Narrative Review

Climate Change and Consumers' Food Choices towards Sustainability: A Narrative Review

C. Berti[1]; M. Baglioni[2]; A. La Vecchia[1,3]; V. D'Oria[4,*]; S. Bettocchi[1]; C. Agostoni[1,5]

[1]Pediatric Unit, Fondazione IRCCS Ca' Granda Ospedale Maggiore Policlinico, 20122 Milan, Italy; [2]Freelancer in Social Sciences, 20144 Milan, Italy; [3]Department of Medicine and Surgery, University of Milano-Bicocca, 20126 Monza, Italy; [4]Pediatric Intensive Care Unit, Fondazione IRCCS Ca' Granda Ospedale Maggiore Policlinico, 20122 Milan, Italy; [5]Department of Clinical Sciences and Community Health, University of Milan, 20122 Milan, Italy

*Corresponding Author: V. D'Oria, Pediatric Intensive Care Unit, Fondazione IRCCS Ca' Granda Ospedale Maggiore Policlinico, Via Della Commenda, 9- 20122 Milan, Italy (veronica.doria@policlinico.mi.it)

This narrative review explores key issues surrounding climate change and diets, highlighting individual-level dynamics and structural constraints to implementing policies that prioritize sustainability through a political economy lens. Strong interconnections exist between climate change and agri-food systems. Current eating patterns are unsustainable, threatening both human and planetary health. Hence, the urgency of promoting "Planetary Health Diets." Available evidence confirms that the healthiest diets exert the least pressure on the environment. Partially substituting meat with plant-based alternatives and reducing the intake of ultra-processed foods can contribute to more climate-friendly dietary patterns. Environmental issues, eco-emotions, health-related dietary motivations, and ethical aspects likely encourage consumers to adopt more sustainable eating habits. In contrast, high prices, consumers' low acceptance, low education, lack of a standardized definition, and weakness in the current information-based instruments related to sustainable food production pose significant challenges to consumers' choices. Effective governance at global, national, and local levels is pivotal. Integrating sustainability issues in national food-based dietary guidelines, education and awareness campaigns, along with reforming public food procurement and offering economic incentives for sustainable foods have the potential to foster the transition towards a healthy sustainable eating. Current dietary patterns negatively affect both planetary and human health. However, consumers are increasingly inclined toward sustainable food options. While individuals play a role in food choices, structural interventions are essential to ensuring a successful transition.

Key words: environmental impacts, dietary patterns, meat substitutes, consumers, behavior, sustainability, political economy, climate change.

INTRODUCTION

The past 8 years have been the hottest ever recorded, and in 2023 the world faced the highest global temperatures in over 100 000 years.[1] Record-breaking extreme weather events occurred on every continent in 2022, and the consequences for human health and survival were detrimental. More than 1700 deaths occurred

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following the exceptional flood in Pakistan[2]; in Europe, record-breaking summer temperatures caused almost 62 000 deaths[3]; in the Horn of Africa, 34.6 million people were affected by drought, with 1.5 million children at risk of severe acute malnutrition.[4] Climate change also poses a wide range of threats to human mental health and wellbeing.[5] Eco-anxiety (or climate anxiety), solastalgia, eco-depression, and related emotions such as worry, grief, despair, and fear arise from a general perception of current or anticipated risks and losses associated with climate change,[6] with children and young people being particularly susceptible.[6,7] By affecting weather, ecosystems, and human systems, climate change jeopardizes global health and exacerbates socio-economic inequities among and within countries,[1] with children, adolescents, and women being the most affected.[8] Alongside obesity and undernutrition, climate change is regarded as a global pandemic, with consequences across the life-course that will affect future generations.[9] In this context, today's food systems, from farm to fork, play a pivotal role. The food supply chain accounts for 26% of total anthropogenic greenhouse gas (GHG) emissions, 32% of terrestrial acidification, and 78% of eutrophication.[10] The farm stage alone is responsible for 61% of the GHG emissions, 79% of the acidification, and 95% of the eutrophication related to the food supply chain. The agricultural system occupies almost 43% of ice- and desert-free lands, and ⅔ of freshwater withdrawals is used for irrigation, driving 90% to 95% of global scarcity-weighted water use.[10] Agriculture, including livestock, is the third-largest sector contributing to global anthropogenic GHG emissions, after the energy and industrial sectors.[11]

This narrative review examines critical issues at the intersection of climate change and diets, aiming to identify major obstacles to implementing policies that prioritize sustainability through a political economy perspective. It seeks to inform stakeholders about future consumer-targeted research and behavioral interventions to drive the transition toward sustainable food systems. We address the following questions: Are consumers willing to modify their behaviors based on the environmental impact of food systems? What are the barriers and facilitators to the transition toward a sustainable food system? What practicable and acceptable dietary changes can be proposed to guide consumer choices?

We present a conceptual framework for discussion of the environmental impact of various dietary patterns and the strategies that may help consumers make sustainable food choices. Our focus is on the eating habits shaped by the current food systems, as they have significant environmental impact at a global level. Accordingly, we explore the individual factors that influence consumers' attitudes toward environmentally sustainable food choices. Finally, we identify barriers and enablers (including policy instruments) that affect the adoption of environmentally responsible dietary behaviors.

CONCEPTUAL FRAMEWORKS

Individual choices can play a crucial role in addressing global warming, given that household consumption contributes to approximately 60% of global GHG emissions.[12] Nevertheless, individual behaviors are heavily constrained by the complex socio-economic and political structures within which consumers' choices take place. The ability of individuals to initiate actions to tackle climate change ultimately depends on global production systems over which most people have little direct control. The extent to which individual climate-friendly actions can lead to a positive change is a topic of ongoing debate, rooted in social sciences' exploration of the tension between agency and structure.[13]

As depicted in Figure 1, our conceptual framework sets out to examine food choices and their environmental impact—influencing health from a global perspective, including the health of humans, animals and ecosystems—through a dual lens, focusing on both individuals (agency) and the broader system (structure).

We draw on insights from 2 conceptual frameworks to illustrate how individual choices are pivotal, yet shaped by the surrounding socio-economic and political contexts. Hampton and Whitmarsh[14] developed a conceptual framework that identifies the 6 domains of choice for climate action that represent the majority of the individual and household carbon footprint (food, household energy, transport, shopping, citizenship, and influence). These domains reflect the multiple roles people occupy, not only as consumers but also as voters, social actors, and participants in broader economic systems. These domains are influenced by 4 main sources—individual (psychological and demographic), social (cultural and social capital), physical (material and spatial), and political (governance and democracy)—that enable or constrain individual choices. In the context of food, this framework reveals how consumption habits may involve personal choices, but those personal choices are embedded in systems of access, regulation, and cultural norms. For instance, the "shopping" and "food" domains highlight how price, labeling, and supermarket layout shape purchasing behavior, while the "citizenship" and "influence" domains capture how individuals shape norms and policies through advocacy, voting, or media engagement. To refine this perspective, we further narrow our analysis by resorting to Downs et al's[15] definition of food

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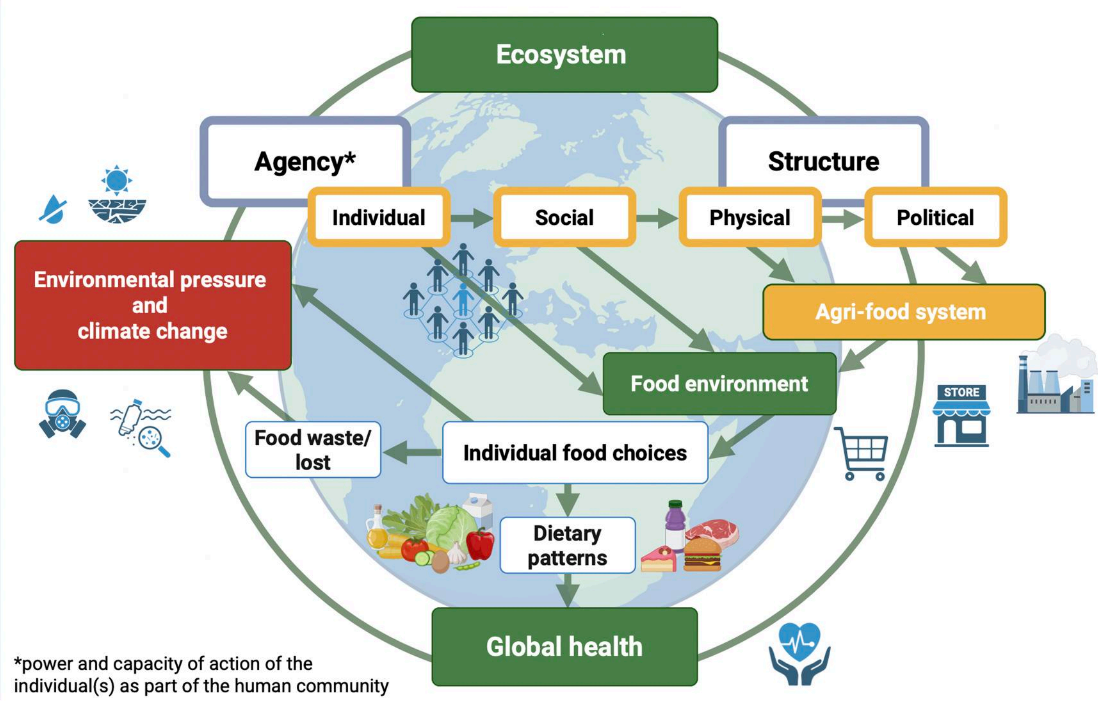

