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BIODIVERSITY ON THE PLATE: SUSTAINABLE DIETARY PATTERNS

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Abstract

Food and nutrition security, as well as a healthy lifestyle for current and future generations, are all facilitated by sustainable diets that have minimal negative effects on the environment. In addition to being culturally appropriate, accessible, equitable in terms of income, and economical, sustainable diets also maximize the use of both natural and human resources while protecting and honoring biodiversity and ecosystems. With regard to sustainable development, the idea of sustainable diets offers a chance to effectively forward the goals of ending poverty, achieving food and nutrition insecurity, and improving public health. Certain adjustments are necessary in order to achieve sustainable food practices. the availability of food in a sustainable manner that does not impede the achievement of other human rights, in quantities and qualities sufficient to satisfy nutritional requirements, free of contaminants, and acceptable within a certain culture. From food production at the farmer's stage to the consumer plate, several techniques of transformation are covered in this overview, along with the variables that affect the biodiversity of sustainable diets.

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

Introduction

The current state of food systems jeopardizes both human health and environmental sustainability, despite their potential to enhance both. Supplying a nutritious diet from sustainable food systems to an expanding global population is the pressing challenge. The world's population has increased food production, but still more than 820 million people do not have access to enough food, and many more eat diets deficient in micronutrients that put them at risk of non-communicable diseases like diabetes, heart disease, and stroke [1]. Ill-healthy diets are more harmful than drug, alcohol, and tobacco use combined in terms of morbidity and mortality [2]. There needs to be some changes made to the global food system because a lot of environmental systems and processes are inefficient, which contributes to the world's population being undernourished. Diets that are sustainable improve nutrition and food security, foster a healthy lifestyle for present and future generations, and have least negative effects on the environment [3]. Healthy choices for a healthy lifestyle are offered by sustainable meals, which are both nourishing and safe. Additionally, they are affordable, accessible, equitable from an economic standpoint, and save biodiversity and ecosystems. 20–30% of worldwide greenhouse gas emissions and up to 66% of groundwater use are attributed to the food production industry, according to the World Health Organization (WHO) [4]. Diversity of foods is emphasized in a sustainable diet, which is good for human growth. The environment, human health, and the health of the food chain as a whole are all considered in a sustainable diet. The sustainability of a diet is influenced by a number of aspects, including cost, general health, biodiversity, ecological safety, and nutritional sufficiency[5]. It will take major improvements in food production methods, substantial reductions in food loss and waste, and large changes in eating patterns to achieve healthy diets from sustainable food systems [6].

Diet plays a critical role in maintaining human health and environmental sustainability. The scientific goals for ecologically friendly and healthful meals are integrated into a single framework, the safe operating zone for food systems, in order to discover win-win diets (i.e., healthy and sustainable)[7]. We suggest this paradigm be universally applicable to all food cultures and production systems worldwide, with tremendous potential for local adjustment and scale. With a sustainable diet, it is possible to preserve one's health and guarantee that there are enough resources in the planet to support future generations of humans]. In the simplest terms imaginable, a sustainable diet aims to have a positive effect on the individual and the environment both now and thereafter. To minimize their impact on the environment, people might choose diets and food items that are more ecologically friendly than others.

Environmental effects of foods:

The precise environmental footprints of many food products are difficult to identify and assess with high precision because of methodological flaws and data shortages. A recent review of the literature reveals underrepresentation of some of the important environmental effect dimensions of food systems as well as a lack of integrated analysis; most current food and nutrition research evaluating environmental consequences only considers greenhouse-gas emissions [9].

