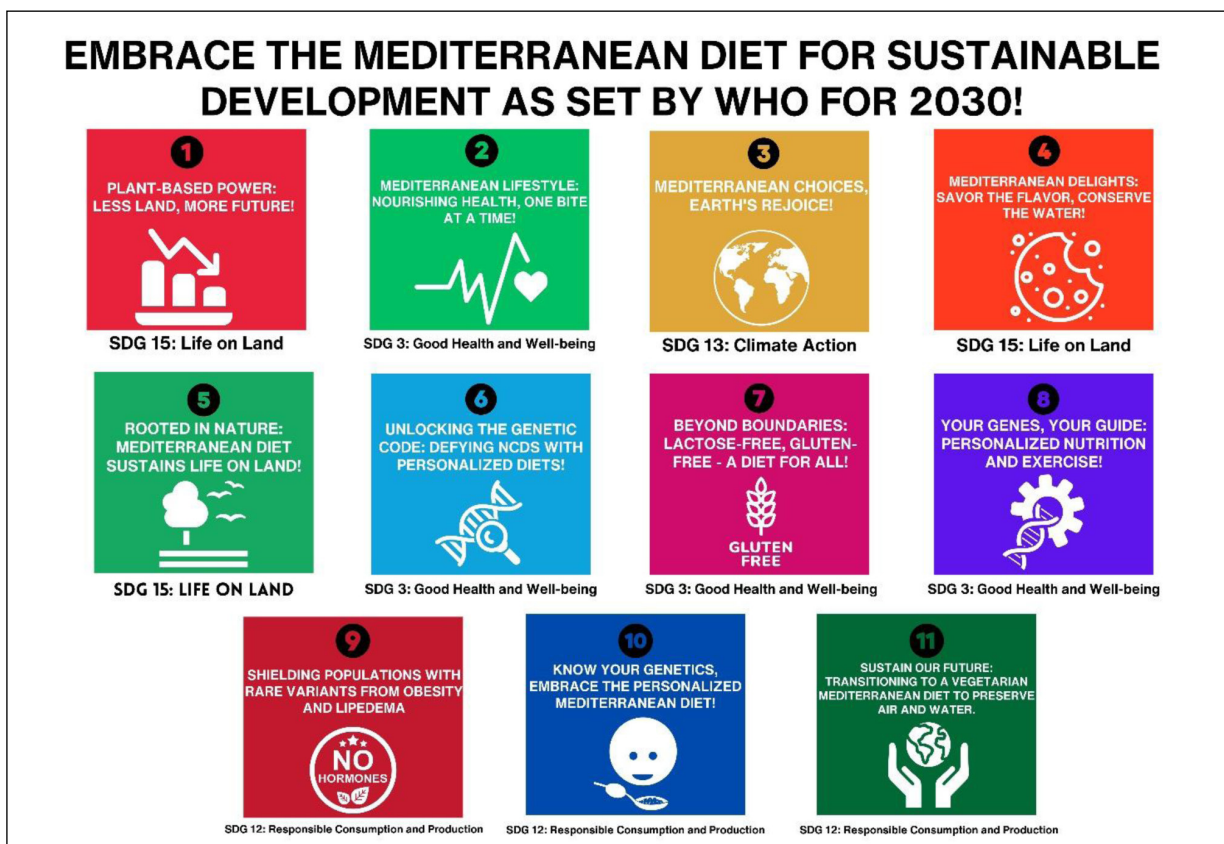


Figure 1. The SDGs and their connection to the Mediterranean diet.

Mediterranean diet is both affordable and readily available, even in distant regions far from Mediterranean basins. It embraces plant-centered foods (raw or minimally cooked fruits, vegetables, cereals, and grains) flavored by different aromatic herbs and spices, further augmented by the inclusion of beneficial fats derived from extra virgin olive oil. Abundant in rich nutrients, vitamins, and minerals, this dietary regimen promotes both individual well-being and contributes to the attainment of a sustainable global landscape<sup>7</sup>. In this review, we are going to explore how Mediterranean diet plan could help in achieving certain SDGs. Figure 1 is the demonstration of relationship between the SDGs set by the WHO for 2030, and their connection to the Mediterranean diet.