Figure 1. Bidirectional Relationship between Food Choices and Their Environmental Impacts. Arrows indicate that, while consumer choices shape production and distribution systems, those systems in turn constrain or enable dietary options, with implications for the health of humans, animals and ecosystems. This cyclical influence underscores the complexity of fostering sustainable diets

environment using a socio-ecological framework: "The consumer interface with the food system that encompasses the availability, affordability, convenience, promotion and quality, and sustainability of foods and beverages in wild, cultivated, and built spaces that are influenced by the socio-cultural and political environment and ecosystems within which they are embedded." This model helps highlight the material and spatial conditions, such as access to supermarkets, meal programs, or school canteens, that shape the food choices individuals can realistically make. The food environment element is part of the food system framework that is interpreted (in our view) from a political economy perspective. It becomes necessary to analyze the existing power relationships between the actors that determine the food system structure (consumers, state institutions, private companies, etc) to identify the barriers to making food choices that have a low impact on the environment.

The mechanisms underlying individual food choices are complex and multi-faceted. They depend on food-related factors, including both intrinsic (sensory properties) and extrinsic factors (information, social environment, physical environment); individual differences, such as personal factors (biological features, physiological needs, psychological components, experiences) and cognitive factors (knowledge and skills, attitude, liking and preference); and society-related features (culture, economic variables, political elements).[16,17] Together, these 2 frameworks enable a multi-layered understanding of consumer behavior, combining individual-level determinants with structural and contextual constraints. They show that effective policy must target not only motivation and education, but also the material conditions and governance structures that enable sustainable food choices. For example, shifting behavior in the "food" domain requires aligned efforts in pricing, procurement, regulation, and education, across public and private sectors. This synthesis underscores the need for multi-domain interventions that address food environments and broader systems of power and governance. Only by aligning influences across these domains can policy truly support a global transition to less resource-intensive food choices.[18,19]

Methods

This article is based on a narrative literature review with an international scope, aiming to analyze the key barriers to and enablers of sustainable food consumption. We searched databases and websites, including PubMed and Google Scholar, to identify relevant literature regarding (1) the environmental impacts of eating patterns and (2) the factors influencing consumers' food choices against sustainability. We performed searches by combining the following key words: environmental

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impacts or footprints, dietary patterns or diets, healthy diets, food systems, sustainable food choices or diets, food waste, sustainability, consumers' food choices or eating behaviors, pro-environmental or sustainable behaviors, plant-based alternatives, meat substitutes, animal-food sources, consumers' attitude or intention, motivational drivers, barriers, socio-economic or political factors, affordability, facilitators or enablers. We selected studies, narrative reviews, systematic reviews, meta-analyses, and documents from international organizations reporting data or findings on: (1) the impact of dietary patterns or foods or food waste on the environmental indicators to depict the pressure of the current eating patterns on the planet's health; and (2) the food-related determinants that influence consumers' behavior towards sustainable eating, to highlight the key factors in which to intervene to facilitate the transition toward more sustainable food choices. Some articles were identified through manual searching and reference tracking. All sources reviewed were in English, which we acknowledge as a limitation in capturing regionally specific literature in other languages.

THE ENVIRONMENTAL IMPACT OF FOOD AND DIETS

In addition to contributing to the global burden of mortality and morbidity, current dietary patterns based on unhealthy energy-dense, animal-based, and processed foods—that are low in fiber and rich in salt, sugars, and saturated fats—threaten the planet's ecosystem stability.[20–22] Providing a growing global population with healthy diets while minimizing the negative environmental impacts of food systems is an urgent challenge. In 2019, the EAT-Lancet Commission launched the call for "Planetary Health Diets," aimed at transforming food systems by improving human health while coping with environmental sustainability.[22] Aligned with the guiding principles established by the Food and Agriculture Organization of the United Nations (FAO) and the World Health Organization (WHO)[23] regarding sustainable healthy diets, this transformation may contribute to achieving the United Nations Sustainable Development Goals and the Paris Agreement.[22]

Table 1 summarizes some of the most recent findings reporting estimates or modeling for the environmental footprints of several dietary patterns or foods.[20,21,24–34] As documented by these studies, the healthiest diets and the most nutritious food categories (ie, fruit, whole grains, nuts, plant-based commodities) are confirmed as the most environmentally sustainable, exerting the least pressure on environmental resources. However, there are exceptions. In some cases, low adherence to healthy dietary patterns or the consumption of unhealthy food items (eg, processed foods high in sugars) may exhibit low environmental impact.[21,27,28] Animal-based foods are responsible for the highest environmental impacts. Livestock use large areas of land, accounting for approximately 20% of the total land on Earth, and emit 8.1 Gt carbon dioxide equivalents (CO_2eq), with enteric methane representing 30% of global methane emissions.[11] Ruminant meat has a higher environmental impact than pork, because ruminants emit methane while digesting food.[27,28] Additionally, ruminant meat production requires more agricultural inputs per unit of meat produced compared with pork.[21] Data from 55 504 individual surveys outlined that reducing the daily consumption of meat from $\geq$100 g to <50 g can lower the impact of GHG emissions, eutrophication, and land use by at least 30%.[31]Achieving a low-carbon-footprint diet does not necessarily require the complete exclusion of meat or animal-based products, and reducing the quantity or changing the type of meat consumed, such as eating fish, turkey, and chicken instead of beef and pork, can make a climate-friendly diet more flexible and acceptable to a wider audience.[26,28,30,35] According to FAO and WHO,[23] sustainable healthy diets must guarantee the optimal growth and development of all individuals and support functioning and physical, mental, and social wellbeing at all life stages, contribute to preventing all forms of malnutrition and reducing the risk of diet-related noncommunicable diseases, while supporting planetary health. Moreover, they must be accessible, affordable, safe, equitable, and culturally acceptable,[23] that is, be inherently linked to environmental, cultural, social, and economic contexts, thereby varying depending on individual preferences, household budget, social identity, community values, tradition, local foods, and cuisine.[36,37]

Reducing food waste at both the retail and consumer levels, as well as minimizing food losses during production and along the supply chains, could also be strategic in meeting sustainable development goals and climate change targets.[38] Globally, 1.3 billion tons of food is wasted or lost every year, despite 690–829 million people going hungry and 3 billion being unable to afford a healthy diet.[39] Every year, food waste and loss account for a significant portion of natural resource use (ie, ∼25% of all water used in agriculture and 23% of global cropland) and generate nearly 8% of global GHG emissions, with considerable socio-economic consequences.[40]

CONSUMERS AND SUSTAINABLE FOOD CHOICES: A PROMISING NEW COURSE OF ACTION?

Eco-emotions, that is, emotional concern or worry, at least to some degree, may work as a source of

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Table 1. Overview of Studies Estimating the Environmental Impacts of Several Diets and Foods

Authors and year	Aim	Food or dietary pattern	Health indicators or nutritional score	Environmental indicators	Impact on environment results	Conclusion
Aidoo et al 2023[24]	To investigate environmental and nutritional performances of modeled diet scenarios, using partial replacements of meat with legumes, ranging between the current and the optimal dietary pattern, to identify feasible sustainable dietary patterns	3 diet consumption models (Ms) including 24 scenarios (Ss) built on data in the Food4HealthyLife calculator defining dietary patterns in relation to life expectancy • Current model diet/ S1M1M2M3: 0% legumes, 2.78% processed meat, 5.56% red meat, 4.17% white meat • Optimal model diet/ S10M1M2M3: 11.11% legumes, 0% processed meat, 0% red meat, 2.78% white meat	HENI and Food Compass scores as developed by Stylianou et 2021[32]	18 EI indicators: global warming (short term), global warming (long term), water use, ionizing radiation, mineral resources, freshwater ecotoxicity, ozone layer depletion, fine particulate matter formation, freshwater acidification, fossil energy use, marine eutrophication, land occupation, freshwater acidification, freshwater eutrophication, terrestrial acidification, human toxicity (cancer and non-cancer), total ecosystem quality damage, total human health damage	• Global warming vs current model diet: • Reduced by 54.72% for S9M3 (10% legumes, 0.28% processed meats, 0.11% red meat, and 2.81% white meat), 46.22% for S9M2 (8.89% legumes, 0.56% processed meats, 0.781% red meat, and 2.97% white meat) • increased by 7.59% for S2M2 (0.83% legumes, 1.39% processed meat, 4.89% red meat, and 4% white meat), 7.56% for S2M3 (1.11% legumes, 2.5% processed meat, 4.89% red meat, and 4% white meat), 7.08% for S2M1 (0.67% legumes, 1.39% processed meat, 4.89% red meat, and 3.47% white meat), models built on a significantly increased intake of fruits, vegetables, whole grains, fish • EI indicators: • highest impact for S2M1, S2M2, and S2M3 scenarios, followed by the current model diet • lowest impact for S9M3	Diet scenarios' EIs decrease approaching the S9M3 diet as the most environmentally friendly, while they increase in the optimal diet scenario.
Burke et al 2023[25]	To characterize the EIs of 5 dietary patterns within high–income countries across Europe and North America, from a farm-to-fork perspective	Data from 23 peer-reviewed articles, published after 2009 High-protein diets (HPs): meat consumption ≥100 g/day • Omnivorous diet (Omin) • Lacto–ovo–vegetarian/ pescatarian diet (VE–Pes) • Recommended diet (Rec): nationally recommended, healthy guidelines, MD and Atlantic diet • Vegan diet (VG)	NA	GHGe (CO_2eq kg person^{-1} day^{-1})	• HP: 5.71; +39%, +43%, +89% vs VE-Pes, Rec, VG • Omni: 4.83 • VE-Pes: 3.86 • Rec: 3.68 • VG: 2.34; −84%, −69%, −49%, −45% vs HP, Omin, VE-Pes, Rec	Shifting from high-meat and omnivorous diets to recommended, vegetarian, or vegan diets, GHGe from the farm-to-fork boundary have the potential to be reduced by up to 86% in Europe and North America.