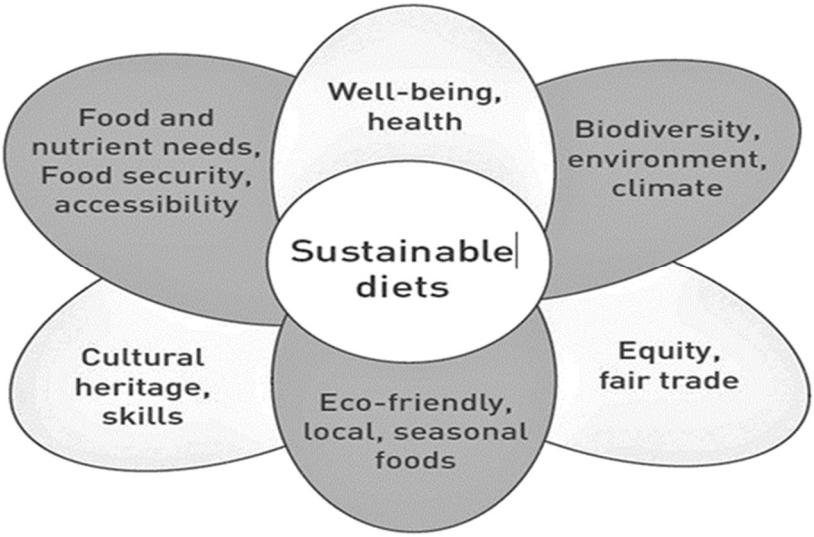

Fig 1: Sustainable Diets

Numerous elements, including as chemical use, biodiversity, animal welfare, and nutrient leakage, are often overlooked in studies on the food footprint. On the other hand, results from an enormous and growing amount of research indicate that there is probably a clear hierarchy of effects among broader dietary groups [10]. For example, Clune and colleagues gave the greenhouse-gas emissions of various food categories from life-cycle assessment studies and showed that meat from ruminants has the most environmental consequences per serving, while cereals, fruits, and vegetables had the lowest effects [11].

The processes of the earth's system are essential to both food production and human well-being, and they must be preserved by creating and implementing sustainable food production methods. The application of farming and fishing strategies that maximize positive environmental benefits while utilizing ecosystem services including pest control, pollination, water regulation, and nutrient cycling has increased the productivity and resilience of agricultural landscapes. [12].

In order to meet their energy needs, some farms are actively experimenting with methane gas capture and recycling animal excrement for use as fertilizer. Eating more plant-based food is more sustainable than eating more animal-based food [13]. Eating more plant-based food is more sustainable than eating more animal-based food. However, a number of issues, like land use, agricultural production using water, and methane production from fishing and poultry, influence the use of a sustainable diet. Using a diet high in locally grown food can be a potential way to avoid using as much land and reducing carbon emissions [14].

Fig 2: Environmental Footprint

Determinants of sustainable diet:

Four essential elements characterize a sustainable diet from the consumer's perspective. The percentage of foods in the diet that are derived from plants versus animals, the proportion of processed foods versus whole foods, and other characteristics are the four factors that determine whether a diet is sustainable.

c) The proportion of imported food compared to food grown locally; d) The proportion of food wasted.

Food production and consumption practices have changed as a result of population increase, urbanization, industrialization, and globalization. These changes have a substantial effect on diets and ecosystems [15]. Long-distance transportation and high-input industrial agriculture have increased the availability and affordability of refined carbs and fats, simplifying diets and emphasizing a select few high-energy meals. Diets heavy on calories but low on variety aggravate the problems of obesity and chronic disease, which are increasingly accompanied with shortages in micronutrients and undernourishment [16].

Strategies for a Great Food Transformation:

The tactics are recommendations for initiating processes. Rather, these methods are proposed as potential avenues for future national, regional, city, and local transformation according to the particular circumstances.

The updated Food Pyramid

The Mediterranean Diet's new food pyramid is intended for healthy adults (18–65 years old), and it can be adjusted to meet the needs of each individual as well as specific obstacles such as lactating or pregnant women, elderly people, or children[17]. In grams per day, the base of the pyramid contributes the most carbohydrates. Because of their large carbon footprint, non-vegetarian proteins are consumed less frequently—weekly instead of daily. The summit of the pyramid represented the lowest possible sugar intake in addition to animal products [18]. You can occasionally eat these things. Additionally, seasonal and locally grown fruits and vegetables are preferred in order to promote biodiversity and traditional diets.

