SUSTAINABLE DIETS: BRINGING BIODIVERSITY TO THE PLATE

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Abstract

Sustainable Diets are diets with low environmental impacts that contribute to food and nutrition security and 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. The concept of sustainable diets presents an opportunity to successfully advance commitments to sustainable development and the elimination of poverty, food and nutrition insecurity, and poor health. For achieving sustainable food practices some transformations are required. the accessibility of food in an amount and quality adequate to meet dietary needs, uncontaminated by harmful substances, and acceptable within a particular culture; the availability of such food in sustainable methods that are not hindering the fulfillment of other human rights. This review discusses different methods of transformation, from food production at the farmer's stage to the consumer plate, and factors that determine the biodiversity of sustainable diets.

Keywords: Sustainable diets, nutrition security, natural resources, biodiversity

1. Introduction

Food systems have the power to promote both environmental sustainability and human health, yet they are currently endangering both. The immediate task is to provide a growing global population with a healthy diet from sustainable food systems. Even though the world's food production has increased along with the population, more than 820 million people still lack access to enough food, and many more consume poor-quality diets that deplete them of micronutrients and significantly increase their risk of developing non-communicable diseases like diabetes, cardiovascular diseases, and stroke [1]. In terms of morbidity and mortality, unhealthy diets are more dangerous than alcohol, drug, and tobacco use together [2]. As many environmental systems and processes are inefficient, a large portion of the world's population is malnourished, and thus some global food system transitions are much required.

Sustainable diets are those that have a minimal negative impact on the environment, support nutrition and food security and promote a healthy lifestyle for both current and future generations [3]. Sustainable meals are safe and nutritious while providing healthy options for healthy living. They are also protective for proving biodiversity and ecosystems, accessible, economically equitable, and affordable.

The World Health Organization (WHO) claims that food production is responsible for up to 66% of groundwater usage and 20–30% of global emissions of greenhouse gases [4]. A sustainable diet is beneficial for human growth, and will also focus on food diversity. A sustainable diet takes into account how it will impact both the environment the human, and the entire food chain. Various factors determine the sustainability of a diet is like, nutritional adequacy, biodiversity, environment safety, cost, and general health [5].

Achieving healthy diets from sustainable food systems will necessitate significant changes in eating habits, significant decreases in food loss and waste, and significant advancements in food production techniques [6].

Human health and environmental sustainability are intricately linked by diet. To identify win-win diets (i.e., healthy and environmentally sustainable), the scientific targets for healthy diets and sustainable food systems are combined into a single framework, the safe operating zone for food systems[7]. With great potential for local modification and scaling, we suggest that this framework is universal for all food cultures and production systems around the globe. Maintaining one's health and ensuring that the world has enough resources to feed future generations of humans are both possible with a sustainable diet[8]. A sustainable diet seeks to have a good impact on the person and the environment now and in the future, in the simplest words possible. However, some diets and food products could be more environmentally friendly than others, and choosing them can help someone lessen their influence on the environment.

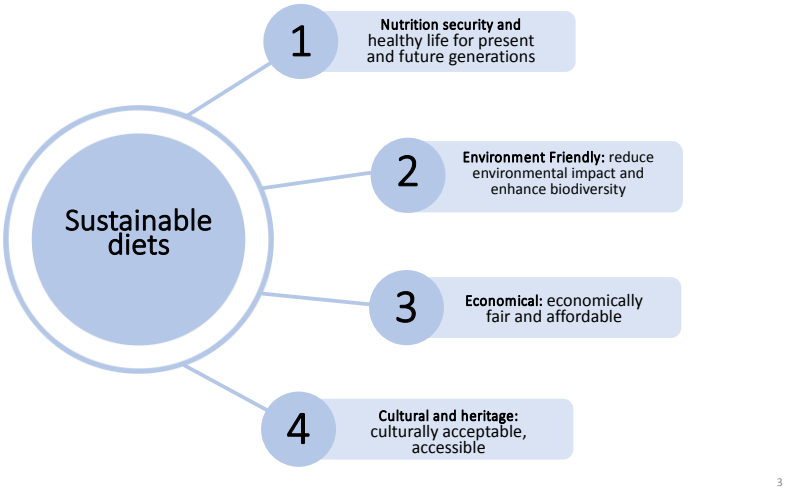

Fig 1: Sustainable Diets

1.2 Environmental effects of foods:

It is challenging to discern and evaluate with a high degree of accuracy the specific environmental footprints of different food products due to methodological discrepancies and data gaps. Recent analyses of the literature reveal a lack of integrated analysis and underrepresentation of some of the key environmental effect dimensions of food systems, and the majority of current food and nutrition research that evaluate environmental consequences only takes greenhouse-gas emissions into account [9].