### **Attainment of SDG 2: Zero Hunger**

Hunger is a significant contributor to serious morbidity and mortality affecting about 10.9% of the population worldwide. Malnutrition, stunted growth due to maternal undernourishment, and nutritionally deficient individuals are attributes of hunger, that are mainly due to limited access to quality food that lacks micronutrients, or due to scarcity of nutrient-rich food<sup>8</sup>. SDG2 primarily aims to eradicate malnutrition and hunger and assures sufficient food accessibility to all people, especially poor and weak populations of the world. The accomplishment of this goal is possible via the sustainability of food systems. Moreover, much emphasis has been given to increase the agricultural productivity of meager food producers in terms of land, resources, and awareness about recent technology that could help in stabilizing the ecosystem too<sup>9</sup>.

Healthy food is assumed to be costly and is often sidestepped. Therefore, an ideal diet should be healthy, balanced, cost-effective, harmless, sufficiently meet nutritional requirements of all age groups, and culturally acceptable for population according to their health status<sup>7-9</sup>.

MD has gained popularity in recent years as it could be an economical way of attaining a sustainable dietary pattern<sup>10</sup>. It is a healthy nutritional model that includes plant-based food products easily available in all parts of the world. Therefore, it can be seamlessly adopted by people from diverse geographical backgrounds and various income levels. MD mostly constitutes vegetables, whole grains, nuts, legumes, unsaturated fats, mostly from olive oil, fresh or dried fruits, and occasionally fish and red meat<sup>7</sup>. These food items

or similar dietary products with analogous health benefits are widely available in different countries other than Mediterranean regions, and thus makes MD an inexpensive healthy choice for dwellers of diverse territories<sup>11</sup>.

Furthermore, being a plant-centered diet, MD reduces reliance on animal agriculture, leading to decreased demand for animal-based products. This decline in demand is valuable in the context of environmental protection because livestock production consumes more agricultural land and produces substantial amounts of greenhouse gases contributing to a rise in global warming<sup>12</sup>. Evidence has shown that plant-based diets consume comparatively reduced land space, water, and other resources than animal food-based diets (particularly beef products). Eventually, it has fewer impressions on climate change and is an environment-friendly diet<sup>12</sup>.

### **Attainment of SDG 3: Good Health and Wellbeing**

Robust health and holistic welfare of individuals across all stages of life are imperative for sustainable development. Therefore, SDG3 is primarily aimed at ensuring the well-being of populations of all ages, by reducing the causes of illnesses and deaths in a wider context<sup>8</sup>. Notable attention has been given to improving life expectancy and mitigating prevalent causes of child and maternal mortality, better access to clean water, eradicating infectious diseases, reducing the rates of NCDs, preventing substance and alcohol use, cheaper access to essential medicines, and universal reduction in deaths and injuries by road accidents, hazardous chemicals, polluted water, air, and soil<sup>13</sup>.

Nevertheless, cultural propagation of unhealthy behaviors and the high prevalence of chronic diseases hinder the achievement of SDG3. Malnutrition is affecting over 2 billion people globally and the rates are increasing; type 2 diabetes (which constitutes 90% of diabetics) has augmented in parallel with obesity, while cancer, neurodegenerative diseases, adverse reproductive effects of chemicals, and antibiotic-resistance are expected to increase in upcoming decades<sup>8</sup>. Mounting evidence suggests that MD has the potential to be a nutrient-packed diet with economic and socio-cultural profits that can bring dietary comfort, good for mental and physical health<sup>7,13</sup>.