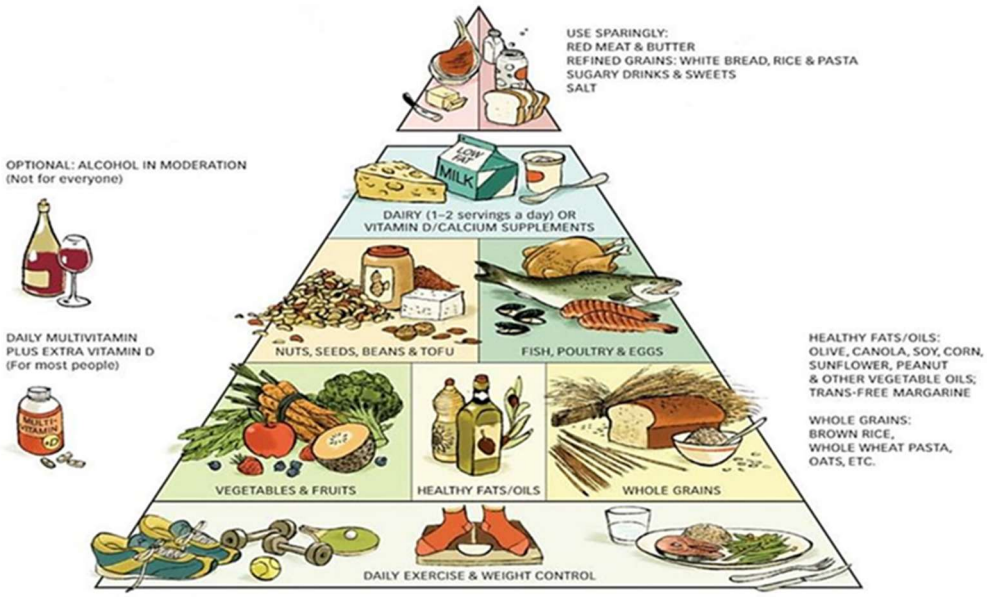

Fig 3 : Updated Sustainable Food Pyramid

Meal Constitution/ Arrangement:

The main meal should consist of cereals, carbs, locally grown fruits and vegetables, and a limited amount of legumes and beans, as recommended by the food pyramid. At every meal, have two to three servings of cereal in the forms of whole grains, pasta, rice, and bread. At lunch and dinner, three to four portions of raw or cooked vegetables should be taken. You can eat two to three servings of fruits as salad or dessert [19]. Foods from a wide variety of hues must be incorporated in the diet to prevent micronutrient deficiencies [20]. In order to prevent and control chronic illnesses and minimize the greenhouse effect, the main meal of the Mediterranean Diet Pyramid recommends consuming more plant-based foods [21]. Reduced processing usually results in foods (vegetables and fruits) that keep more of their nutrients. Therefore, the food ought to be seasonal and little processed [22]. Additionally, consuming more plant-based meals will result in a reduction in the use of land, water, and other resources and provide food security for a large number of people [23]. The amount of land used, however, is determined by productivity,

investment patterns, and population increase

Source of Mediterranean Diet

Olive Oil:

Due to its tolerance to high temperatures, extra virgin olive oil (EVOO), a source of dietary lipids, should be ingested [24]. It can be applied as salad dressing or utilized in low-flame cooking. The Mediterranean diet frequently includes potatoes, pasta, vegetables, or rice with its main meals, which boosts the nutritional content of the oil [25]. Effective farming practices can mitigate adverse environmental effects, even though olive cultivation necessitates substantial land usage [26]. Additionally, olive trees help to remove carbon dioxide from the atmosphere. For every liter of olive oil produced, olive trees absorb 10–12 kg of CO2 from the atmosphere [27]. Cardiovascular disorders benefit from the use of olive oil. Apart from that, palm oil is also utilized in many processed meals and other commercial food products and is regarded as a valuable substitute for olive oil [28].

Olives and seeds intake:

Consuming nuts and oilseeds on a regular basis can help prevent and manage diabetes and cardiovascular disease by improving metabolic profile and lowering death and morbidity rates. Potential providers of dietary fiber, good fats, vitamins, minerals, and antioxidants include oilseeds and olives [29, 30, 31]. A healthy lifestyle focused on plant-based proteins and sustainable development can be achieved by following the Mediterranean Diet food pyramid, which recommends consuming a small amount of nuts and oilseeds as snacks.

Herbs and Spices:

Food is more palatable when it has a distinct aroma that is imparted by herbs, spices, onions, and garlic. Spices and herbs are excellent providers of micronutrients and antioxidants. Not only are herbs and spices native to the Mediterranean region, but they are also becoming more and more popular worldwide [32].