Studies on the food footprint typically ignore many factors, that include biodiversity, welfare for animals, leakage of nutrients, and chemical use. But findings from a vast and expanding body of literature suggest that there is very likely a definite hierarchy of impacts among larger dietary categories [10]. Clune and colleagues for instance, give the greenhouse-gas emissions of several food categories from life-cycle assessment studies and demonstrated that cereals, fruits, and vegetables have the lowest environmental effects per serving, whereas meat from ruminants has the highest effects [11].

Food production and human well-being depend on the earth's system processes, which must be protected through the development and application of sustainable food production strategies. Agricultural landscapes are being made more productive and resilient through the employment of farming and fishing techniques that utilize ecosystem services like insect control, pollination, water regulation, and nutrient cycling while minimizing negative environmental effects 12].

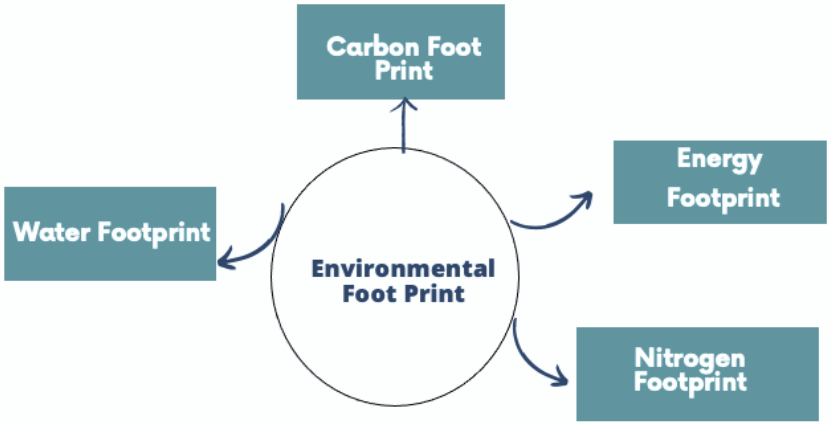

Fig 2: Environmental Footprint

Some farms are currently experimenting with recycling animal manure for use as fertilizer and methane gas capture to meet their energy requirements. It is more sustainable to eat more plant-based meals than animal-based foods [13]. It is more sustainable to eat more plant-based meals than animal-based foods. However, the use of a sustainable diet largely depends on various factors like methane production from poultry and fishing, land use, and water utilization for crop production. To prevent maximum land utilization and carbon footprint, local food diet utilization can be a promising approach [14].

2. Determinants of sustainable diet:

From the standpoint of the consumer, a sustainable diet is defined by four key factors. The four factors that determine whether a diet is sustainable are:

a) the percentage of foods in the diet that is of animal versus plant origin;
b) the percentage of processed versus whole foods;
c) the percentage of imported versus locally grown foods; and
d) the percentage of food that is wasted.

Globalization, industrialization, population growth, and urbanization have all altered food production and consumption practices in ways that have a significant impact on ecosystems and dietary habits [15]. The availability and affordability of refined carbohydrates and fats have expanded due to high-input industrial agriculture and long-distance transportation, simplifying diets and placing a greater emphasis on a small number of foods that are high in energy. The issues of obesity and chronic disease, which are increasingly accompanied by micronutrient deficiencies and undernourishment, are exacerbated by diets that are high in calories but lacking in variety [16].

3. Strategies for a Great Food Transformation:

The strategies are suggestions for starting procedures. These approaches are instead offered as possible starting points for future context-specific national, regional, city, and local change.