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Table 1. Continued

Authors and year	Aim	Food or dietary pattern	Health indicators or nutritional score	Environmental indicators	Impact on environment results	Conclusion

Cavaliere et al 2023[26]	To explore the extent to which alternative diets may alleviate the EI with respect to the current Italian diet and the recommended MD	Data from the Italian Household survey in 2020 conducted by the Italian Institute of Statistics
		• MD
		• Current diet (CD) vs MD: less plant-based foods, cereals, and milk; more animal-based products and sweets
		• Flexitarian diet (FD): similar to MD, with lower intake of meat products
		• White meat diet (WMD): no red meat
		• Pesco–vegetarian (PV): no meat
		• VG no meat or fish
				• CF = overall amount of GHGe throughout the life cycle of a product (CO_2eq person-years)
				• Ecological footprint (EF) = a biologically productive hectare with world average biological productivity for a given year (gha)
					• CD: CF = +39.5% vs MD
					• FD:
					  • CF = −30% vs current diet; −2.3% vs MD
					  • EF = −42.4% vs current diet
					• WMD and PVD vs FD:
					  • CF = −0.07%
					  • EF = −0.05%
					• VG: the lowest EI
						All diets have a remarkably lower EI compared with the current Italian diet; thus, the reduction of both CF and EF could be achieved by lowering consumption of meat and other animal-based products to levels beneficial for environmental and human health.

Chen et al 2019[20]	To assess the consequences of various modeled dietary change scenarios in Switzerland by integrating environment, nutrition, economic, and human health indicators	Current Swiss diet (REF): daily intake of meat 4 times higher than recommended), Healthy Global Diet (HGD), diet relying on the Swiss Society in Nutrition recommendation (RSN), Vegan diet (VGN), lacto-ovo vegetarian diet (VGT), lacto-ovo pescatarian diet (PST), flexitarian diet, protein-oriented diet (PTO), meat-oriented diet (MTO), greenhouse gas tax diet (TAX)	• Health indicator: DALYs
			• Nutrition quality indicators: nutrient balance score, disqualifying nutrient score, % population with adequate nutrients
				GHGe (kg CO_2eq) water (WFP, m), cropland use (LFP, m/kg), nitrogen (NFP, gN), phosphorus (PFP, gP)	• DALYs: transition to VGN scenario exerts the most health benefits avoiding ∼21 000 DALYs, followed by the RSN scenario avoiding >15 000 DALYs, while transitioning to MTO or PTO alternatives increases the risk of disease, with additional ∼24 000 DALYs
					• EI:
					  • GHGe: highest for MTO (∼4000) and PTO (∼3300), followed by REF (∼2300), and lowest for VGN (∼380), followed by VGT and PST (∼780); highest for beef and lamb (∼30), followed by pork (∼3), eggs, milk, rice, palm oil (∼1–2);
					  • WFP: ∼0.4 for HGD and RSN, ∼0.6 for the other scenarios; high for animal-sourced products, sugar, legumes, rice (0.5–1)
					  • LFP: lowest for HGD and RSN (∼3), highest for MTO and PTO (∼5); high for legumes,
						• Transitioning towards a healthy diet as recommended by the Swiss Nutrition Society may carry the highest sustainability benefits, by reducing by 36% the environmental footprint, saving ⅓ of expenditure on food, and lowering adverse health outcomes by 2.67% compared with the current diet
						• - Shifting to a meat- or protein-oriented diet represents the least sustainable option by resulting in large increases in diet-related adverse health outcomes, environmental footprint, daily food expenditure, and low intakes in essential nutrients

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Table 1. Continued

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					vegetable oils, oil crops, nuts, seeds, animal-sourced products (5–11) • NFP: lowest for RSN and HGD (∼20), highest for MTO and PTO (∼32.5) followed by REF and TAX (29); high for animal-sourced products, cereals, oil crops, nuts, seeds, fruits, vegetables (10–50) • PFP: same trends as for NFP	
Clark et al 2019[21]	To consider how consuming a serving of 15 food groups is associated with 5 health outcomes and 5 aspects of environmental degradation	Chicken, dairy, eggs, fish, SSBs, unprocessed red meat, processed red meat, minimally processed plant-based foods (fruits, vegetables, whole-grain cereals, legumes, nuts, potatoes, refined grain cereals)	Type II diabetes mellitus, stroke, coronary heart disease, colorectal cancer, mortality	• GHGe, land use, scarcity-weighted water use, acidification, eutrophication per serving of food produced, as estimated by meta-analyses of life-cycle assessments • AREI = averaged relative EI (across all indicators)	• Minimally processed plant-based foods, olive oil, SSBs: the lowest EI for all indicators, often <5; AREI <5 • Dairy, eggs, fish, chicken: EI from 3 to 40 for GHGs, acidification, eutrophication, land use; AREI = 14 (for eggs <5) • Unprocessed red meat: the highest EI for all indicators, from 16 to 230; AREI = 73 • Processed red meat: the second-highest impact on acidification, GHGe, land use; the third-highest impact on eutrophication; AREI = 37	Foods with the lowest EIs often have the greatest health benefits (lowest relative risks of disease or mortality), while those with the largest EIs (unprocessed and processed red meat) often have the largest negative impacts on human health.
Clark et al 2022[27]	• To derive estimates of a food product's environmental sustainability by an algorithm using publicly available information • - To explore relationships between environmental and nutritional impacts	57 000 products available at Tesco in the United Kingdom and Ireland	NA	EI score for 100 g of products	• Vegetables, fresh fruit; snacks (eg, chips, crisps, popcorn); cereal grains, breads, breakfast cereals, crackers, crisp breads; dairy and meat alternatives, dairy, eggs; sugary drinks, water-based beverages: EI score <2 • Desserts, cakes, biscuits, brioches, pies, pastries, cookies, muffins; prepared foods (eg, pizzas, ready-to-eat meals): EI score = 2–5 • Nuts, dried fruit; sweet and savory spreads; cheese; fish, pork, poultry: EI score = 5–10 • Beef and lamb: EI score > 10	More nutritious products are often more environmentally sustainable, with some exceptions.

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Table 1. Continued

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Dixon et al 2023[28]	To calculate the impacts of 6 popular diets within the United States on planetary health	• Standard American or Western diet (WD)
		• MD
		• Vegan diet (VG)
		• Paleolithic diet (Paleo): relying on lean meats, seeds, eggs, fruits, vegetables
		• Ketogenic diet (Keto): consumption of foods rich in fat and protein, with significant limitation of carbohydrates
		• Climatarian diet (Clima, including vegetarian and meat-eating scenarios): relying on local, seasonal, and fresh food, avoidance of ruminant meats, and moderate intake of pork, poultry, sustainable fish
			NA	CF (kg CO_2eq)	• VG: 1.63
					• MD: 2.17
					• Clima:
					  • Vegetarian: 1.88
					  • Meat-eating : 2.54
					• WS:
					  • No ruminant meat: 2.63
					  • With ruminant meat: 8.14
					• Paleo:
					  • No ruminant meat: 3.11
					  • With ruminant meat: 5.91
					• Keto:
					  • No ruminant meat: 4.85
					  • With ruminant meat: 9.72
						• MD, VG, and climatarian diets comprise the lower-emission category, that is, diets associated with more health benefits for humans tend to be healthier for the planet
						• Diets more dependent on beef meats are less environmentally sustainable

Kesse-Guyot et al 2021[29]	To explore the association between environmental impacts and the related quintile (Q1–5) of adherence to the EAT-Lancet diet among French adults	Data from the NutriNet_Santé Study	Level of adherence to the EAT-Lancet diet through the EAT-Lancet diet index (ELD-I)	• GHGe (CO_2eq/day), cumulative energy demand (CED; MJ/day), land occupation (LO; m/day) • - overall EI aggregate score (pReCiPe) based on GHGe, CED, LO	Environmental indicators associated with ELD-I Q_5 vs Q_1: • GHGe = −56%: (2.63 vs 6.03) • LO = −54%: (7.17 vs 15.53) • CED = −31%: (15.16 vs 21.98) • pReCiPe = −63%: 0.168 vs 0.449	Adherence to the EAT-Lancet diet is strongly negatively associated with EI indicators.