The Mediterranean diet is a healthy nutritional model that encapsulates the traditional link between human beings and food. As outlined by UNESCO,

MD symbolizes a way of living rather than a mere dietary regimen. It is advantageous for humans and simultaneously exerts minimal strain on the environment, and thus preserves agricultural biodiversity<sup>13</sup>. Relying on the consumption of phytonutrients, MD is a scientifically proven dietary pattern that, along with physical activity and sociable lifestyle, reduces the risk of chronic diseases like NCDs<sup>7,11</sup>.

### **Role of MD in Reducing NCDs like Diabetes and Obesity**

The debilitating effects of undernutrition may be huge on the population, but overweight, obesity, and other non-communicable diseases have surpassed it by posing a more significant burden than undernourishment<sup>8,13</sup>. As a result, people have longer life spans, but they are unable to spend good quality of life<sup>9</sup>.

Multiple studies have consistently demonstrated the effectiveness of the Mediterranean diet and its accompanying lifestyle in maintaining optimal weight, diminishing the susceptibility to NCDs<sup>6-8,13</sup>, and enhancing brain health<sup>11,13</sup>. Whereas, unhealthy eating habits of consuming calorie-rich and energy-deficient ultra-processed foods containing refined flour, sugar, and endocrine disrupting chemicals (EDC) undoubtedly contribute to hormonal dysregulation and lead to diabetes, obesity, and other NCDs like lipedema, and certain inflammatory diseases like lymphedema<sup>8,14,15</sup>.

In particular, lymphedema, which is swelling of lymph nodes, can be treated by a compound hydroxytyrosol (HT) primarily extracted from olive trees<sup>14-19</sup>. Being a fundamental ingredient of MD, olive oil can potentially prevent inflammatory diseases and promote overall well-being. Additionally, olive oil contains anti-thrombotic and anti-oxidative properties, making it an inevitable nutritional element for MD<sup>7,20</sup>. Although genetic predisposition is the primary cause of lymphedema<sup>17,21,22</sup>, it is also genetically linked with obesity<sup>23-25</sup>. Hence, obesity causes lymphatic dysfunction due to high-fat diet and results in gene alterations in lymphatic endothelial cells, eventually leading to lymphedema<sup>25</sup>. Similarly, lipedema coexists with obesity most often in women at the age of puberty. Lipedema is painful accumulation of fat in adipose tissues of limbs which is misdiagnosed as obesity<sup>26,27</sup>. However, lipedema also has genetic causes of its onset<sup>27,28</sup>, but is manageable through exercise and dietary interventions. In this disease, recently recognized by the WHO but still

not included among the diseases covered by the public and private health systems of many countries, the fat cells in the affected areas do not respond to the common self-regulating mechanisms of healthy adipose tissue and, growing and replicating abnormally, they induce physical and mental disabilities in affected individuals (it affects almost exclusively the female sex). In its evolution, important epigenetic aspects, such as hormonal factors, lifestyle, and dietary habits, are added to the genetic cause. For such reasons, it is manageable through exercise and dietary interventions<sup>28</sup>.

Another chronic disease named celiac disease, more common in the pediatric population, is also treated by the adoption of the Mediterranean diet. Basically, celiac disease is an autoimmune disorder that is triggered by adversity of a substance gluten. For such patients, a gluten-free diet is recommended, but it is not successful in providing adequate nutrition. Moreover, a gluten-free diet is usually unbalanced due to the richness of sugar, fats, salt, and scarcity of dietary fiber. Research suggests that MD is successful in maintaining better health status for people with celiac disease<sup>29</sup>.

### **Role of MD in Reducing Psychological Disorders**

Evidence has shown that adherence to MD is directly correlated with a significant decline in the rate of incidence of Parkinson's and Alzheimer's disease (AZD)<sup>20</sup>. Moreover, compliance with MD in patients of dementia demonstrated a noticeable reduction in mild cognitive impairment that later on converted into AZD<sup>30</sup>. Observance of MD is good for entire psychological health. Regular intake of fruits and vegetables with good quality of fats on a daily basis is able to suppress depression, anxiety, and psychological distress in individuals<sup>31,32</sup>.

