

## Evaluation of Popular Diets for Sustainability

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## ABSTRACT

According to the State of Food Security and Nutrition in the World 2021 report, between 720 and 811 million people in the world faced hunger. Therefore, transforming food systems for food security, improved nutrition and affordable healthy diets for all is important issue in the fight against hunger. Healthy diets can also play a considerable role in increasing the sustainability of food systems. But can all healthy diets also be considered sustainable diets? Sustainable diets are low in environmental effects, culturally acceptable, accessible, economically viable, nutritionally adequate, safe, and healthy. As can be understood from the definition, being healthy can actually be considered as one of the conditions necessary for the sustainability of diets. While examining diets in terms of sustainability, aspects such as environmental effects, cultural acceptability and economic accessibility should also be evaluated. The aim of this review is to evaluation sustainability of popular diets eaten for their health effects, applied by many people to achieve weight loss, or to prevent or provide treatment for various diseases.

**Keywords:** Popular diets, Sustainability, Mediterranean Diet, Vegetarian diet, Nordic diet

## Introduction

Our current food system:

- Contributes approximately 20-30% of anthropogenic greenhouse gas (GHG) emissions.
- Contributes to deforestation (to provide space for production), which is considered among the leading causes of land use change and biodiversity loss.
- Is responsible for 70% of water use and is the major cause of water pollution.
- Includes unsustainable fishing practices causing loss of fish species and biodiversity in the aquatic environment (Garnett et al., 2014).

All these situations destroy the environment that future food production will need. In addition, with the effects of climatic and environmental changes, food production has become more difficult and unpredictable in many parts of the world. All these problems will become more acute unless an action plan on this issue is developed (Garnett et al., 2014). In addition, increases in the global population and in urbanization also stimulate changes in our eating habits. Our demand for foods with high land use and GHG density such as meat and dairy products cause more damage to the environment and aggravate chronic disease problems (Garnett, 2014). Therefore, we need to reduce the amount of food lost or wasted along the entire supply chain, and replace our food systems and diets with more 'sustainable' food systems, with lower environmental impact, and healthier for people (Garnett et al., 2014).

Does a healthy diet also mean a sustainable diet? There is no simple answer to this question because of the fundamental differences between a healthy diet and a diet with a low environmental impact. A healthy diet is mainly associated with the intake of nutrients and other healthy substances. Therefore, providing a variety of foods and adequate intakes are sufficient for a healthy diet model. In contrast, GHG emission is associated with the food itself rather than the nutrient content. With regard to protein, for example, dietary reference values have been established for minimum protein intake, and protein can be obtained from plant-based or animal sources. However, determining the protein source as plant or animal based or how it is produced, transported will significantly change the GHG emission. In this context, it cannot be assumed that a healthy diet that meets nutrient requirements will necessarily have low GHG emissions and that this diet must necessarily be a sustainable diet (Macdiarmid, 2013). The

purpose of this review is the evaluation of popular diets regarding sustainability while explaining the concept of sustainable diets and their determinants.

## Definition and Historical Perspective of the Sustainable Diet Concept

In recent years, interest in sustainable diets has increased significantly, both as a public health issue and as a critical issue for sustainable environment. This concept was first proposed by Gussow and Clancy in the early 1980s for a healthier environment and longer-term stability in nutrition systems (Gussow & Clancy, 1986). However, over time, it has become a concept that simultaneously refers to the rules for the protection of health while preventing excessive degradation and consumption of natural resources.