Muñoz-Martínez et al 2023[30]	To explore the potential benefits of reducing animal meat and milk and replacing them with plant-based alternatives	• Meat scenarios: all meat gradually replaced (30%, 50%, 70%, 100%) by a plant-based hamburger; 4 types of meat replaced with a plant-based hamburger
		• Milk scenarios: milk replaced (50%, 100%) by a calcium-fortified soy-drink
				GHGe, land use, blue-water footprint (BWF)	• Meat scenario:
					  • Replacing 100% of meat: GHGe decreased by 43%, land use by 13%, BWF by 13%
					  • Type of meat: improvement in all parameters across meat types, with pork replacement displaying the smallest change, beef substitution the greatest reduction in GHGe (24%), processed meat replacement the lowest land use and BWF (6% to 5%)
					• Milk scenario: GHGe, land, and water used decreased by 6%, 4%, and 5%, respectively, after milk replacement
						Compared with current consumption, a Sustainable Healthy Diet in Spain can be more nutritious and reduce cost, GHGe, land-, and blue-water use by 32%, 46%, 27%, and 41%, respectively.

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Table 1. Continued

Authors and year	Aim	Food or dietary pattern	Health indicators or nutritional score	Environmental indicators	Impact on environment results	Conclusion
Scarborough et al 2023[31]	To estimate food-level data on environmental indicators associated with observed diets of vegans, vegetarians, fish-eaters, and meat-eaters in the United Kingdom	Baseline data collection of the EPIC-Oxford prospective cohort study 3 main groups: vegans; vegetarians; fish-eaters; meat-eaters, split into: low (0 to <50 g/day), medium (≥50 to <100 g/day), and high meat-eaters (≥100 g/day)	NA	Emissions of methane, nitrous oxide, and CO_2; estimates of water use, land use, eutrophication, biodiversity impact on terrestrial vertebrates, from 570 life-cycle assessments covering more than 38 000 farms in 119 countries in 5 continents[10]	Dietary impacts vs high meat-eaters: • Vegans: 25.1% for GHGe, 25.1% for land use, 46.4% for water use, 27.0% for eutrophication, 34.3% for biodiversity • Low meat eaters: 57.4% for eutrophication, 43.8% for land use	All EI indicators show a positive association with increased amounts of animal-based food consumption.
Stylianou et al 2021[32]	• To evaluate the nutritional performance of 5853 foods as estimated by a new epidemiology-based nutritional index • To classify 167 individual foods, representative of the diet, into prioritization classes based on their nutritional and environmental impacts	Foods consumed by adults from the What We Eat in America database	HENI score quantifying the net minutes of healthy life gained (+) or lost (−) from all-cause mortality and morbidity per standard serving of food	18 environmental indicators damaging human health, ecosystems and resources	• Green zone: foods with HENI > 0 (nutritionally beneficial) and low EIs (<50th percentile, ie, shorter-term global warming impacts <3.2 kg CO_2eq per serving). Nuts, fruits, vegetables, legumes, whole grains, some seafood • Red zone: foods with considerable negative nutritional or high EIs (scores >75th percentile, ie, >3.2 min lost per serving or >0.61 kg CO_2eq per serving, respectively). Nutritional impacts driven by processed meat and SSBs; EIs by beef, processed meat, pork, cheese-based foods, some salmon dishes • Amber zone: foods slightly nutritionally detrimental (0–3.2 min lost, 75th percentile of HENI) or exerting moderate EIs (50th–75th percentiles). Most poultry, dairy, egg-based foods, cooked grains, and vegetables produced in a greenhouse	Replacing even just 10% of daily caloric intake from beef and processed meat with fruits, vegetables, nuts, legumes, and selected seafood may substantially enhance health by 48 min gained per person and a 33% reduction in dietary carbon footprint.

(continued)

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Table 1. Continued

Authors and year	Aim	Food or dietary pattern	Health indicators or nutritional score	Environmental indicators	Impact on environment results	Conclusion

Telleria-Aramburu et al 2022[33]	To explore health nutrition and environmental dimensions of diets consumed by students of the University of the Basque Country (Spain)	Data from the EHU12/24 project	Healthy Eating Index (HEI-2010) and MedDietScore (MDS)	GHGe data obtained from literature	• Mean estimated GHGe = 4.71 kg CO_2 eq/day; 0.23 kg CO_2 eq/1000 kcal
					• Low-emitting diets among subjects with low HEI-2010 scores and high MDS scores
					• GHGe/1000 kcal:
					  • diets in the highest quintile: 27.3% emissions
					  • diets in the lowest quintile: 14.3% emissions
					• Food groups with the greatest contributions to GHGe (%): red and deli meat (28.23 ± 13.34), fruits and vegetables (19.18 ± 12.02), milk and dairy products (12.14 ± 7.05)
						Diets of the highest quality are not always those with the lowest diet-related GHGe.

Tepper et al 2022[34]	To explore the environmental footprints of various diets consumed in Israel	Population-based cross-sectional data	MD score, EAT-Lancet score, and Sustainable-HEalthy-Diet (SHED) score	Land footprint, water footprint, GHGe per unit of agricultural and food products	• GHGe: 26% for dairy products, 14% for both meat and vegetables • Land use: 30% for beef, 14% for poultry • Water use: 40% for fruits, 12% for vegetables, 11% for dairy • Higher MD and EAT-Lancet adherence and SHED scores associated with lower land use, lower GHGe, and higher water use	• Animal proteins are the highest contributor to GHGe and land use; fruits and vegetables are the highest contributor to water consumption (mostly treated wastewater, reducing environmental pressure) • MD and EAT-Lancet diets are to be included in national dietary guidelines and their consumption encouraged.

Abbreviations: CF, carbon footprint; CO_2eq, carbon dioxide equivalent; DALYs, disability-adjusted life years; EI, environmental impact; GHGe, greenhouse gas emissions; HENI, health nutritional index; MD, Mediterranean diet; NA, not available; SSBs, sugar-sweetened beverages.

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motivation for active engagement and play a crucial role in the adoption of pro-environmental behaviors.[41–45] However, obstacles such as lack of knowledge, false beliefs (eg, organic food as an effective mitigation option), difficulty in assessing the actual environmental impact of food choices, and the attitude–behavior gap (ie, the discrepancy between having a favorable attitude toward a sustainable behavior and actually practicing it) persist.[35,46–48] Nonetheless, consumers today are increasingly aware of climate change issues and express an intention to adopt eco-friendly behaviors, such as reducing meat consumption, opting for active transportation (ie, riding a bike or walking), and recycling (ie, reusing and reducing food waste).[49] A meta-analysis of studies from Europe, Asia, America, and Oceania[50] and a systematic review of studies from Oceania, Latin America, Africa, Asia, China, Europe, the United Kingdom, the United States, and Canada[51] demonstrate that consumers are willing to pay premium prices for sustainable food products.

Notably, heightened awareness of the everyday impacts of the climate crisis has likely driven the shift toward plant-based eating, as consumers try to contribute to climate change mitigation.[24] Moreover, health-related dietary motivations, such as the recognized health benefits of certain dietary patterns (Table 2)[52–72] also influence food choices.[18,47,73] Over the past decade, there has been a growing trend toward adopting plant-based diets, particularly in Western countries.[24,74] The sales of meat decreased by 5% in 2015 and those of dairy milk by almost 16% in 2018, while the number of vegan/vegetarian restaurants increased by nearly 1664% from 1997 to 2022.[24] By 2030, the plant-based food market has been projected to reach US$162 billion. One way to attain the sustainable dietary transition might be to replace meat with plant-based alternatives, which consist of either minimally processed pulses (eg, tofu, soy milk) or ultra-processed foods (UPFs) including plant protein isolates (eg, plant-based burgers). Life-cycle analyses suggest that plant-based products are likely to exert a lower burden on the environment than their conventional animal-based counterparts. Shifting from current dietary patterns toward a diet excluding animal products is expected to help restore natural vegetation and soil carbon, while reducing land use by 76%, food's GHG emissions by 49%, acidification by 50%, eutrophication by 49%, and scarcity-weighted freshwater withdrawals by 19%.[10] A considerable reduction in the global environmental impacts is projected by 2050 if 50% of the main animal-based foods (pork, chicken, beef, and milk) are replaced with novel plant-based alternatives, leading to a 31% reduction in GHG emissions.[75] The environmental performance of such substitutions would vary depending on the type of meat replaced. It has been calculated that the environmental impact of sausages containing beef or lamb is, on average, 240% higher than that of pork, which in turn has a 100% higher impact than poultry. Poultry sausages exert a 170% higher environmental impact than vegan and vegetarian products.[27]

The origin of food products has increasingly influenced consumers' intentions to eat sustainably and their purchasing decisions. There has been some recent research investigating how people across Europe, the