3.1 The updated Food Pyramid

The updated food pyramid suggested in Mediterranean Diet targets the healthy adult population (18-65 years) and can be modified as per individual nutritional requirements and special challenges like pregnant women, lactating women, and elderly or kids[17]. The base of the pyramid contributes the highest amount of carbohydrates in grams per day. Proteins from non-vegetarian sources are reduced from daily to weekly consumption due to their high carbon footprint. The pyramid's top showed the minimum intake of sugar along with animal products [18]. These foods can be consumed occasionally. And the preference is given to seasonal, locally grown fruits and vegetables, to support biodiversity and traditional foods.

Fig 3 : Updated Sustainable Food Pyramid

3.2 Meal Constitution/ Arrangement:

As per the food pyramid, the main meal must have cereals, carbohydrates, fruits and vegetables locally grown, and a small quantity of legumes and beans. Cereals can be taken in the form of pasta, rice, bread, and whole grains in 2-3 servings in every meal. 3-4 servings of vegetables should be consumed in both lunch and dinner in raw salad form or cooked. Fruits can be consumed as dessert or salad in 2-3 servings [19]. To prevent micronutrient deficiency, foods from a broad range of colors must be included in the diet [20]. The main meal in Mediterranean Diet Pyramid suggests the intake of more plant-based foods for the prevention and control of chronic illnesses and minimizing the greenhouse effect [21]. Foods (fruits and vegetables) that undergo less processing tend to retain more nutrients. Hence, the foods must be minimally processed and seasonal [22]. Furthermore, the more plant-based foods are consumed, the lesser will be land, water, and resource utilization and ensure food security to a wide population [23]. However, the area of land utilization depends on population growth, investment pattern, and productivity.

3.3Source of Mediterranean Diet

3.3.1 Olive Oil:

Olive oil, a source of dietary lipids, should be consumed as Extra Virgin Olive Oil (EVOO), due to its resistance to high temperatures [24]. It can be used for both low-flame cooking and salad dressing. Many times, in Mediterranean Diet, olive oil is served in major meals along with potatoes, pasta, vegetables, or rice, which increases its nutritional value [25]. Although olive production requires significant land usage, however, negative impacts on the environment can be reduced by adopting good farming practices [26]. Moreover, olive trees assist in removing CO2 from the environment. Olive trees remove 10-12kgs of CO_2 from the environment for the production of 1 liter olive oil [27]. Olive oil has beneficiary effects on cardiovascular diseases. Other than this, palm oil, is also considered a valuable alternative to olive oil and is used in several commercial food products like processed foods [28].

3.3.2 Olives and seeds intake:

Regular consumption of Nuts and oilseeds plays an important role in preventing and controlling cardiovascular diseases, and diabetes, improving the metabolic profile and thus reducing the episodes of mortality and morbidity. Olives and oilseeds are potential sources of dietary fiber, healthy fats, vitamins, minerals, and antioxidants [29,30,31]. Mediterranean Diet food pyramid suggests a handful of nuts and oilseed intake as healthy snacks, which can be a promising approach towards a healthy lifestyle from plant-based proteins and sustainable development.

3.3.3 Herbs and Spices:

Herbs and spices along with onions and garlic give a particular aroma that increases the palatability of food. Herbs and spices are good sources of antioxidants and micronutrients. Herbs and spices are not only limited to the Mediterranean basin, but also now spreading aroma, throughout the world [32].

3.3.4 Pulses and Legumes:

As per sustainable development, more proteins must be obtained from plant-based sources. Other than this, lean meats, fish, poultry, and eggs can be used if available at a reasonable cost. The modified Mediterranean Diet pyramid suggests 1-2 servings of protein-based foods. Pulses and legumes, being plant origin, fix the nitrogen in the soil and improve soil fertility [33].

3.3.5 Milk and Milk Products:

Milk and milk products must be consumed on a daily basis with 1-2 servings, in the form of curd, milk, or cheese. Dairy products are a great source of calcium, phosphorus, and proteins [34]. In addition to this, it improves the digestive system through probiotic drinks. The intake of dairy products along with meat is an area of concern, as it requires the specified land and water, along with feed [35]. So the variety of dairy products from local farmers and small-scale industries must be preferred.