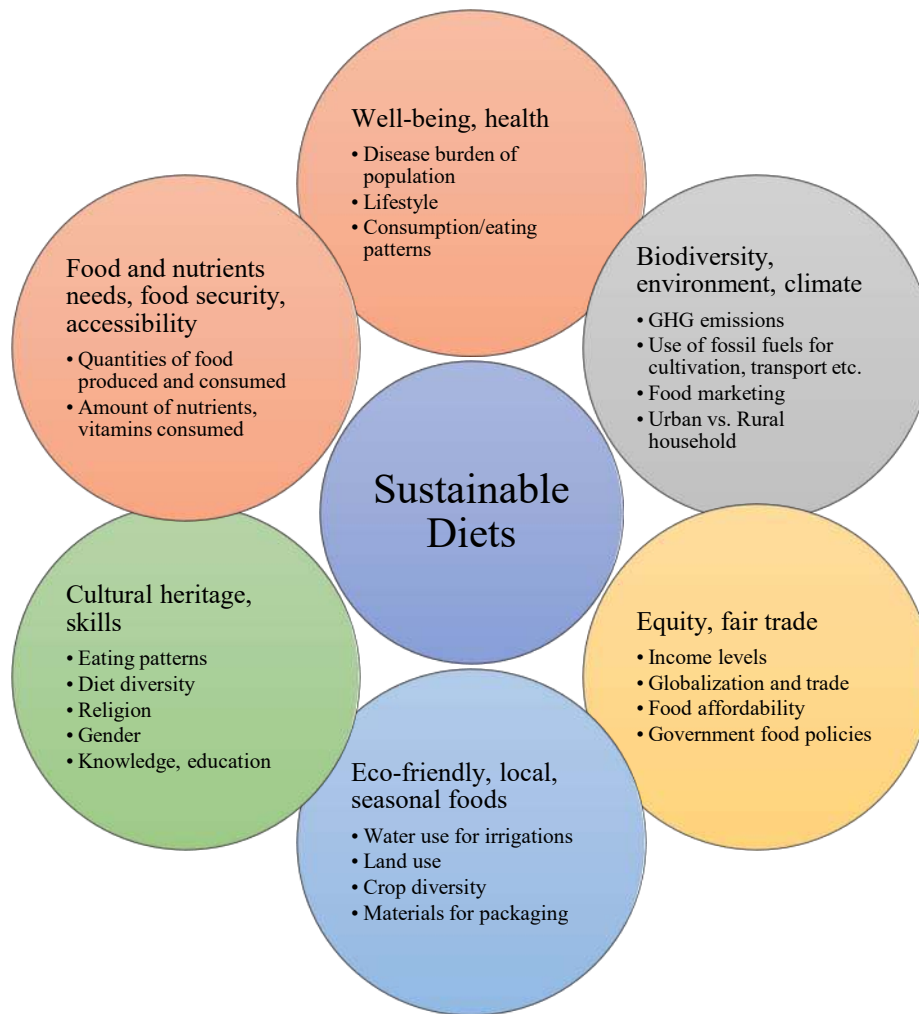
In 2010, FAO defined the concept of sustainable diets as: “Sustainable diets are protective and respectful to biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable; nutritionally adequate, safe and healthy, and it is a diet that optimizes natural and human resources ” (Burlingame & Dernini, 2012)(page 83). This internationally accepted definition today acknowledges the relationship between food production and consumption with nutrient requirements and also reaffirms the idea that human health cannot be isolated from the health of ecosystems (Dernini, 2019).

## Determinants of Sustainable Diets

To understand a sustainable diet, it is necessary to consider the nutritional value of diet and the agricultural, environmental, socio-cultural and economic determinants that affect food consumption (Johnston et al., 2014). Figure 1 illustrates the determinants of a sustainable diet, including interrelated and influencing factors and processes. In the figure, the rings are formed according to the key components included in FAO's definition of sustainable diets. Within each key component, different factors and processes that can affect sustainable nutrition are also identified. Each component is directly related to the definition of sustainable diet in the middle of the figure and they can also affect each other. Classifying a food as only animal or plant-based, locally produced or imported may mislead us when evaluating its contribution to sustainability. When considered in terms of sustainability, it is important what, how, where it is produced and how much is consumed. Thus, many factors affect sustainability, from production to consumption of food.

## The Contribution of Basic Food Groups to Sustainability

The energy and nutrients needed daily must be taken into the body with foods, and healthy nutrition is based on a variety of foods. Foods are divided into groups according to the nutrients they contain (Pekcan et al., 2016). But there is no internationally standardized approach to food groupings because the actual classification of food has been shown to be highly culturally dependent. Databases related to food composition may contain 10-25 food groups. Examples of food groups included in databases related to food composition are as follows: cereals and cereal products, vegetables and vegetable product, fruits and fruit product, fish and fish products, meat and meat products, eggs, milk and milk products, nuts and seeds, oils and fats, beverages, sugar and syrups etc. (Greenfield & Southgate, 2003). The contribution of food groups to sustainability is summarized in Table 1, which also shows the contribution of foods and food groups to global warming potential.



**Figure 1.** The key components and determinants of a sustainable diet (Johnston et al., 2014)

### Milk and dairy products

Foods in this group have high environmental impacts in terms of GHG emissions, biodiversity, water and land use. The fact that cows are ruminants is a major reason for dairy products creating high environmental effects. The main sources of GHG emissions are feed production and processing (45% of the total), output of greenhouse gases during cow digestion (39%) and manure decomposition (10%) (Stoll-Kleemann & O’Riordan, 2015).