Table 2. The EAT-Lancet Diet (EAT-LD) and the Mediterranean Diet (MedDiet): Beneficial Effects on Diseases

- **Type 2 diabetes mellitus (T2DM)**
  EAT-LD: Greater adherence is associated with both lower risk of developing T2DM[52,53] and decreased risk of incident T2DM among people with various levels of genetic risk.[54]
  MedDiet: Reduces the inflammatory profile of T2DM, partially because of the anti-inflammatory action of citrus bioflavonoids,[55] and several metabolites associated with higher relative risk of T2DM.[56]
- **Cardiovascular diseases (CVDs)**
  EAT-LD: Adhering is associated with a lower risk of cardiovascular disease and coronary heart disease,[57] coronary events (including fatal and nonfatal myocardial infarction or death due to ischemic heart disease[58]), subarachnoid stroke,[59] incident atrial fibrillation (mostly in individuals with higher genetic risk[60]), and heart failure[61]. Overall, EAT-LD is associated with a better cardiometabolic profile (ie, lower values for blood pressure, total cholesterol and some its fractions, such as LDL-c and non-HDL-c); that is, better cardiovascular health is observed.[62]
  MedDiet: Exerts a favorable effect on blood pressure, insulin sensitivity, lipid profiles, lipoprotein particles, inflammation, oxidative stress, and carotid atherosclerosis, thus representing an ideal model for CVD prevention.[63] Interestingly, the MedDiet likely decreases cardiovascular risk factors in obese children and adolescents exhibiting any metabolic syndrome component by improving body mass index, blood glucose levels, and lipid profile.[64]
- **Non-Alcoholic Fatty Liver Disease (NAFLD)**
  MedDiet: Is effective in reducing liver steatosis.[65,66] Overall, adherence is associated with a lower prevalence of NAFLD in patients with cardiometabolic disorders.[67]
- **Cognitive aging**
  EAT-LD: Is associated with better global cognitive functioning and slower cognitive decline in cognitively healthy older adults.[68]
  MedDiet: May slow age-related cognitive decline in older populations.[69,70]
- **Cancer**
  EAT-LD: Adoption reduces the risk of incident cancer and all-cause mortality.[71]
  MedDiet: Likely exhibits a beneficial effect in the primary prevention of breast cancer.[72]

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United States, and Latin America adjust their food choices with respect to environmental aspects and the sustainability of the food chain. Evidence has shown that most consumers prefer fresh, local, and seasonal foods that minimize food waste at home and originate from sustainable processing systems with minimal low-impact packaging.[18] Beyond environmental concerns, ethical aspects, and social dimensions encompassing the respect for human and workers' rights, animal welfare, and fair trade may influence people's food choices.[48,76,77] Buying local food is perceived as a way to support local communities and establish local production systems.[18] Indeed, modern consumers seem to place greater value on ethical, social, and health aspects than on environmental issues.[78,79]

BARRIERS TO THE ADOPTION OF SUSTAINABLE DIETS

We have identified 3 main factors that undermine the ability of consumers to make sustainable food choices. These are (1) shortcomings in defining and measuring sustainable diets; (2) low availability of food alternatives to meat and UPFs; and (3) ineffective policy instruments for promoting sustainable food choices.

Definition and Metrics

One central barrier to making sustainable food choices is a lack of consensus on what sustainability means and how to measure it in food systems. The term sustainability has been used to encompass environmental, economic, public health, and sociocultural dimensions.[80] The best-known definition of a sustainable and healthy diet was worked out in 2019 by FAO and WHO.[23] However, its guiding principles are very much qualitative in nature, and it lacks recommendations on how to quantitatively assess the sustainability of diets. In the same year, the EAT-Lancet Commission proposed the "Planetary Health Diet," a largely plant-based reference diet with modest quantities of animal foods and minimal red and processed meats, sugars, refined grains, and starchy vegetables.[22] The Commission also provided global scientific targets defining a safe operating space for food systems, emphasizing the links between agriculture and climate change.[22] However, it has been suggested that providing a single reference for the whole world population might be a shortcoming.[81]

While food-based dietary guidelines (FBDGs) offer country-specific healthy diet guidance, only 37 include reference to environmental sustainability, mainly in upper-middle- and high-income countries in Europe and Latin America.[82]

Production: Alternatives to Meat Consumption

In addition to plant-based alternatives, other sources for meat protein substitutes include fungi-, or insect-based proteins, single-cell proteins (microalgae and bacteria), and cultured meat. Meat substitutes, or meat analogs, are terms referring to the products that mimic the processing, nutritional, and sensorial qualities of meat. They include a wide range of products that can be categorized according to the product's application, depending on whether they are mimicking the whole muscle tissue, a fragment of muscle tissue (eg, ground meat), or processed meat product (eg, hot dogs).[83] Meat substitutes, their overall characteristics, and their environmental impacts are summarized in Table 3.[75,83–101] Overall, the current evidence indicates they have the potential to promote sustainability and a circular economy. In the context of reducing meat consumption, understanding the drivers behind consumer acceptance of, or willingness to purchase, various alternative protein sources is essential. A systematic review of studies conducted in several countries from Europe, the United States, and Australia revealed that acceptance of pulses, algae, insects, plant-based meat substitutes, and cultured meat was relatively low in comparison with meat, and that pulses and plant-based alternatives were the most accepted, while insects were the least accepted, followed by cultured meat,[102] in line with the general trend observed (Table 3). Taste, healthiness, familiarity, attitudes, food neophobia, disgust, and social norms were the significant drivers of consumer acceptance, with differences across alternative meat proteins. For example, for insects and other novel proteins, familiarity, food neophobia, and disgust seemed the most relevant determinants of acceptance.[102] Commonly, social and cultural factors (norms, preferences, perceptions, beliefs) are strong drivers of meat consumption, because it can symbolize tradition, wealth, social connection, and masculinity, so these can be additional obstacles to the adoption of alternative protein consumption.[79,103] Furthermore, high prices, low availability, and a lack of convenience have been identified as motivational barriers preventing widespread adoption of a sustainable diet.[36,85] Age and education likely also influence sustainable food choices worldwide, with younger generations[104–107] and more educated consumers[107–109] being more prone to consuming less meat and more meat substitutes, as demonstrated for example by studies carried out in the United States, the United Kingdom,[104] South Africa,[105] Belgium,[106] New Zealand,[107] Slovenia,[108] and Canada.[109]

It is important to note that, while the environmental benefits of plant-based meat substitutes are well established, their health effects are more debated. A

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Table 3. Meat Substitutes: Classification, Characteristics, and Environmental Impact

• **Plant-based.** The most commonly used are legumes (soybeans, lupine, peas, lentils) and cereals or pseudo-cereals (chia, quinoa), frequently mixed. Plant-based substitutes are characterized by low environmental impact and resource consumption, while they exert the highest impact when being mixed with animal-sourced ingredients. Generally, higher levels of processing are linked to higher environmental impact.[83,84] If half of the meat and milk were to be replaced by plant-based products by 2050, a reduction of 31% of agriculture and land use greehouse gas emissions might occur.[75] Overall, consumers perceive plant-based diets as ethical, healthy, and environmentally friendly, but plant-based foods and meals are sometimes regarded as less convenient and tasty.[85]
• **Fungi-based.** Mycoprotein, produced by fungal biomass, is a source of protein for meat substitutes. Various edible mushrooms (eg, *Rhizopus oligosporus*, *Fusarium venenatum*, *Penicillium limosum*) have been studied and/or sold in many countries.[86–88] Fungi-based substitutes are commercialized in the United States and Europe, but they are still pricy. In addition, their environmental footprint has still to be quantified by quality studies, despite preliminary research showed high energy requirements and greenhouse gas emissions.[83,86]
• **Insect-based.** Entomophagy is practiced in 113 countries around the world, mostly in Africa, Asia, Latin America, and Oceania.[89] More than 2000 species of insects are edible,[89] and they are a good source of proteins. Insects mixed with vegetable proteins are used to mimic meat texture and can have high nutritional value.[90] The major concerns are allergic reactions due to tropomyosin and arginine kinase, chemical contamination with heavy metals, and biological contamination by Enterobacteriaceae.[90,91] Insect-based proteins have an environmental footprint lower than that of animal proteins but higher than that of plant proteins.[100] Plant–insect hybrid products show a lower environmental impact than plant–animal hybrid products.[83] A systematic review including 22 studies from developed countries and 10 from developing countries indicates that the consumer acceptance of insects remains low, particularly in high-income countries, thus target strategies for specific populations should be developed to improve their acceptance.[93]
• **Single-cell.** Microalgae are a safe alternative source of protein of quality, and have a higher growth rate than plant proteins.[90] Some researchers have studied the possibility of producing microbes rich in protein using urban waste.[94,95] However, more efficient production is required.[83] Even though the current method for producing single-cell sources of protein is almost 50 years old, there is skepticism about the possibility of industrial production and its energy demand.[90] Low environmental impact would depend on the use of renewable energy in production processes.[83] Possible advantages are the reduction of cultivable land[96] required and the reuse of waste steam as a nutrient source.[97] However, the attraction of microalgae as a food source seems to be relatively low, due to their yellow-green color, fishy smell, and high prices.[90]
• **Cultured meat.** Meat produced by cellular agriculture is a promising alternative to current systems, but it is still in its developmental stages. Major challenges are obtaining low-cost culture medium and achieving energy efficiency.[98] Compared with livestock farming, cultured meat reduces energy consumption, greenhouse gas emissions, and land use.[99] It could be a possible option in the long term if all ethical and safety concerns could be solved and its production widely authorized.[100] There is large cultural variation in the acceptance of cultured meat, with perceived unnaturalness and disgust being important factors, so cross-cultural research may be paramount for the acceptance of this novel food-production technology.[101]

large cohort study conducted in the United Kingdom found a positive association between the consumption of UPFs, including plant-based UPFs, and cardiovascular diseases.[110] Although they are a good source of healthy nutrients, some of the processed meat alternatives are high in saturated fat and sodium, which suggests the need for the consumer to pay attention when choosing meat alternatives and for the food industry to improve the nutritional profile of meat alternatives. However, dietary patterns centered on whole plant-food, such as beans and whole grains, are overall healthier.[111]