Pulses and Legumes:

More protein needs to come from plant-based sources in accordance with sustainable development. Lean meats, fish, poultry, and eggs can also be used if they are reasonably priced. One to two portions of foods high in protein are recommended by the modified Mediterranean Diet pyramid. Due to their plant origin, pulses and legumes increase soil fertility by fixing nitrogen [33].

Milk and Milk Products:

You should have one or two servings of milk or milk products per day, whether they are in the form of curd, milk, or cheese. Protein, calcium, and phosphorus are all abundant in dairy products [34]. Furthermore, probiotic drinks help to boost the digestive system. Dairy products should be

consumed with meat, but this is concerning because they need a certain amount of land, water, and feed [35]. Therefore, it is necessary to favor the range of dairy products produced by nearby farmers and small businesses.

Fish, Seafood, Eggs, and Poultry:

Eating fish and shellfish is an integral aspect of the Mediterranean diet, since it provides ample amounts of omega-3 fatty acids, eicosapentaenoic acid (EPA), and docosahexaenoic acid (DHA), in addition to being an excellent source of protein [36]. There is always a risk of depletion in terms of sustainability because fish and seafood are considered wild stocks. Fish raised for aquaculture is therefore the most viable and sustainable way to preserve the stock and reduce the risk of depletion. The nutritional advantages of aquaculture fish are comparable. They are also an excellent source of micronutrients and animal proteins; nevertheless, the lipid profile varies greatly depending on the type of feed [37]. A balanced diet must include three to four servings of poultry and eggs per week, as they are excellent sources of protein. The sustainability of the environment is least affected by poultry meat and eggs. Waste from organic seafood production and chicken rearing is recycled to increase soil fertility [38].

Red and processed meats should be consumed in moderation—less than two servings per week—as they are high in saturated fats and cholesterol and are linked to a higher risk of death, type 2 diabetes, and cardiovascular disease. Reduced consumption of red and processed meat is therefore linked to health advantages and has a significant influence on the environment. A significant amount of land is also needed for the production and processing of beef, and these activities emit methane, which increases greenhouse gas emissions [39].

Sugar, Sweets, and Pastries:

Sugar, sweets, and highly processed foods make up the top of the pyramid and should only be consumed in small amounts because they are high in calories and low in nutrients, and their production and processing demand a lot of fuel and resources, including land. Therefore, the consumption needs to be restricted to two or three tiny servings each week, or it needs to be done on occasion. As more sustainable and healthful options for sweetness in the diet, customers may choose natural sources including honey, dried foods, fruit juices, and whole fruits [18, 40].\

Water and Fluid Intake:

A healthy person needs to drink 1.5 to 2 liters of water each day, though this might vary depending on factors including age, level of physical activity, and ambient circumstances. Water is a vital component of the human body. To lessen the impact on the environment and prevent harm, tap Offer water instead of packaged or store-bought drinking water. Plastic bottles and containers should not be used [41].Drinking alcohol and using other beverages must be restricted, as they are the only sources of sugars, except from water. As much as feasible, local tea and coffee producers should be preferred over that.

Serving Size:

Every item should have its serving size determined by the individual's energy requirements and level of physical activity. To prevent food waste, portions should start at the base of the pyramid and be consumed in bigger amounts. It is recommended to consume items from the top section in smaller amounts and less frequently [42].

In addition, consistent physical activity (at least 30 minutes per day) and workouts that strengthen the muscles are necessary to maintain a healthy weight and energy balance. In addition to maintaining population biodiversity, a modified Mediterranean diet that emphasizes a range of traditionally grown, locally grown, and seasonal foods will also improve sustainability and lessen harmful environmental effects[43].