### Meat, eggs, legumes and nuts

Meat and fish have more environmental impact than the other foods in this group. In particular, meat has high environmental impacts on GHG emissions, biodiversity, water and land use (Garnett et al., 2014). Meals containing meat are known to produce an average of nine times more GHG emissions than their plant-based equivalents. In the case of beef, 10-20 times greater environmental impact can occur (Reynolds et al., 2014).

## Cereals and starchy tubers

Foods in this group (corn, wheat, potatoes, etc.) generally have low GHG emissions. However, rice production usually requires irrigation and causes high levels of methane gas production (Williams et al., 2013).

## Fruit and vegetables

With few exceptions, many fruits and vegetables have low GHG emissions and low environmental impacts (Garnett, 2006; Stoessel et al., 2012).

# The Contribution of Popular Diets to Sustainability

## Western diet

Today's Western diet is characterized by inadequate intake of mono and polyunsaturated fatty acids, dietary fiber, and micronutrients, but high levels of processed and other foods with saturated fatty acids and trans fatty acids. The most consumed foods in the Western diet are beef, processed meat products, refined grain products, eggs, french fries, high-fat dairy products, sugar, and sugar-containing products (Neustadt, 2006).

Excessive energy intake is also associated with the Western style dietary pattern and a resultant high risk of obesity, heart disease, diabetes, some cancers and metabolic dysfunctions. The energy from added sugars likewise plays a role in the development of heart disease, diabetes mellitus, insulin resistance, increased blood lipid levels, and other adverse health conditions. Excessive sodium intake has been associated with prehypertension and hypertension. At the same time, high sodium intake has a great effect on the development of stroke, kidney disease and coronary heart disease (Grotto & Zied, 2010).

Western-style diets cause negative effects on the environment due to the foods they contain. A significant share of the environmental impacts of Western diets, including land use, water use, GHG emissions, nitrogen and phosphorus pollution, results from animal husbandry. In addition, the high demand for beef in Western countries can be considered among the most important reasons for the destruction of tropical forests and loss of biodiversity. Therefore, the adoption of alternative diets that are richer in plant-based foods and contain less animal products plays an important role in reducing negative environmental impacts as well as the risk of noncommunicable diseases worldwide (Laroche et al., 2020).

## High protein diets

With the increasing prevalence of obesity worldwide, a wide variety of dietary recommendations are given for weight loss and weight management. One of these is the high protein diets that have become the focus of attention in recent years (Schwingshackl & Hoffmann, 2013). In general, although there is no general consensus on the concept of a high protein diet, diets in which the ratio of energy from protein exceeds 25% or diets containing more than 2g/kg protein are specified as high protein. An example of a high protein diet is the Zone diet, in which 35% of the energy is provided from protein (De Souza et al., 2008).

Studies have shown that high protein diets are effective in weight loss and its preservation (Hansen et al., 2021). Significant improvements in fasting insulin, indicators related to lipid metabolism and blood pressure can be achieved with high protein diets (Santesso et al., 2012). However, it has been reported that high-protein diets may cause health-threatening side effects as well. Although more common in people with any health problems such as metabolic

syndrome and type-2 diabetes, it has been shown that high protein diets can adversely affect renal health or stimulate an increase in blood pressure (Westerterp-Plantenga et al., 2012).

**Table 1.** Summary of global warming potential (GWP) values (kg CO<sub>2</sub>-eq/kg) for production of foods (Clune et al., 2017)

Food Groups	Cultivated (not wild) Foods	Mean GWP values (kg CO <sub>2</sub> -eq/kg)
<b>Fruits &amp; Vegetables</b>	All field grown vegetables	0.47
	All field grown fruit	0.50
	Passive greenhouse fruit and vegetables	1.02
	Heated greenhouse fruit and vegetables	2.81
<b>Starchy Tubers &amp; Grains</b>	Cereals	0.53
	Rice	2.66
	Potatoes	0.20
	Carrots	0.22
	Beetroot	0.23
	Celery	0.18
<b>Proteins</b>	Legumes and Pulses	0.66
	Tree nuts combined	1.42
	Milk (world average)	1.39
	Yoghurt	1.43
	Cheese	8.86
	Butter	11.52
	Cream	5.32
	Eggs	3.39
	Chicken	4.12
	Turkey	6.04
	Fish (all species combined)	4.41
	Prawns, shrimp	14.85
	Mussels	7.54
	Lobster	21.74
	Lamb (world average)	27.91
	Beef (world average)	28.73
<b>Fats</b>	Seeds (Rapeseed (canola), mustard seed, sesame seed and sunflower seed)	1.46
	Avocados	1.30

\*Some studies have found that organic production practices reduce GHG emission rates compared to conventional production (Lynch et al., 2011; Skinner et al., 2014).