Policy Instruments for Behavioral Change

The most recent research has identified 4 main categories of policy instruments that aim to boast consumers' awareness of environmental concerns.[112–113] These are information-based, nudging, market-based, and regulatory instruments. Although the information-based instruments (eg, labels, education, campaigns) are the most widespread and promoted, both by food companies and governments, their impact has been found to be minimally effective, mostly depending on sociodemographic characteristics.[112–113] Regarding the effect of the consumer's age on the impact of information-based instruments, the literature presents mixed results. Some studies have found that older generations are more likely to buy products displaying eco-labels,[114,115] while others have reported environmental knowledge as the determinant affecting a younger individual's inclination towards the consumption of sustainable food products.[116,117] As to gender, the findings generally show that women are more inclined than men[114,115,118–120] to purchase sustainable foods. Higher education and income also correlate with sustainable choices.[114,118,120,121]

Regardless of the consumer group's characteristics, scholars and policymakers have been debating about the effectiveness of strategies for designing food product labels. Although eco-labels overall increase public awareness of environmental problems and promote purchases of sustainable products,[122,123] some studies have shown that general knowledge about sustainability and how to read label content is low.[120,121,124,125] Poor communication through the information on labels can lead to confusion when choosing a product.[126] The effectiveness of combination labels displaying information on different spheres of sustainability (eg, carbon footprint and nutritional values) is another field that deserves further attention, in the light of the conflicting findings encountered

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so far.[127,128] Nudging instruments—defined as measures that voluntarily shift consumers towards more sustainable food choices—can lead to small improvements.[129] However, the adoption of these instruments alone has proven minimally impactful.[130]

OPPORTUNITY AND SOLUTIONS

Consumers need to be stimulated and supported to make food choices that are both sustainable and health-promoting. This requires substantial transformation of food systems and environments, alongside increased consumer knowledge, awareness, and empowerment. Addressing both health and sustainability is essential for shifting from inadequate diets high in animal proteins and UPFs toward balanced, plant-based diets. Cross-sector partnerships—between authorities, academia, civil society, producers, and industry—and interdisciplinary strategies are needed. Double- and triple-duty actions that address climate change, undernutrition, and obesity are required.[9,131] To be effective, global targets must be adapted locally, reflecting national disease burdens, environmental challenges, and cultural traditions.[37] As a single global diet cannot fit the whole world, the general features of the "Planetary health diet" have to be tailored to the specific geographic, cultural, social, and economic context. Indeed, several traditional healthy diets are already including these features, for example, the territorial Japanese diet, the Mediterranean diet, and the Nordic diet,[23] and traditional healthy diets in Indonesia, Mexico, India, China, and West Africa.[22]

Which policy measures should be implemented to encourage and guide consumers to make long-term more sustainable and healthier food choices in an attainable way?

Integrating sustainability into national FBDGs that reflect cultural and economic peculiarities, as well as public health needs, can be a starting point for the uptake of healthy and sustainable diets at a population level. By offering country-specific guidance on sustainable dietary patterns and how to make changes, FBDGs have the potential to become a key instrument for practically assisting consumers in their food choices. Although originally focusing only on promoting healthy eating, since 2014 FBDGs have been starting to embed aspects related to sustainability,[82] such as reducing GHG emissions, promoting plant-based diets, preserving biodiversity, and addressing food loss and waste. For example, the latest Italian guidelines provide advice on the selection of local seasonal products and include strategies to reduce food waste.[35] Brazilian dietary guidelines promote whole or minimally processed foods and their culinary preparations over UPFs.[132] Belgian, French, and Swedish dietary guidelines explain the "what," "why," "how," and "quantity" for dietary change towards a more sustainable diet, emphasizing the consumption of plant protein sources while reducing the consumption of red meat.[133] The 2020–2025 Dietary Guidelines for Americans establishes strong recommendations for plant-based diet consumption.[79] Implementing education and public awareness campaigns that incorporate sustainability concepts can empower individuals to make informed decisions about climate-friendly foods, such as: the "Nationale Week Zonder Vlees & Zuivel" campaign motivating the population to eat meat-free for 1 week in March (the Netherlands);[134] the "Eat A Whole Lot More Plants" campaign (New York City);[134] the Waste and Resources Action Programme and the "Love Food, Hate Waste!" campaign helping reduce waste behaviors by individuals and households (the United Kingdom);[19] and the "Shokuiku" policy promoting lifelong food literacy and incorporating environmental and cultural values into school curricula (Japan).[135] Nutrition education empowers consumers to shape their diet in politically conscious, socially resposible, and democratically participatory ways.[137] Nutrition knowledge equips them with competencies for understanding nutrition-related topics and labeling, as well as for actively engaging in food-related decisions and shaping processes. Children and the younger generations should be mostly targeted, as they may be more receptive to change and more sensitive to environmental issues. This could accelerate the cultural transition toward more sustainable healthy food consumption.[79] Health personnel and organizations could also play a critical role in educating people about environmental impacts of dietary choices. Furthermore, a key strategy could be the channeling of information through instrumental social platforms such as TikTok, Facebook, and Instagram.[79]

Overall, the above-mentioned less intrusive policy measures, resulting in a gradual, incremental transition, are more acceptable than those that push for drastic changes or are mandatory.[78,79] However, market-based instruments and regulatory interventions should also be gradually scaled up to support the effectiveness of the transition as acceptability allows.[78,137] Implementing fiscal tools, such as incrementing the price of UPFs and high-impact animal products through taxes (eg, of red meat), or making fruits, vegetables, legumes, and plant-based proteins affordable through subsidies or value-added tax reductions, can help incentivize the consumption of plant-based foods, while discouraging that of animal-based foods.[78,137–139] Furthermore, social protection measures are needed for resource-constrained and marginalized individuals.[140] Reforming public food procurement (ie, through schools, hospitals, and other

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public facilities) to incorporate plant-based, minimally processed, and locally sourced options may stimulate the acceptance of and familiarity with sustainable eating.[134,141,142] In particular, school meal programs can become an educational tool, instilling in children lifelong dietary knowledge.[143]

Cities can also play a central role in fostering the implementation of sustainable food systems, creating collaborative networks to enhance a collectivity's environmental, economic, and social health. The international agreement of Mayors from all over the world launched at the World Expo 2015, the so-called Milan Urban Food Policy Pact,[143] is worthy of mention. It is the first guide on urban food policies to advance the common goal of sustainable, inclusive, and resilient urban food systems.[142–144]

CONCLUSION

There is substantial evidence that current consumption patterns negatively affect both planetary and human health, with food systems being no exception. Consumer choices and associated dietary habits can contribute significantly to reducing environmental pressure. However, a more equitable, sustainable food system is not only a matter of consumer responsibility but also a governance imperative, as the production and availability of sustainably sourced foods are shaped by complex interactions among various stakeholders, policies, and market dynamics. While consumers are increasingly inclined toward sustainable food options, their choices are often limited by systemic, economic, and social barriers, including no standardized definition, weakness in the current information-based instruments, high prices, and low education. Long-term change demands holistic approaches: cross-sector collaboration, combined strategies, and multi-level interventions. Policies must be tailored to local contexts reflecting national conditions, economic systems, and cultural traditions. Actions such as integrating sustainability into FBDGs, funding education and awareness campaigns, reforming public procurement, and providing economic incentives can drive healthy, planetary-friendly diets.

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Conflicts of Interest

None declared.

Data Availability

No new data were generated or analyzed in support of this research.