3.3.6 Fish, Seafood, Eggs, and Poultry:

Fish and seafood have always been an essential part of the Mediterranean Diet and it is not only a great source of protein but also, a rich source of omega-3 fatty acids, eicosapentaenoic acid (EPA), and docosahexaenoic acid (DHA) [36]. In terms of sustainability, since, fish and sea foods are reported as wild stock, there are always risks of depletion. Hence, to prevent the risk of depletion, and maintain the stock, aquaculture fish is the most promising and sustainable alternative. Aquaculture fish are equally good in nutritional benefits. Moreover, they are a great source of animal proteins and micronutrients; however, the lipid profile is largely depending on the type of feed [37]. Poultry and eggs are a good source of proteins and required to take three to four servings per week to achieve a balanced diet. Poultry meat and eggs have a minimum impact on environmental sustainability. Waste produced organically produced sea foods or poultry farming is recycled to improve soil fertility [38].

Red and processed meats must be limited to less than 2 servings/ week, as considered to be high sources of cholesterol and saturated fats and associated with increased risk of cardiovascular diseases, type 2 diabetes, and mortality. Thus, the reduced intake of red meat and processed meat is associated with health benefits and has a high environmental impact. In addition to this, meat cultivation, and processing require large land use and release methane, which is a contributory factor for greenhouse gas emissions [39].

3.3.7 Sugar, Sweets, and Pastries:

The top of the pyramid consists of sugar, sweets, and ultra-processed foods that should be consumed at minimum amounts as they not only lack nutrients but also, the cultivation and processing require a large number of resources, land use, and fuel. Hence, the intake must be limited to two to three small servings per week or must be consumed occasionally. Other than this, consumers can prefer, natural sources like fruit juices, whole fruits, dried foods, and honey as more healthy and sustainable alternatives for sweetness in the diet [18, 40].

3.3.8 Water and Fluid Intake:

Water is an essential part of the human body and must be consumed at least 1.5 lit to 2 lit for healthy individuals, although the requirement may vary as per age, physical activity, and environmental conditions. To prevent environmental damage, and reduce the footprint, tap

water should be proffered over packed and commercial drinking water. The usage of plastic bottles and containers must be avoided [41].

Other than water, there must be limitations on the usage of beverages and alcohol intake as they are only the source of sugars. Instead of that, the preference can be given to locally produced tea and coffee, as much as possible.

3.3.9 Serving Size:

The serving size of all the foods should be calculated as per individual energy needs and physical activity. The portion size should be larger from the base of the pyramid and consumed in large quantities to avoid food wastage. The foods from the upper portion should be consumed in small quantities and less frequently [42].

Other than this, regular physical activity (at least 30 min. a day) and muscle strengthening exercises must be practiced for energy balance, and maintain a healthy weight. To promote sustainability, and reduce adverse environmental effects, a modified Mediterranean Diet, promote the variety of locally grown, traditional, and seasonal foods to maintain biodiversity among the population also and indeed it will not increase the expenses as well[43].

3.4 Sustainable and Environment-Friendly Food Production:

For healthy well-being and wide food production to cater to the large population, there is a need to safeguard the earth by developing a sustainable food production system. Increasing evidence shows that food production is the largest cause of global environmental change, and a transition to sustainable food production is necessary for global sustainable development. A universal definition of sustainable food production should use a system-wide assessment of the environmental effects of a comprehensive set of parameters at various scales [44]. Greenhouse-gas emissions, land and water use, nitrogen and phosphorus application, biodiversity loss, and chemical pollution from herbicides and pesticides are increasingly assessed and used in definitions of sustainable food production. The development of a sustainable food system takes sustainability into account on all levels. The development of the food system must concurrently produce positive value in the three dimensions of economic, social, and environmental to be sustainable[45]. Various innovative agriculture and seafood farming techniques have been developed now to increase productivity and reduce losses by nutrient cycling, water supply and regulation, pest control, and advanced pollination. These practices, improve carbon soil concentration, prevents nutrient losses, and increase water usage, and are implemented at the farm stage, for sustainable crop production. However, various environmental issues like climate change, Soil degradation, air and water pollution, and/or biodiversity, may adversely affect food production[46].