Additionally, MD has shown successful results when applied to patients suffering from binge eating disorder (BED) and planning to get a weight loss program<sup>32</sup>. BED is an eating disorder similar to bulimia nervosa, in which the patient loses control on eating and consumes large amounts of palatable food in a short period of time. Anorexia is also an eating disorder that is opposite to BED, characterized by intense fear of gaining weight and food restriction. Although these eating disorders are heritable, the contribution of environmental triggers, psychological factors, and dietary patterns cannot be neglected<sup>33</sup>. MD is packed with a myriad of functional nutrients that possess

fiber, antioxidant and anti-inflammatory properties beneficial in maintaining healthy weight. High fiber in MD acts as an anorexigenic agent, provided by fruits and vegetables, that stimulates satiety and restricts putting on excess weight<sup>32</sup>.

### **Role of MD in Reducing CVD and Cancers**

Numerous pieces of research so far have documented that adherence to MD is protective against CVD, coronary artery disease, and various cancers<sup>20,34,35</sup>. This is due to the health benefits of important nutrients, such as monounsaturated fatty acids, omega-3 fatty acids, antioxidants, anti-inflammatory substances, polyphenols and fiber. In contrast, the prevalent dietary pattern in the population contains excess salt, sugars, heme iron from red meat, and saturated fats, leading to the development of CVD<sup>20</sup>. Moreover, important ingredients present in MD are associated with a statistically significant decrease in the overall mortality rate<sup>20</sup>. MD is enriched with nutrients that have shown protective properties against DNA damage and thus lead to the prevention of cell proliferation and protection of cell membrane from metastasis<sup>35</sup>.

### **SDG 12: Responsible Consumption and Production**

The principles of the Mediterranean diet are aligned with responsible consumption and production of food that is interconnected to achieve sustainable diets<sup>36</sup>. By emphasizing diverse plant-based meals, MD promotes sustainable food consumption. Moreover, MD favors minimally processed foods over highly processed and packaged products, which can minimize the associated environmental impacts, such as excessive packaging waste and energy-intensive manufacturing processes. Culinary crops require fewer resources and have lower greenhouse gas emissions compared to diets that rely heavily on animal products<sup>37</sup>.

Preservation and promotion of the Mediterranean diet play a crucial role in safeguarding the remarkable biological diversity. A study<sup>38</sup> showed that a higher adherence to the Mediterranean Diet Pattern (MDP) has a significant positive impact on various environmental footprints. It leads to a reduction in greenhouse gas emissions, land use, and

energy and water consumption. In contrast, adherence to a Western dietary pattern has been found to increase all of these environmental parameters<sup>36</sup>.

Consuming fresh and locally sourced products in season, promoting biodiversity, engaging in traditional culinary practices, fostering conviviality, and embracing frugality represent key factors involved in maintaining the heritage of the Mediterranean diet. A study conducted in Italy<sup>39</sup> demonstrated that following MDP has a notable effect in reducing the environmental impact of food production, particularly in terms of water consumption and its impact on natural resources.

### **Sustainable Agriculture is a Key to Responsible Food Production**

Food production significantly contributes to environmental pressures, including climate change, water use, and emissions of greenhouse gases (GHGs) like CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O. Agriculture is a major source of these emissions, while other aspects of the food system, such as processing, transportation, and storage, contribute to carbon dioxide emissions through the use of fossil fuels<sup>38</sup>. As modern agriculture heavily relies on high-input practices involving fuel-powered machinery, chemical fertilizers, and pesticides. However, by integrating genetic engineering and biotechnology into traditional smallholder farming systems through a smart combination of farming techniques, there is a promising opportunity to meet the increasing food demand<sup>40</sup>.

Preserving ancient Mediterranean crop varieties safeguards biodiversity and helps maintain cultural heritage and traditional agricultural practices. These varieties often possess unique flavors, nutritional qualities, and cultural significance, making them essential for culinary traditions and local food systems<sup>36</sup>. The conservation of age-old crop varieties contributes to the overall resilience of agricultural systems.