Sustainable and Environment-Friendly Food Production:

The creation of a sustainable food production system is necessary to protect the environment and ensure both a large enough supply of food to feed the world's population and a healthy standard of living. A shift to sustainable food production is required for global sustainable development, as there is mounting evidence that the food industry is the primary driver of environmental change worldwide. An all-encompassing definition of sustainable food production ought to incorporate an evaluation of the environmental impacts of a wide range of characteristics at different scales, conducted across the system [44]. A growing number of factors are being considered and included in definitions of sustainable food production, including greenhouse gas emissions, biodiversity loss, nitrogen and phosphorus application, land and water consumption, and chemical contamination from pesticides and herbicides. Sustainability is taken into consideration at every stage of the construction of a sustainable food system. To be sustainable, the growth of the food system must simultaneously yield positive values in the three areas of the economy, society, and environment[45]. Many cutting-edge methods of advanced pollination, sophisticated insect control, nutrient cycling, water supply and regulation, and marine farming have been developed recently to boost output and decrease losses. Implemented at the farm level, these strategies increase water usage, decrease nutrient losses, and boost soil concentration of carbon for sustainable crop production. Food production, however, may be negatively impacted by a number of environmental problems, including biodiversity, air and water pollution, soil degradation, and climate change[46].

Economically speaking, a food system is considered sustainable if all of its members or providers of supporting services turn a profit. All groups of interested parties should benefit from the activities, including workers' wages, governments' taxes, businesses' profits, and consumers' increased access to food, or economic value-added [47]. Sustainable food production can be achieved by protecting the environment and using good agricultural practices such as:

• Using multiple spatial and/or temporal scales to purposefully incorporate functional biodiversity, agro-ecological diverse farming systems (DFS) preserve the ecosystem services that are vital inputs to agriculture, such as soil fertility, pest and disease control, water use efficiency, and pollination.Ecological intensification, which preserves or increases food output per unit area, is

defined as sustainable and use natural processes to replace human-produced inputs like pesticides and fertilizers [48].48]

• Degraded soils can be restored while retaining arable land by using a farming technique called conservation agriculture (CA). It supports the maintenance of a diverse range of plant species, minimal soil disturbance, and a stable soil cover. Enhancing biodiversity and fundamental biological processes can lead to increased water and nutrient efficiency, as well as better and more consistent crop yields.49]

• Using information technology (IT), precision agriculture (PA) is a farm management technique that ensures crops and soil receive the precise nutrients needed for maximum health and productivity. Profitability, sustainability, and environmental protection are the goals PA aims to achieve[50].

• The agricultural practice known as organic farming, often called ecological farming or biological farming, uses organic fertilizers like compost manure, green manure, and bone meal and stresses techniques like crop rotation and companion planting. Reference 51.

• It becomes imperative to lessen the effects of climate change on agriculture in order to limit greenhouse gas emissions (GHG), boost food production to feed the growing population, and prevent hunger and poverty. For food security and sustainable food production, the FAO's Climate-Smart-Agriculture (CSA) strategy has been modified. The CSA was put into effect with the following goals in mind:

1. A rise in population income due to increased agricultural productivity.
2. Strengthening and adjusting to the effects of climate change.
3. Reducing environmental emissions of greenhouse gases [52].

In order to increase food production, improve quality of life, and promote well-being under the effects of climate change, Climate Smart Agriculture (CSA) is predicated on the transformation and reorientation of the agriculture ecosystem.

The local farmers have been using traditional methods to improve the ecology and produce high amounts of food for thousands of years. Scientists' interest in ancient methods of producing food has returned, as evidenced by the Climate Smart Agriculture movement. The CSA incorporates a number of conventional techniques, including crop rotation, organic composting, intercropping, crop-animal husbandry, and agroforestry, to maximize crop yield and mitigate the effects of climate change. The utilization of regional resources and agricultural expertise is part of traditional production [53]. Energy-intensive processes are involved in producing food, from planting to harvesting to distributing it in the neighborhood market. Using local resources regularly lowers energy costs and enhances the soil-agroecosystem. In regions like India's Western Ghats, where traditional farming is still practiced, traditional landscapes for food production are still conserved. The terrain of Southwest China, Mexican rural areas, and typical tiny towns. Conventional farming has the ability to maintain its genotype and withstand the harmful effects of climate change under all circumstances [54].