In terms of the economy, a food system is deemed sustainable if the operations of each participant or supplier of auxiliary services are profitable. All stakeholder categories should reap the benefits of the activities—wages for workers, taxes for governments, profits for businesses, and improvements in the availability of food for consumers—or economic value-added[47].

Sustainable food production can be done by taking care of the environment and practicing good agricultural methods like:

- Agro-ecological diverse farming systems (DFS)maintain the ecosystem services that are essential inputs to agriculture, such as soil fertility, pest and disease control, water use efficiency, and pollination, that intentionally include functional biodiversity at multiple spatial and/or temporal scales.[48]
- Sustainable and Ecological intensification uses natural processes to substitute human-produced inputs like pesticides and fertilizers while preserving or increasing food output per unit area is referred to as ecological intensification.[48]
- A farming method known as conservation agriculture (CA) can restore degraded soils while preventing the loss of arable land. It encourages the preservation of a stable soil cover, little soil disturbance, and plant species diversity. It improves biodiversity and ground-level natural biological processes that help boost the efficiency with which water and nutrients are used and support improved and sustained crop output.[49]
- A method of farm management known as precision agriculture (PA) makes use of information technology (IT) to make sure that soil and crops receive the exact nutrients they require for optimum health and yield. PA seeks to achieve profitability, sustainability, and environmental preservation[50].
- An agricultural approach known as organic farming, often referred to as ecological farming or biological farming, emphasizes methods like crop rotation and companion planting and uses organic fertilizers including compost manure, green manure, and bone meal [51].
- To reduce greenhouse gas emissions (GHG) and increase food production to cater to the large population and prevention of hunger and poverty, it becomes necessary to reduce the impact of climate change on agriculture. Hence the Climate-Smart-Agriculture (CSA) approach, suggested by FAO is adapted for food security and sustainable food production. The CSA was implemented with the following objectives:

1. Increasing agricultural productivity and thus population income.
2. Enhancing and adapting resilience to climate change impact.
3. Reducing Green House Gas emissions from the environment [52].

Hence, Climate Smart Agriculture (CSA) is based on the transformation and reorientation of the agriculture ecosystem for enhanced food production, improved quality of life, and well-being under the impact of climate change.

For thousands of years, the local farmers are practicing traditional approaches to enhance the ecosystem and high food productivity. The traditional approaches to food production have regained scientists' interest as the Climate Smart Agriculture approach. Various traditional practices such as crop rotation, organic composting, intercrop, crop-animal farming, and agroforestry are included in CSA for high crop production and to prevent climate impact. Traditional production includes the use of local resources and knowledge for farming [53]. Food production requires a high amount of energy from sowing to harvesting the crop to distribution in the local market. The regular use of local resources reduces the cost of energy as well as improves the soil- agroecosystem. Traditional Landscapes for food production are still preserved in areas where traditional farming is practiced like the Western Ghats in India,

South-western China's landscape, Local farming areas in Mexico, and traditional small villages. Traditional farming can tolerate the stress of climate change in all adverse situations and preserve its genotype [54].