REFERENCES

1. Romanello M, Napoli CD, Green C, et al. The 2023 report of the Lancet Countdown on health and climate change: the imperative for a health-centred response in a world facing irreversible harms. *Lancet*. 2023;402:2346-2394. https://doi.org/10.1016/S0140-6736(23)01859-7
2. Li B, Zhou L, Qin J, et al. Middle East warming in spring enhances summer rainfall over Pakistan. *Nat Commun*. 2023;14:7635. https://doi.org/10.1038/s41467-023-43463-0.
3. Ballester J, Quijal-Zamorano M, Méndez Turrubiates RF, et al. Heat-related mortality in Europe during the summer of 2022. *Nat Med*. 2023;29:1857-1866. https://doi.org/10.1038/s41591-023-02419-z
4. UNICEF, WHO. *Progress on Household Drinking Water, Sanitation and Hygiene 2000–2022: Special Focus on Gender*. United Nations Children's Fund (UNICEF) and World Health Organization (WHO); 2023. Accessed July 23, 2024. https://www.who.int/publications/i/item/9789240073791
5. Crandon TJ, Dey C, Scott JG, Thomas HJ, Ali S, Charlson FJ. The clinical implications of climate change for mental health. *Nat Hum Behav*. 2022;6:1474-1481. https://doi.org/10.1038/s41562-022-01477-6.
6. Hickman C, Marks E, Pihkala P, et al. Climate anxiety in children and young people and their beliefs about government responses to climate change: a global survey. *Lancet Planet Health*. 2021;5:e863-e873. https://doi.org/10.1016/S2542-5196(21)00278-3.
7. Tsevreni I, Proutsos N, Tsevreni M, Tigkas D. Generation Z worries, suffers and acts against climate crisis—the potential of sensing children's and young people's eco-anxiety: a critical analysis based on an integrative review. *Climate*. 2023;11:171. https://doi.org/10.3390/cli11080171.
8. Anton B, Cuevas S, Hanson M, et al. Opportunities and challenges for financing women's, children's and adolescents' health in the context of climate change. *BMJ Global Health*. 2024;9:e014596. https://doi.org/10.1136/bmjgh-2023-014596
9. Swinburn BA, Kraak VI, Allender S, et al. The global syndemic of obesity, undernutrition, and climate change: the Lancet Commission report. *Lancet*. 2019;393:791-846. https://doi.org/10.1016/S0140-6736(18)32822-8.
10. Poore J, Nemecek T. Reducing food's environmental impacts through producers and consumers. *Science*. 2018;360:987-992. https://doi.org/10.1126/science.aaq0216
11. Beal T, Gardner CD, Herrero M, et al. Friend or foe? The role of animal-source foods in healthy and environmentally sustainable diets. *J Nutr*. 2023;153:409-425. https://doi.org/10.1016/j.tjnut.2022.10.016.
12. Liu L, Qu J, Maraseni TN, et al. Household CO_2 emissions: current status and future perspectives. *Int J Environ Res Public Health*. 2020;17:7077. https://doi.org/10.3390/ijerph17197077
13. Newell P, Twena M, Daley F. Scaling behaviour change for a 1.5-degree world: challenges and opportunities. *Glob Sustain*. 2021;4:e22. https://doi.org/10.1017/sus.2021.23
14. Hampton S, Whitmarsh L. Choices for climate action: a review of the multiple roles individuals play. *One Earth*. 2023;6:1157-1172. https://doi.org/10.1016/j.oneear.2023.08.006
15. Downs SM, Ahmed S, Fanzo J, Herforth A. Food environment typology: advancing an expanded definition, framework, and methodological approach for improved characterization of wild, cultivated, and built food environments toward sustainable diets. *Foods*. 2020;9:532. https://doi.org/10.3390/foods9040532