Existing agricultural technology alone will not be enough to ensure adequate food production for present and future needs. The adoption of innovative technologies like biotechnology offers a valuable approach to conserving and protecting ancient Mediterranean crop varieties, which are often rich in genetic diversity and adapted to local environments. This allows for the production of a large number of disease-free and genetically uniform plants, ensuring the conservation of these valuable crop varieties<sup>40</sup>.

## **Precision Nutrition with Mediterranean Diet**

Nutrients have noticeable imprints on gene expression. The interplay of genetic, epigenetic, physiological, and socio-cultural factors plays a crucial role in the development of chronic diseases at a molecular level. Prolonged periods of high-calorie intake, imbalanced omega-6/omega-3 fatty acids, and sedentary lifestyles contribute to the onset of NCDs. Achieving precise nutrition involves considering the interactions between genetics, dietary habits, behaviors, physical activity, and the microbiota. One approach to precision nutrition is developing tailored dietary recommendations to prevent or treat metabolic disorders. The Mediterranean diet, known for its health benefits, emphasizes plant-based consumption with abundant fruits and vegetables, as well as high fiber and complex carbohydrates<sup>41</sup>.

For example, a study of patients at high cardiovascular risk found that a polymorphism in the PPAR $\gamma$  gene was associated with telomere length. It has been observed that cardiovascular risk is reduced as a result of these individuals being fed a Mediterranean diet<sup>42</sup>.

Research has revealed that certain genetic variants interact with unhealthy dietary habits, such as the consumption of sugary beverages, high intake of fried food, or saturated fat, leading to alterations in gene expression levels. Conversely, long-term dietary interventions, like the Mediterranean diet, have demonstrated positive effects on gene expression, even among individuals with these genetic polymorphisms<sup>41</sup>.

Nutrigenomic studies have shown that interventions with Mediterranean diets have beneficial effects, particularly when interacting with specific genetic variants. The renowned PREDIMED (PREvención con DIeta MEDiterránea) trial provides strong evidence that the Mediterranean diet, rich in fibers, unsaturated fats, and polyphenols, serves as an ideal and sustainable model for preventing cardiovascular diseases (CVD)<sup>41,43</sup>.

## **The Role of Nutrigenomics in Mediterranean Diet**

The Mediterranean diet, renowned for its health benefits, is a dietary pattern that has garnered considerable attention in the context of nutrigenomics. Nutrigenomics investigates how an individual's genetic

variations influence their response to specific dietary components, including those abundant in the Mediterranean diet. Genetic factors can impact an individual's ability to metabolize certain nutrients, absorb phytochemicals, or respond to oxidative stress.

Individuals possess genetic variations that affect their metabolism of nutrients present in the Mediterranean diet. For instance, certain polymorphisms in genes involved in lipid metabolism influence an individual's response to dietary fats. Studies have shown that individuals with specific variations in genes related to lipid metabolism may experience different outcomes in terms of cholesterol levels and cardiovascular disease risk when consuming a Mediterranean diet<sup>44</sup>.

The Mediterranean diet is replete with antioxidant-rich foods, which can help combat oxidative stress. However, the efficiency of an individual's antioxidant defense mechanisms can be influenced by genetic variations. Variations in genes responsible for antioxidant enzyme production, such as superoxide dismutase (SOD) or glutathione peroxidase (GPx), can affect an individual's response to the antioxidant compounds in the diet<sup>45</sup>. Understanding these genetic variations can help identify individuals who may benefit more from the antioxidant properties of the Mediterranean diet.

By integrating nutrigenomics into the study of the Mediterranean diet, personalized dietary recommendations can be developed. Genetic testing and analysis can identify individual genetic variations that affect responses to specific dietary components. Genetic variations influence an individual's response to the diet's components, affecting nutrient metabolism, antioxidant defense mechanisms, inflammatory response, and overall health outcomes.