When high protein diets are examined in terms of sustainability, the first issue that needs to be addressed is the protein source in the diet. Dietary proteins are obtained from animal foods, plant foods and alternative sources such as mushrooms (mycoproteins). Globally, between 1961 and 2009, the average intake of animal protein per person increased by 59%, while vegetable protein increased by only 14%. In fact, the total consumption of animal foods is expected to increase by approximately 80% between 2006-2050. Animal foods have a more destructive effect on the environment than plant foods (Diouf & Sheeran, 2010). These impacts include (a) water use, (b) an increase in anthropogenic GHG emissions and global warming, (c)

environmental effects due to ammonia (NH<sub>3</sub>) and urea production, and (d) soil erosion due to grazing animals (Wu et al., 2014).

Therefore, encouraging the replacement of animal proteins with vegetable protein sources can have a positive effect on reducing climate changes and biodiversity loss. On the other hand, the effect of vegetable proteins on the environment cannot be ignored, as they contribute moderately to deforestation and desertification due to agricultural activities, reduced soil fertility, pollution of water resources with agricultural chemicals, and efforts to increase cultivated areas. However, some of the most harmful practices relate to animal feed production. Overall, the use of vegetable proteins in general can reduce the demand for animal protein sources and consequently the environmental impact of the diet (Fasolin et al., 2019).

## Vegetarian diets

The term “vegetarian” was established in 1847 by the UK Vegetarian Society. However, vegetarianism has its origins in ancient India and Greece as far back as at least 600 BC. The typical motivations for vegetarianism include health concerns, religious or ethical beliefs, political, and ecological reasons. There is no consensus on the definition of a vegetarian diet. The Vegetarian Society defines the term vegetarianism as “a diet with or without dairy products and eggs but with grains, legumes, oilseeds, vegetables and fruits”. Vegetarian diets are often categorized as lacto-vegetarian (containing milk and dairy products), ovo-vegetarian (containing eggs), lacto-ovo vegetarian (containing milk and / or eggs) (Burkholder et al., 2016) or vegan (eliminating all foods and other products of animal origin, often even honey).

Vegetarians differ in their gut microbiota profile from omnivores, for example because they contain more phytonutrients. Intestinal microbiota is thought to be the main link between dietary patterns and inflammatory response. This is one way in which vegetarian diets can reduce inflammation and produce positive health effects. Vegetarian diets can help prevent or treat diseases such as cardiovascular disease, hypertension, metabolic syndrome and diabetes, obesity, cancer, kidney disease and rheumatoid arthritis. Epidemiological and clinical studies increasingly focus on vegetarian diets to help explain disease rates and all-cause mortality (Yeh & Glick-Bauer, 2016); (Salonen & Helne, 2012).

In addition to their effects on health, vegetarian diets have a lower ecological footprint (Salonen & Helne, 2012). One study in Scotland found that the ecological footprint of the lacto-ovo vegetarian diet was 40% lower than that of omnivorous diets (Frey & Barrett, 2007). This is because, compared to plant foods, meat and dairy products are clearly responsible for a large share of the environmental burden of natural resource use and food production.

In a study in California, it was shown that the agricultural inputs required to produce the foods consumed by non-vegetarians required 2.9 times more water, 2.5 times more energy, 13 times more fertilizer and 1.4 times more pesticides (Marlow et al., 2009). Similarly, data from the Adventist Health Study-2 (AHS-2) and the EPIC (European Prospective Investigation of Cancer)-Oxford, each of which consists largely of vegetarian participants, vegetarian diets showed 29-60% less GHG emissions than non-vegetarian diets (Segovia-Siapco & Sabaté, 2019). As a result, vegetarian diets, with their positive health effects and low carbon footprints, are important for ensuring global food supply and environmental sustainability. However, as mentioned earlier, source (e.g., locally produced vs air-shipped) and the production mode (e.g., greenhouse, open-air vs organic) of the foods and adequacy of diet in terms of nutrients also affects the sustainability of vegetarian diets.