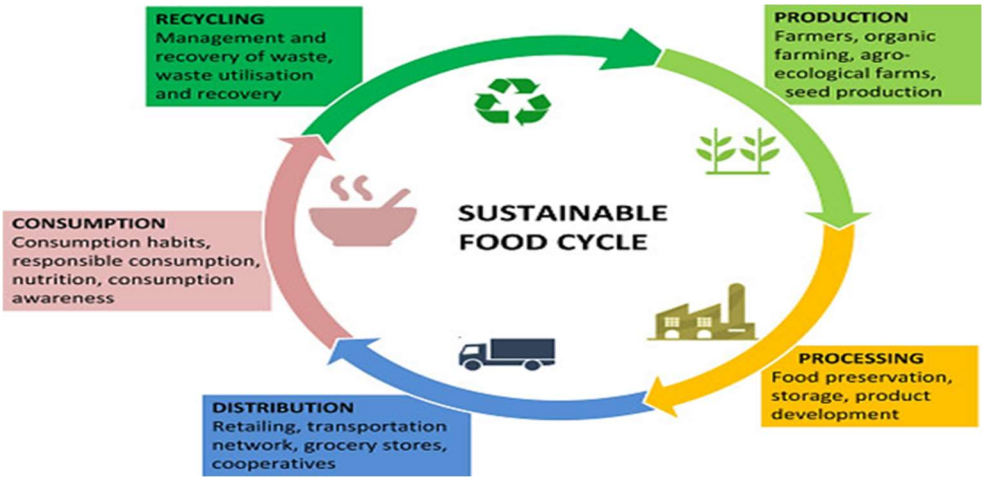

Fig:4 Different Methods for Sustainable Food Production

Food Transformation:

The term "food transformation" describes the adjustments made to the world food system to meet consumer demand while considering food production, processing methods, environmental effects, and consumer demand in order to ensure that everyone has access to a healthy diet. This transition does, in fact, need a great deal of labor, a number of government agreements, and the availability of local resources. The strategy needs to provide the public with scientific information with the goals of promoting environmentally safe practices and balanced diets. A tried-and-true plan needs to be put into action in order to accomplish these goals.

Policy 1: International and national political pledges to transition to a healthier diet: Establishing a link between a healthy diet and more readily available, sustainably generated food is crucial to winning over government bodies to the cause of political commitment. In high-income societies, this can be accomplished by lowering portion sizes, packaging costs, and options. Innovative cuisine must be introduced coupled with scientific data to minimize deficiency and ensure proper portion sizes. However, the population in the low-income group can gain from using a variety of foods and better storage conditions. Both the public and commercial sectors must manage stock levels and deliver nutritious foods based on need. Political backing should be provided for the purchase of wholesome, sustainably farmed food in public spaces like workplaces, colleges, and schools. Appropriate infrastructure, such as roads and transportation facilities, should also be established in a timely manner in order to reach large populations, ensure food availability, and lower food costs. In addition, it is necessary for the women and farmers in the country to possess the necessary skills for sustainable food production at an affordable price. It is imperative for government authorities to guarantee that subsidies on raw resources such as fuels, electricity, pesticides, and water usage are necessary for efficient and sustainable food production and consumption [55].

Policy 2: Transition agriculture from large-scale food production to locally sourced, sustainable, and healthful food production. Any nation's economy and the nutritional state of its people are

significantly influenced by agriculture. Therefore, rather than emphasizing production volume, agricultural strategies should concentrate on producing a wide variety of nutritious foods. Crop quality evaluation should be regularly monitored and prioritized in light of dietary guidelines and food security. Incentives, training, and technical assistance should be extended to small and medium-sized farmers who practice traditional farming in order to increase crop diversity and guarantee nutritional quality. Although the consumption of animal products can be decreased by counseling and the manufacture of similarly nutritious meals, the nutritional value of animal products makes them beneficial for children and vulnerable groups. Therefore, it is possible to produce beef, poultry, and seafood using environmentally benign methods that involve less microbiological contamination [56]. Policy 3: Encouraging food production while upholding strict quality requirements Not only may food production be increased, but nutritional quality is also improved through the efficient use of locally available resources and the modification of agricultural practices based on soil characteristics, water availability, and climate change. The nutritional quality of both soil and crop can be improved in drought-prone locations, for instance, by using drought-sensitive crops, conserving water, and using appropriate techniques. Farmers should be able to affordably access appropriate agricultural techniques. To achieve high crop yields with minimal water usage, farmers must be encouraged to practice crop rotation, agricultural forestry, organic composting, and soil restoration [57]. Policy 4: In accordance with the worldwide Sustainable Development Goals, cut down on food loss and waste by half. The government must recognize food loss and waste resulting from subpar harvesting and handling, and it may help farmers avoid food loss by offering them modern post-harvest technologies, processing unit investments, and sufficient storage facilities. Food loss can be decreased by promoting animal cleanliness and sanitation techniques that lower microbiological contamination. For farmers and women engaged in post-harvest operations in underdeveloped nations, this calls for intensive counseling and instruction. However, in highly developed nations where food waste is the responsibility of the consumer, campaigns that promote healthy eating habits, preparation and storage planning, comprehension of food labels, food preparation methods, and sufficient awareness of how to use leftover food must be supported [58].