## **Attainment of SDG 13: Climate Action**

Unstable food systems can contribute to immense climatic changes through various interconnected factors. Extension in land utilization, depletion of freshwater reservoirs, and the contamination of both aquatic and terrestrial ecosystems due to excessive influx of nitrogen and phosphorus all contribute to a surge in environmental pressures<sup>44</sup>. Therefore, for the sake of a dynamic and healthy environment, the integration of sustainable foods in dietary plans has been extensively debated in the past decades. As a matter of fact, human health is intricately linked to the health of the ecosystem<sup>36</sup>.

In this context, the Mediterranean diet is widely recognized as the most sustainable diet plan that yields greater benefits for the planet. MD is considered to have an overall low environmental impact and low carbon footprint, especially because it mainly relies on plant-based foods, it supports local and seasonal products, and it reduces reliance on livestock. Moreover, it also helps in preserving and optimizing human and natural resources for future generations<sup>45</sup>. It is clear that individual dietary choices alone cannot solve the climate crisis. There is a need for stable dietary interventions that can collectively contribute to environment conservation in several ways. The Mediterranean diet serves this purpose in many ways. Some key aspects are as follows.

### ***Sustainable Food Systems***

MD is mainly based on plant-based foods, which require fewer resources and generate lower greenhouse gas emissions compared to animal-based products. Moreover, the Mediterranean region is known for its coastal communities and rich seafood traditions, which include moderate consumption of fish and other seafood. In this way, MD promotes a sustainable diet and reduces the environmental impact associated with animal-origin food systems. The EAT-Lancet Commission aimed to develop a comprehensive diet that is both healthy and sustainable, or most often coined as a “planetary” healthy reference diet designed for an average daily intake of 2500 kcal, mostly following MD pattern. In this way, it leads to decreased environmental degradation caused by food consumption<sup>37</sup>.

### ***Reduced Reliance on Livestock Farming***

Livestock is responsible for 70% of forested clearance for grazing and feeding crop production, which makes it a number one contributor to greenhouse gas emissions. Meat production involves about 2,000% to 10,000% (per kilocalorie of food production) higher greenhouse gas emissions than that of plant-based food production, increased fertilizer use, inflated pollution of fresh water and marine ecosystem and poor air quality, all of these paving a way to the diminishing environmental quality<sup>45</sup>.

Mediterranean diet contributes to the sustainability of the planet by promoting biodiversity which means it reduces the overall demand for meat thereby resulting in plummeted demand for livestock farming<sup>45</sup>.

### ***Reduced Fresh Water Consumption***

Mediterranean diet which is based more on whole cereals, legumes, vegetables, fruits, nuts and olive

oil with lesser consumption of dairy meat and poultry, has proved to reduce the water footprint of food consumption by 17% to almost 48%<sup>46</sup>. The livestock industry is the largest consumer of freshwater used for drinking and cleaning animals. By comparison, the amount of freshwater used to grow the feed that livestock animals eat is quite higher than the water required to grow grains, legumes, beans, fruits, and vegetables that make up a more sustainable diet. Less water consumption by MD also helps in reducing global water scarcity<sup>46</sup>.

### ***Local and Seasonal Food Choices***

The Mediterranean Diet encourages the consumption of locally produced and seasonal foods as suggested by Food and Agricultural Organization (FAO). Choosing locally sourced foods reduces the carbon footprint associated with long-distance transportation and supports local farmers and food producers. By embracing seasonal foods, the diet also promotes a more sustainable use of resources, as these foods require less artificial intervention like extensive greenhouse cultivation or refrigeration<sup>37</sup>.

### ***Preservation of Biodiversity and Reduced Food Wastage***

Mindful eating and portion control are integral parts of MD. By decreasing food waste and irresponsible consumption through proper storage practices and frugality, we can minimize the environmental impact of food production and decrease the amount of organic waste that ends up in landfills. This helps conserve resources such as water, energy, and agricultural land. Moreover, by promoting and preserving traditional food practices through MD, we can maintain biodiversity, protect local ecosystems, and support traditional farming methods that are often more environmentally sustainable compared to industrialized agricultural practices<sup>37</sup>.