## Dietary approaches for prevention of hypertension (DASH diet)

In response to the increasing prevalence of hypertension in the United States, the DASH diet was developed in the mid-1990s. Although this diet model was originally developed to lower blood pressure, it has also been found to have positive effects on various other disease risk factors and outcomes, including improvements in cholesterol level and insulin sensitivity. This is a balanced diet that can be followed by anyone seeking a healthier lifestyle (Lessens & Rakel, 2018). The DASH diet includes high amounts of vegetables and fruits, protein (low-fat dairy products, poultry, fish, etc.), whole grains, oilseeds and the other foods rich in fiber, potassium, calcium and magnesium known to have a positive effect on lowering blood pressure. On the other hand, the ratio of total and saturated fat, cholesterol, red meat, sodium, and sugar-containing beverages is very low in this diet (Rifai & Silver, 2016).

Reducing red meat consumption, total and saturated fat intake and increasing consumption of fruits and vegetables in the DASH diet reduces the environmental impact of the diet (Reynolds et al., 2014). Using data from the EPIC Norfolk UK cohort study, the contribution of the DASH diet model to GHG emissions and the estimated cost of the diet were evaluated (Perignon et al., 2017). The contribution of adults in the group with high compliance with the DASH diet to GHG emissions was found 16% less than the individuals with low diet compliance. However, compliance with the DASH diet model was also recorded as being associated with an 18% higher cost. One of the most important changes in making diets more sustainable is reducing the amount of meat in the diet. However, the choice of meat replacement foods is crucial (Perignon et al., 2017). In fact, although available evidence shows that a diet low in red meat and rich in fruit and vegetable content has less environmental impact, in some cases, an increase in the amount of fruits, vegetables and grains consumed to replace animal protein may have a similar environmental impact (Reynolds et al., 2014). Because source, production mode, where it is produced and how much is consumed of the foods recommended to replace meat in the diet are the main determinants of GHG emissions, thus affecting the sustainability of the diet. Also, removing meat from the diet can negatively affect diet quality by causing nutrient deficiencies. In this case, it is necessary to consider the foods recommended instead of meat in terms of both nutrient content and sustainability (Perignon et al., 2017).

## Mediterranean Diet

The Mediterranean Diet refers to the eating habits observed in the Mediterranean region, proposed and developed in the 1950s. It was studied as a healthy diet model in the 1960s, and it has been reported to play an important role in reducing the risk of metabolic syndrome, type 2 diabetes, cardiovascular diseases, some neurodegenerative diseases and cancer development. In addition, with the increase in compliance with the Mediterranean diet model, a reduction in waist circumference, which is important for maintaining healthy body weight and central obesity, can be achieved. There are also health effects that are still under investigation. Therefore, compliance with the Mediterranean Diet is an important health promotion strategy (Bendall et al., 2018; Sánchez-Sánchez et al., 2020).

Research on the Mediterranean Diet as a sustainable diet model date back to the 1990s. As the Mediterranean Diet is plant-based, Gussow (1995) has pointed out that it reduces the need for water and energy resources, reducing its effect on the ecosystem. In 2010, after the sustainable diet concept was updated by FAO, the Mediterranean Diet was accepted as an example of a sustainable diet (Dernini & Berry, 2015). In Mediterranean cultures, meals go beyond meeting physiological energy needs. Meals that are consumed with the family or collectively represent an opportunity for social change and communication. Therefore, the Mediterranean Diet

actually represents a socio-cultural heritage. Finally, the Mediterranean Diet has important economic implications. Recognition of the Mediterranean Diet as the Intangible Cultural Heritage of Humanity by the United Nations Educational, Scientific and Cultural Organization (UNESCO) reinforces its status as a healthy and sustainable diet (Serra-Majem et al., 2019). The Mediterranean Diet has a lower environmental impact than other diet models. This effect is due to the fact that more plant-based foods are consumed and fewer animal products are consumed, resulting in a lower water footprint and GHG emissions. In addition, the Mediterranean Diet promotes the consumption of not only cultivated products but also wild species. Therefore, preserving and promoting the Mediterranean Diet is of paramount importance for preserving biodiversity in the region. Many other factors such as seasonal consumption of fresh and local products and traditional cooking methods are also important factors for the Mediterranean Diet to be a sustainable diet (Dernini et al., 2017).

These effects are due to the fact that local and traditional consumption is at the forefront, there is no serious dependence on agriculture, and food imports are very low. In addition, preventing and reducing food waste are among the other economic effects of this diet model. Thus the acceptance of the Mediterranean Diet as a sustainable diet is due to the nutritional, health, socio-cultural, economic and environmental effects of this diet model (Dernini et al., 2017).