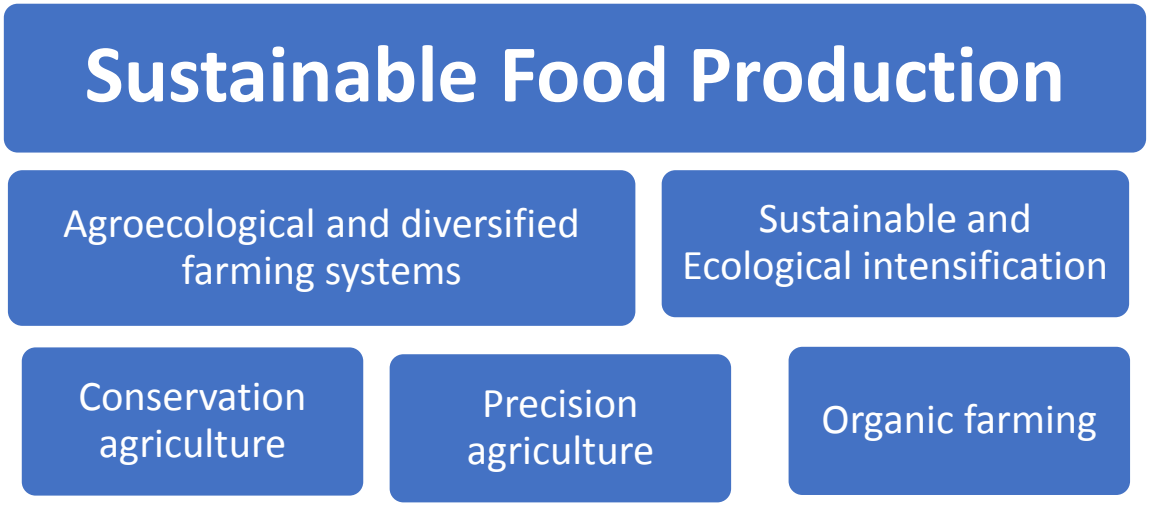

Fig:4 Different Methods for Sustainable Food Production

3.5 Food Transformation:

The Food transformation refers to the changes in the global food system based on consumer demand, food production, processing technique used, and its impact on the environment, in view to providing a healthy diet for the population. This transformation indeed demands hard work and various government agreements along with the availability of local resources. The approach must reach the population with scientific facts with the objective of healthy diet combinations and environmental safety. To achieve these objectives, a well-established and practiced strategy should be implemented.

Policy 1*: National and International political commitments to shift towards a healthy diet:* To achieve political commitment from government bodies, it is essential to improve the availability of sustainably grown foods and establish a correlation with a healthy diet. This can be achieved by reducing portion size, packaging cost, and choices among high-income societies. To prevent deficiency and fulfilling portion size innovative food along with scientific facts must be introduced. On the other hand, by using a wide range of foods, and improved storage conditions, the low-income group population can be benefitted. Healthy foods must be provided as per need and stock must be maintained in both the private and public sectors. Political support should be given for procurement of healthy sustainable locally grown foods in public sectors like schools, colleges, and workplaces, and timely evaluation must be ascertained along with adequate infrastructure like roads, and transportation facilities, to reach out to large populations and food availability, as well as reduced food prices. Furthermore, the farmers and women at home are required to be skilled enough to practice sustainable food production along with cost affordability. Government authorities must ensure the subsidies on raw materials like electricity, fuels, pesticides, and water usage are required for effective sustainable food production and usage [55].

Policy 2: *Agricultural shift from massive food production to sustainable healthy food production with local resources.* Agriculture plays an important role in any country's economy and its population's nutritional status. Hence, Agricultural policies must focus on the production of a large variety and nutritious crops rather than the large quantity produced. Regular checks and emphasis should be given on crop quality assessment, with respect to nutritional recommendations and food security. Small and medium-scale farmers with traditional farming should be promoted by providing incentives, education, and technical support to enhance crop diversity and nutritional quality assurance. Animal food consumption can be reduced by counseling and by the production of equally nutritious food production, however, to some extent, animal foods are advantageous for vulnerable populations and children due to their nutritional quality. Thus the production of meat, poultry, and sea foods, can be done with environment-friendly techniques and reduced microbial contamination [56].

Policy 3: *Improved food production while maintaining high-quality standards:* Efficient use of locally available resources, an adaptation of agricultural practices based on soil characteristics, water supply, and climate change enhances not only food production but also increases nutritional quality as well. For example, in drought-prone areas, drought-sensitive crops and limited water usage and adequate technique will enhance the nutritional quality of both soil and crop. The adequate agricultural technique should be approachable to farmers at a low cost. Crop rotation, agricultural forestry, Organic composting, and soil restoration, must be promoted among farmers to obtain high crop yields with minimum water usage[57].

Policy 4: *Reduce food loss and waste by at least half, in line with global Sustainable Development:* Food wastage and loss due to poor harvest and careless handling must be acknowledged by the government authority, and adequate storage facilities, investment in processing units, advanced post-harvest technologies, can be provided to farmers, to prevent food loss. Animal hygiene and sanitation practices to reduce microbial contamination can be encouraged to reduce food loss. This requires extensive counseling and education for farmers and women involved in post-harvest practices in developing countries. On the other hand, in highly developed countries, where, the consumers are responsible for food waste, campaigns for promoting healthy food patterns, planning in purchasing and storage, understanding food labels, food preparation techniques, and adequate knowledge of food leftover usage must be encouraged [58].