Role of food Biodiversity in achieving sustainability:

The risk of several types of malnutrition, which can lead to undernutrition as well as overweight and obesity, increases when there are fewer food options accessible and less food that is locally and seasonally available is consumed [59]. Powell et al. (2015) state that a number of studies looking at nutrient consumption may have found a link between crop diversity and mean nutritional sufficiency, which is an indication of a nutritious diet [60]. In order to investigate the connection between dietary quality and various dietary-rich food production, Lachat et al. (2018) carried out a worldwide study. 6226 women and children from low-income and middle-income nations who were members of vulnerable groups were among the participants. 24-hour dietary recalls were gathered from the participants for nutritional assessment.

They measured the mean adequacy of minerals and vitamins such as calcium, iron, zinc, folate, vitamin A, and vitamin C as part of their inquiry on the nutritional quality of their diet. When

measuring the richness in dietary species, they account for the variety of species that each individual consumes. Their results showed that nutritional markers and biodiversity indicators (species richness) correlated well in both the rainy and dry seasons [61]. According to Powell et al. (2013), who investigated dietary diversity and wild plants in Tanzania, these plants contributed a mere 2% of the diet's total energy content but were a major source of vitamin A (31%), vitamin C (20%), and iron (19%). Unconventional food plants were the specific focus of this investigation. Although research on biodiversity in the diets of industrialized and urban contexts still needs to be improved, the data that are now available show that food plants that are biodiverse are important sources of energy, micronutrients, and bioactive compounds [62, 63]. Therefore, any recommendations for healthy or sustainable diets—especially those that stress a range of plant-based meals while avoiding the consumption of highly processed foods and animal products—are based on the intake of these plants [64].

There cannot be food sovereignty in the absence of biodiversity. Additionally, maintaining biodiversity depends on the local population's capacity to manage its natural resources. The following food integrity policy planks are therefore important: Genetic resources, ecology, and evolution; (2) institutions, policies, and agreements governing governance; (3) food, nutrition, health, and disease; and (4) socio-ecological interactions with causes of global change [65]

Consumption through one's own production or wild harvesting are the two main pathways that lead from food biodiversity to healthful results. 2) Purchasing biodiversity, either farmed or natural. Understanding the significance of biodiversity in promoting food diversity and nutrition security, which improve health outcomes and reduce environmental damage, is made easier by following these paths [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 beachieved 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]

Conclusion:

Large-scale adjustments must be made to the food we eat and the way it is produced in order to stop declining life expectancy and additional environmental damage. This analysis provides an integrated framework with quantifiable scientific targets for healthy diets and sustainable food production to assure the attainment of a wide variety of environmental sustainability and human health goals. Together, these goals provide the safe operational parameters that food systems ought to follow. With its internationally applicable boundaries, this paradigm has a significant potential for local adaptation and scalability. Together with whole grains, legumes, nuts, and unsaturated oils, our generally healthy reference diet includes a low to moderate amount of seafood and chicken. It either completely excludes or contains very little red meat, processed meat, added sugar, refined grains, and starchy meals. The term "sustainable food production" refers to a set of six environmental processes that together determine the overall status of the Earth system: biodiversity loss, freshwater consumption, land-system change, climate change, and disturbance of the global nitrogen and phosphorus cycles. But in order for this enormous shift in food consumption to occur, there must be a worldwide shift toward healthier eating habits, notable reductions in food loss and waste, and notable advances in food production techniques.

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