## **Attainment of SDG 15: Life on Land**

By the integration of nutrition and ecology, food can be produced through promising agro-ecological systems. Adoption of the Mediterranean diet can contribute to minimizing deforestation and protecting biodiversity by making conscious choices that prioritize plant-based foods, local and seasonal products, sustainable farming practices, and responsible seafood consumption<sup>47</sup>.

Through the consumption of predominantly plant-based meals, the demand for animal products

## Achievement of sustainable development goals through the Mediterranean diet

**Table 1.** Characteristics of Mediterranean diet in promoting sustainable food consumption and accomplishment of SDGs.

Name of SDG	Basic targets	Role of Mediterranean diet in achieving the goal	References
SDG 2: Zero Hunger	<ul style="list-style-type: none"> <li>• Eradicate malnutrition and hunger, and ensure food accessibility to all people.</li> <li>• Promote the adoption of a sustainable and nutritious dietary pattern.</li> <li>• Emphasize the consumption of plant-based foods and reduce reliance on animal agriculture.</li> </ul>	Mediterranean diet consists of mostly plant-based food products, that serves as inexpensive, nutrient-packed healthy regimen ideal for sustainable food consumption.	9,10,11
SDG 3: Good Health and Well-being	<ul style="list-style-type: none"> <li>• Reduce the causes of morbidities and mortalities worldwide.</li> <li>• Highlight the benefits of high-fiber and low-fat diet in reducing the risk of non-communicable diseases (NCDs).</li> <li>• Encourage the adoption of an energy-balanced diet for weight management and overall well-being.</li> </ul>	<ul style="list-style-type: none"> <li>• As MD is rich in dietary fibers, so adoption to MD is effective in reducing the risks of many chronic diseases like obesity, diabetes, CVD, and cancers.</li> <li>• MD is also prescribed to patients of celiac disease, as food products in MD are lacking gluten.</li> <li>• Adherence to MD is associated with reduced onsets of psychological disorders like Alzheimer's &amp; Parkinson's diseases, dementia, anxiety, binge eating disorder and bulimia nervosa.</li> </ul>	3,6,7, 19,29,30- 32
SDG 12: Responsible Consumption and Production	<ul style="list-style-type: none"> <li>• Promote sustainable food production systems which require less land, water, and resources compared to animal-based diets.</li> <li>• Encourage the preservation of ancient crop varieties through biotechnology, supporting biodiversity and sustainable agriculture.</li> <li>• Advocate the use of personalized nutrition.</li> </ul>	<ul style="list-style-type: none"> <li>• MD promotes the consumption of fresh and seasonal crops, and saves biological diversity that has lesser environmental footprints.</li> <li>• MD encourages sustainable agriculture that leads to a reduction in greenhouse gas emissions, land use, and energy and water consumption.</li> <li>• MD has demonstrated positive effects on gene expression. So, through nutrigenomics with MD, the concept of personalized nutrition can be promoted.</li> </ul>	35,36,38, 40-42
SDG 13: Climate Action	<ul style="list-style-type: none"> <li>• Highlight the environmental benefits of the Mediterranean diet, as it reduces greenhouse gas emissions by reducing the demand for livestock farming.</li> <li>• Emphasize the water-saving characteristics of the Mediterranean diet, which relies on plant-based foods adapted to warm climates and requires less irrigation.</li> </ul>	<ul style="list-style-type: none"> <li>• MD is ideal for preserving human and natural resources including climate and ecosystem.</li> <li>• MD reduces the dependence on livestock farming, which in turn saves fresh water, agricultural land and diminish landfills and pollution.</li> <li>• MD conserves biodiversity and reduces food wastage.</li> </ul>	35,36, 43, 44
SDG 15: Life on Land	<ul style="list-style-type: none"> <li>• Advocate for sustainable agricultural practices aligned with the Mediterranean diet, which minimize deforestation and protect biodiversity.</li> <li>• Encourage the cultivation of plant-based foods and promotion of traditional Mediterranean crops, preserving the genetic diversity of the region.</li> </ul>	<ul style="list-style-type: none"> <li>• MD encourages supports local farmers, decreasing the need for large-scale agricultural expansion.</li> <li>• MD prevents deforestation by decreasing dependence on livestock.</li> <li>• MD encourages the cultivation of plant-based foods and promotion of traditional Mediterranean crops, preserving the genetic diversity of the region.</li> </ul>	36, 45, 46