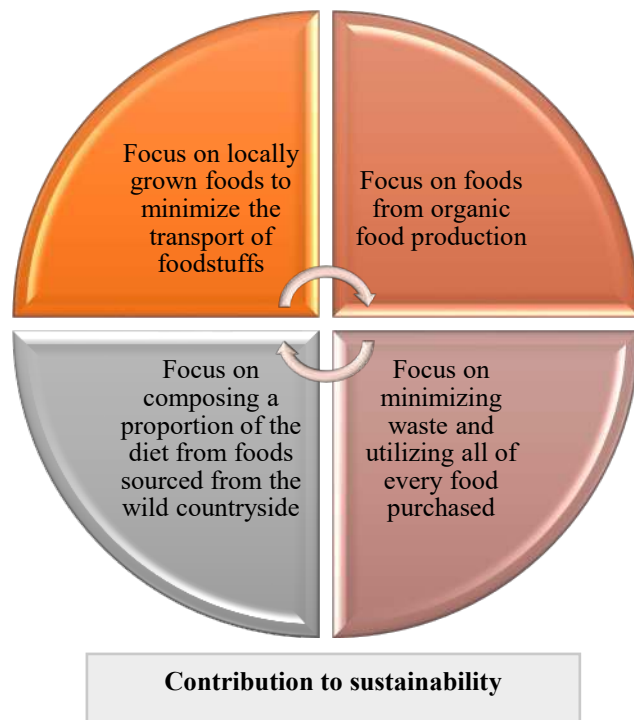
### Nordic diet

In recent years, the Nordic diet has emerged as a healthy and regional diet option. However, the history of this diet is much older in Nordic regions (Bügel et al., 2016). The Nordic diet and the Mediterranean Diet are similar in many ways, such as eating more fruits and vegetables, consuming whole grains, fish, eating less meat, and avoiding processed foods. However, in the Nordic diet, foods and tastes from the Northern climate are more prominent. For example, while olive oil is used in the Mediterranean Diet, the use of canola oil is higher in the Nordic diet. Therefore, the basic principles for the Nordic diet are that foods should have a Scandinavian identity, be sustainable, high gastronomic quality and healthy. For the Nordic diet, four basic principles are especially important in ensuring sustainability (Mithril et al., 2012). In Figure 2, Nordic diet general guidelines and four basic principles that ensure sustainability especially in terms of environmental impact is shown. High organic food production, care for soil, biodiversity, quality, health and the welfare of nature all contribute to making this a sustainable diet model. It also includes a proportion of the diet from wild foods, helping to preserve biodiversity and minimizing the use of fertilizers and pesticides (Mithril et al., 2012). The Nordic diet is considered to be similar to the Mediterranean Diet due to its health-promoting effects (Renzella et al., 2018).

### Conclusion and Suggestions

Sustainable diets are low environmental impact, culturally acceptable, accessible, economically appropriate, nutritionally adequate, safe and healthy diets. All healthy diets are not necessarily also sustainable. In order to be a sustainable, in addition to being healthy, a diet has to have a low environmental impact, to be accessible by everyone, thus having a low cost. A preference for unprocessed foods produced locally and in accordance with the principles of organic production, consumption of foods in season, and the prevention food waste are among the determinants of sustainable diets. The Mediterranean Diet is the main diet that has been accepted as a sustainable diet model. In addition, the Nordic diet and vegetarian diet principles can be preferred in ensuring adequate and balanced nutrition, health protection and sustainability. General recommendations for sustainable, healthy diets are listed as follows by the UK Department of Environment, Food and Rural Affairs (Garnett et al., 2014):

- Choosing a varied and balanced diet to ensure a healthy body weight
- Consumption of plant foods, at least 5 portions of fruit and vegetables a day (produced locally and in accordance with organic farming principles can be preferred)
- Knowing where and how food is produced, avoiding food waste
- Reducing meat consumption, increasing legumes and other protein sources (those with low GHG emissions should be preferred)
- Reducing high-fat, sugar and salt-containing foods in the diet



**Nordic diet general guidelines**

- Consumption of more fruits and vegetables (especially berry group fruits, cabbage, root vegetables, potatoes and fresh herbs)
- More whole grains - especially oats, rye and barley
- Better quality but less meat
- Higher seafood consumption

**Figure 2.** Nordic diet general guidelines and four basic principles that ensure sustainability, especially in terms of environmental impact (Mithril et al., 2012)

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