4. Role of food Biodiversity in achieving sustainability:

Reduction of numerous food options with less consumption of local and seasonally available food increases the risk of various forms of malnutrition, which may result in undernutrition as well as overweight and obesity [59]. According to Powell et al. (2015), various research that examined nutrient consumption may have discovered a connection between diversity in the production of crops and mean nutrient sufficiency, which is a sign of a healthy diet [60]. Lachat et al. (2018) conducted an international study to examine the relationship between different dietary-rich food production and dietary quality. Participants included 6226 vulnerable groups (women and children) living in low-income areas and middle-income countries. For nutritional assessment, 24-hour dietary recalls were collected from the

participants. Their investigation of the nutritional quality of their diet included the mean adequacy of minerals and vitamins like calcium, iron, zinc, folate, vitamin A, and vitamin C. They take into account the variety of species that each person consumes when calculating richness in dietary species. In both the wet and dry seasons, their findings indicated a favorable correlation between nutritional markers and biodiversity indicators (species richness) [61]. Powell et al. (2013) studied dietary diversity and wild plants in Tanzania and found that although these plants only made up 2% of the total energy in the diet, they provided significant amounts of vitamin A (31%), vitamin C (20%), and iron (19%). This study specifically focused on unconventional food plants. Even if there is still room for improvement in the study of biodiversity in diets of industrialized and urban environments, the available data demonstrate that biodiverse food plants are relevant sources of energy, micronutrients, and bioactive chemicals [62,63]. Thus, the intake of these plants forms the basis of any recommendations for sustainable or healthy diets, particularly those that emphasize a variety of plant-based foods while minimizing the consumption of highly processed foods and animal products [64]

Without biodiversity, there can be no food sovereignty. Furthermore, the ability of the local population to manage its natural resources is essential for the preservation of biodiversity. As a result, the following pillars of food integrity policies are pertinent: (1) genetic resources, ecology, and evolution; (2) governance policy, institutions, and legal agreements; (3) food, nutrition, health, and disease; and (4) socio-ecological interactions with global change causes [65]

The two principles pathways that govern mostly food biodiversity to healthy outcomes these are:1)consumption via own production or gathering from the wild 2) purchase of wild or cultivated biodiversity. These pathways help us to understand the role of biodiversity in creating nutrition security and diet diversity which leads to better health outcomes and less environmental damage [66].

Table 1: Measures Required for Sustainability

Sustainable food pyramid	Diets that play a part in enhancing population health and benefiting the environment are seen as having dual positive effects. A universally sustainable diet that substitutes plant protein for animal protein has co-benefits for both health outcomes and a smaller global environmental footprint.	[67]
Food waste	The target, 12.3 of sustainable development goals can be achieved by a sustainable diet as the food waste and food losses will be less. Reference figure no. The food production	[68]
Food production	A significant contributor to the world's environmental footprints, which also include significant water and land consumption, escalating climate change, and environmental degradation, is food production.	[69]
Biodiversity	Less consumption of locally and seasonally available food increases the risk of various forms of malnutrition. The ability of the local population to manage its natural resources is essential for the preservation of biodiversity.	[70]

5. Conclusion:

To prevent decreased life expectancy and further environmental deterioration, significant changes must be made to the food we eat and how it is produced. To ensure the achievement of a wide range of human health and environmental sustainability goals, this review offers an integrated framework with quantitative scientific targets for sustainable food production and healthy diets. These targets together define the safe operating environment within which food systems should operate. This paradigm has a strong potential for local adaptation and scalability and offers internationally relevant boundaries. A low to moderate amount of seafood and poultry are included in our universally healthy reference diet, along with whole grains, legumes, nuts, and unsaturated oils. Red meat, processed meat, added sugar, refined grains, and starchy food are either absent from it entirely or are present in very small amounts. Our definition of sustainable food production takes into account the six environmental processes—climate change, land-system change, freshwater use, biodiversity loss, and disruption of the global nitrogen and phosphorus cycles—that collectively govern the state of the Earth system. However, the global move toward healthier eating habits, significant decreases in food loss and waste, and significant advancements in food production methods are all necessary for this great food transformation to be required.

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