and their associated environmental impacts are reduced. Although not strictly vegetarian, the MD suggests limited consumption of meat, which helps in lowering the demand for livestock production and is a leading cause of deforestation in many regions. Moreover, the consumption of locally sourced and seasonal foods reduces the reliance on long-distance transportation and supports local farmers, decreasing the need for large-scale agricultural expansion. In addition, the MD promotes traditional and sustainable farming practices that have been passed down through generations<sup>37</sup>.

These practices often prioritize biodiversity conservation, including the preservation of heirloom crop varieties, crop rotation, and agroforestry systems, which can help protect ecosystems and mitigate deforestation<sup>12</sup>. By incorporating diverse crop varieties and traditional farming practices, we can enhance resilience, adaptability, and nutritional diversity in food production systems. Agrobiodiversity plays a pivotal role in agriculture as it ensures global food security. The conservation of genetic resources and their sustainable use is essential to maintain a diverse gene pool for future improvements of indigenous crops. In addition, it will also help in the adaptation of crops to changing environmental conditions<sup>48</sup>.

Here, we are summarizing the selected SDGs aligned with the adoption of MD (see Table I), which demonstrates the characteristics of MD in accomplishing these goals.

## Conclusions

Sustainable development is a vital global objective that seeks to balance human prosperity with ecological well-being. Sustainable development goals set by WHO aim to address poverty, economic growth, ecological sustainability, governance, climate change, and resource distribution. Sustainable food systems, including the Mediterranean diet, contribute to achieving these goals by providing healthy diets for all, promoting environmental preservation, and preventing non-communicable diseases. The Mediterranean diet, recognized as an “Intangible Heritage of Humanity” by UNESCO, is a sustainable and accessible dietary pattern that fosters individual well-being and contributes to a sustainable global landscape. By exploring how the Mediterranean diet aligns with specific SDGs, we can uncover its potential to support the achievement of these global objectives.

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## Ethics Approval

Not applicable.

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## Data Availability

Data are reported in the manuscript.

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## Authors' Contributions

Conceptualization, MB; Investigation, KD, MCM and DM; Writing - Original Draft, KD, MCM and LS; Writing - Review & Editing, TB, MD, RSM, SM, EB, CZ HE, GS and DM; Supervision, MB; Funding acquisition, MB. Each author approved the final version of the manuscript.

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## Conflict of Interests

M.C. Medori and D. Malacarne are employees at MAGI'S LAB. K. Donato is employee at MAGI EUREGIO and MAGI-SNAT. M. Bertelli is president of MAGI EUREGIO, MAGI-SNAT, and MAGI's LAB. E. Borghetti is president at AERSAFE srl. C. Zuccato is researcher at AERSAFE srl. E. Borghetti is patent inventor (IT202100021344A1, IT202100020330A1, WO2021260537A1, WO2022259165A1). M. Bertelli is patent inventor (US20220362260A1, US20230173003A1, WO2022079498A1). D. Malacarne is patent inventor (WO2022079498A1; US20230173003A1). S. Michelini is patent inventor (US20220362260A1). M. Bertelli, S. Michelini, and K. Donato are patent applicants (Application Number: 18/516,241). M. Bertelli and K. Donato are patent applicants (Application Number: 18/466.879). M. Bertelli, K. Donato, and S. Michelini are patent applicants (Application Number: 63/495,155). The remaining authors have no conflict of interest to disclose.

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