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16. Chen P-J, Antonelli M. Conceptual models of food choice: influential factors related to foods, individual differences, and society. *Foods*. 2020;9:1898. https://doi.org/10.3390/foods9121898.
17. Karanja A, Ickowitz A, Stadlmayr B, McMullin S. Understanding drivers of food choice in low- and middle-income countries: a systematic mapping study. *Glob Food Secur*. 2022;32:100615. https://doi.org/10.1016/j.gfs.2022.100615
18. Guiné RPF, Bartkiene E, Florença SG, et al. Environmental issues as drivers for food choice: study from a multinational framework. *Sustainability*. 2021;13:2869. https://doi.org/10.3390/su13052869
19. Rampalli KK, Blake CE, Frongillo EA, Montoya J. Why understanding food choice is crucial to transform food systems for human and planetary health. *BMJ Glob Health*. 2023;8:e010876. https://doi.org/10.1136/bmjgh-2022-010876.
20. Chen C, Chaudhary A, Mathys A. Dietary change scenarios and implications for environmental, nutrition, human health and economic dimensions of food sustainability. *Nutrients*. 2019;11:856. https://doi.org/10.3390/nu11040856.
21. Clark MA, Springmann M, Hill J, Tilman D. Multiple health and environmental impacts of foods. *Proc Natl Acad Sci U S A*; 2019116:23357-23362. https://doi.org/10.1073/pnas.1906908116.
22. Willett W, Rockström J, Loken B, et al. Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems. *Lancet*. 2019;393:447-492. https://doi.org/10.1016/S0140-6736(18)31788-4.
23. FAO and WHO. Sustainable healthy diets—Guiding principles, Rome. 2019. Accessed March 19, 2024. https://openknowledge.fao.org/server/api/core/bitstreams/03bf9cde-6189-4d84-8371-eb939311283f/content
24. Aidoo R, Abe-Inge V, Kwofie EM, Baum JI, Kubow S. Sustainable healthy diet modeling for a plant-based dietary transitioning in the United States. *NPJ Sci Food*. 2023;7:61. https://doi.org/10.1038/s41538-023-00239-6.
25. Burke DT, Hynds P, Priyadarshini A. Quantifying farm-to-fork greenhouse gas emissions for five dietary patterns across Europe and North America: a pooled analysis from 2009 to 2020. *Resour Environ Sustain*. 2023;12:100108. https://doi.org/10.1016/j.resenv.2023.100108
26. Cavaliere A, De Marchi E, Frola EN, et al. Exploring the environmental impact associated with the abandonment of the Mediterranean diet, and how to reduce it with alternative sustainable diets. *Ecol Econ*. 2023;209:107818. https://doi.org/10.1016/j.ecolecon.2023.107818
27. Clark M, Springmann M, Rayner M, et al. Estimating the environmental impacts of 57,000 food products. *Proc Natl Acad Sci U S A*. 2022;119:e2120584119. https://doi.org/10.1073/pnas.2120584119.
28. Dixon KA, Michelsen MK, Carpenter CL. Modern diets and the health of our planet: an investigation into the environmental impacts of food choices. *Nutrients*. 2023;15:692. https://doi.org/10.3390/nu15030692.
29. Kesse-Guyot E, Rebouillat P, Brunin J, et al. Environmental and nutritional analysis of the EAT-Lancet diet at the individual level: insights from the NutriNet-Santé study. *J Clean Prod*. 2021;296:126555. https://doi.org/10.1016/j.jclepro.2021.126555
30. Muñoz-Martínez J, Elías RA, Batlle-Bayer L, Cussó-Parcerisas I, Carrillo-Álvarez E. Optimizing sustainable, affordable and healthy diets and estimating the impact of plant-based substitutes to milk and meat: a case study in Spain. *J Clean Prod*. 2023;424:138775. https://doi.org/10.1016/j.jclepro.2023.138775
31. Scarborough P, Clark M, Cobiac L, et al. Vegans, vegetarians, fish-eaters and meat-eaters in the UK show discrepant environmental impacts. *Nat Food*. 2023;4:565-574. https://doi.org/10.1038/s43016-023-00795-w.
32. Stylianou KS, Fulgoni VL, Jolliet O. Small targeted dietary changes can yield substantial gains for human health and the environment. *Nat Food*. 2021;2:616-627. https://doi.org/10.1038/s43016-021-00343-4.
33. Telleria-Aramburu N, Bermúdez-Marín N, Rocandio AM, et al. Nutritional quality and carbon footprint of university students' diets: results from the EHU12/24 study. *Public Health Nutr*. 2022;25:183-195. https://doi.org/10.1017/S1368980021002640.
34. Tepper S, Kissinger M, Avital K, Shahar DR. The environmental footprint associated with the Mediterranean diet, EAT-lancet diet, and the sustainable healthy diet index: a population-based study. *Front Nutr*. 2022;9:870883. https://doi.org/10.3389/fnut.2022.870883.
35. Rossi L, Ferrari M, Ghiselli A. The alignment of recommendations of dietary guidelines with sustainability aspects: lessons learned from Italy's example and proposals for future development. *Nutrients*. 2023;15:542. https://doi.org/10.3390/nu15030542.
36. Drewnowski A, Finley J, Hess JM, Ingram J, Miller G, Peters C. Toward healthy diets from sustainable food systems. *Curr Dev Nutr*. 2020;4:nzaa083. https://doi.org/10.1093/cdn/nzaa083.
37. Biesbroek S, Kok FJ, Tufford AR, et al. Toward healthy and sustainable diets for the 21st century: importance of sociocultural and economic considerations. *Proc Natl Acad Sci U S A*. 2023;120:E2219272120. https://doi.org/10.1073/pnas.2219272120.
38. Sadiq MB, Secondi L, Velickova E, et al. Editorial: nutrition and sustainable development goal 12: responsible consumption. *Front Nutr*. 2024;11:1394417. https://doi.org/10.3389/fnut.2024.1394417.
39. Roy P, Mohanty AK, Dick P, Misra M. A review on the challenges and choices for food waste valorization: environmental and economic impacts. *ACS Environ Au*. 2023;3:58-75. https://doi.org/10.1021/acsenvironau.2c00050.
40. Teigiserova DA, Hamelin L, Thomsen M. Towards transparent valorization of food surplus, waste and loss: clarifying definitions, food waste hierarchy, and role in the circular economy. *Sci Total Environ*. 2020;706:136033. https://doi.org/10.1016/j.scitotenv.2019.136033.
41. Ágoston C, Balázs B, Mónus F, Varga A. Age differences and profiles in pro-environmental behavior and eco-emotions. *Int J Behav Dev*. 2024;48:132-144. https://doi.org/10.1177/01650254231222436
42. Attiq S, Chau KY, Bashir S, Habib MD, Azam RI, Wong W-K. Sustainability of household food waste reduction: a fresh insight on youth's emotional and cognitive behaviors. *Int J Environ Res Public Health*. 2021;18:7013. https://doi.org/10.3390/ijerph18137013.
43. Coffey Y, Bhullar N, Durkin J, Islam MS, Usher K. Understanding eco-anxiety: a systematic scoping review of current literature and identified knowledge gaps. *J Clim Change Health*. 2021;3:100047. https://doi.org/10.1016/j.joclim.2021.100047
44. Whitmarsh L, Player L, Jiongco A, et al. Climate anxiety: what predicts it and how is it related to climate action? *J Environ Psychol*. 2022;83:101866. https://doi.org/10.1016/j.jenvp.2022.101866
45. Zeng Z, Zhong W, Naz S. Can environmental knowledge and risk perception make a difference? The role of environmental concern and pro-environmental behavior in fostering sustainable consumption behavior. *Sustainability*. 2023;15:4791. https://doi.org/10.3390/su15064791
46. Hartmann C, Lazzarini G, Funk A, Siegrist M. Measuring consumers' knowledge of the environmental impact of foods. *Appetite*. 2021;167:105622. https://doi.org/10.1016/j.appet.2021.105622.
47. Slotnick MJ, Falbe J, Wolfson JA, Jones AD, Leung CW. Environmental-, climate-, and health-related dietary motivations are associated with higher diet quality in a national sample of US adults with lower incomes. *J Acad Nutr Diet*. 2024;124:594-606. https://doi.org/10.1016/j.jand.2023.11.021.
48. Van Bussel LM, Kuijsten A, Mars M, Van T, Veer P. Consumers' perceptions on food-related sustainability: a systematic review. *J Clean Prod*. 2022;341:130904. https://doi.org/10.1016/j.jclepro.2022.130904
49. Chevance G, Fresán U, Hekler E, et al. Thinking health-related behaviors in a climate change context: a narrative review. *Ann Behav Med*. 2023;57:193-204. https://doi.org/10.1093/abm/kaac039.
50. Li S, Kallas Z. Meta-analysis of consumers' willingness to pay for sustainable food products. *Appetite*. 2021;163:105239. https://doi.org/10.1016/j.appet.2021.105239
51. Byrareddy V, Islam MA, Nguyen-Huy T, Slaughter G. A systematic review of emerging environmental markets: potential pathways to creating shared value for communities. *Heliyon*. 2023;9:e19754. https://doi.org/10.1016/j.heliyon.2023.e19754.
52. Langmann F, Ibsen DB, Tjønneland A, Olsen A, Overvad K, Dahm CC. Adherence to the EAT-Lancet diet is associated with a lower risk of type 2 diabetes: the Danish Diet, Cancer and Health cohort. *Eur J Nutr*. 2023;62:1493-1502. https://doi.org/10.1007/s00394-023-03090-3.
53. Xu C, Cao Z, Yang H, Hou Y, Wang X, Wang Y. Association between the EAT-lancet diet pattern and risk of type 2 diabetes: a prospective cohort study. *Front Nutr*. 2022;8:784018. https://doi.org/10.3389/fnut.2021.784018.
54. Zhang S, Stubbendorff A, Olsson K, et al. Adherence to the EAT-Lancet diet, genetic susceptibility, and risk of type 2 diabetes in Swedish adults. *Metabolism*. 2023;141:155401. https://doi.org/10.1016/j.metabol.2023.155401.
55. Al-Aubaidy HA, Dayan A, Deseo MA, et al. Twelve-week Mediterranean diet intervention increases citrus bioflavonoid levels and reduces inflammation in people with type 2 diabetes mellitus. *Nutrients*. 2021;13:1133. https://doi.org/10.3390/nu13041133.
56. Guasch-Ferré M, Santos JL, Martínez-González MA, et al. Glycolysis/gluconeogenesis- and tricarboxylic acid cycle–related metabolites, Mediterranean diet, and type 2 diabetes. *Am J Clin Nutr*. 2020;111:835-844. https://doi.org/10.1093/ajcn/nqaa016.
57. Colizzi C, Harbers MC, Vellinga RE, et al. Adherence to the EAT-lancet healthy reference diet in relation to risk of cardiovascular events and environmental impact: results from the EPIC-NL cohort. *J Am Heart Assoc*. 2023;12:e026318. https://doi.org/10.1161/JAHA.122.026318.
58. Zhang S, Dukuzimana J, Stubbendorff A, Ericson U, Borné Y, Sonestedt E. Adherence to the EAT-lancet diet and risk of coronary events in the Malmö diet and cancer cohort study. *Am J Clin Nutr*. 2023;117:903-909. https://doi.org/10.1016/j.ajcnut.2023.02.018.
59. Ibsen DB, Christiansen AH, Olsen A, et al. Adherence to the EAT-lancet diet and risk of stroke and stroke subtypes: a cohort study. *Stroke*. 2022;53:154-163. https://doi.org/10.1161/STROKEAHA.121.036738.
60. Zhang S, Stubbendorff A, Ericson U, et al. The EAT-Lancet diet, genetic susceptibility and risk of atrial fibrillation in a population-based cohort. *BMC Med*. 2023;21:280. https://doi.org/10.1186/s12916-023-02985-6.

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61. Zhang S, Marken I, Stubbendorff A, et al. The EAT-lancet diet index, plasma proteins, and risk of heart failure in a population-based cohort. *JACC Heart Fail*. 2024;12:1197-1208. https://doi.org/10.1016/j.jchf.2024.02.017.
62. Cacau LT, Benseñor IM, Goulart AC, et al. Adherence to the EAT-Lancet sustainable reference diet and cardiometabolic risk profile: cross-sectional results from the ELSA-Brasil cohort study. *Eur J Nutr*. 2023;62:807-817. https://doi.org/10.1007/s00394-022-03032-5.
63. Martínez-González MA, Salas-Salvadó J, Estruch R, Corella D, Fitó M, Ros E, PREDIMED investigators. Benefits of the Mediterranean diet: insights from the PREDIMED study. *Prog Cardiovasc Dis*. 2015;58:50-60. https://doi.org/10.1016/j.pcad.2015.04.003.
64. Velázquez-López L, Santiago-Díaz G, Nava-Hernández J, Muñoz-Torres AV, Medina-Bravo P, Torres-Tamayo M. Mediterranean-style diet reduces metabolic syndrome components in obese children and adolescents with obesity. *BMC Pediatr*. 2014;14:175. https://doi.org/10.1186/1471-2431-14-175.
65. Properzi C, O'Sullivan TA, Sherriff JL, et al. Ad libitum Mediterranean and low-fat diets both significantly reduce hepatic steatosis: a randomized controlled trial. *Hepatology*. 2018;68:1741-1754. https://doi.org/10.1002/hep.30076.
66. Ryan MC, Itsiopoulos C, Thodis T, et al. The Mediterranean diet improves hepatic steatosis and insulin sensitivity in individuals with non-alcoholic fatty liver disease. *J Hepatol*. 2013;59:138-143. https://doi.org/10.1016/j.jhep.2013.02.012.
67. Baratta F, Pastori D, Polimeni L, et al. Adherence to Mediterranean diet and non-alcoholic fatty liver disease: effect on insulin resistance. *Am J Gastroenterol*. 2017;112:1832-1839. https://doi.org/10.1038/ajg.2017.371.
68. Van Soest APM, Van D, Res O, Witkamp RF, De Groot L. The association between adherence to the EAT-Lancet diet and cognitive ageing. *Age Ageing*. 2024;53:ii39-ii46. https://doi.org/10.1093/ageing/afae032.
69. Morris MC, Tangney CC, Wang Y, et al. MIND diet slows cognitive decline with aging. *Alzheimers Dement*. 2015;11:1015-1022. https://doi.org/10.1016/j.jalz.2015.04.011.
70. Valls-Pedret C, Sala-Vila A, Serra-Mir M, et al. Mediterranean diet and age-related cognitive decline: a randomized clinical trial. *JAMA Intern Med*. 2015;175:1094-1103. https://doi.org/10.1001/jamainternmed.2015.1668.
71. Karavasiloglou N, Thompson AS, Pestoni G, et al. Adherence to the EAT-Lancet reference diet is associated with a reduced risk of incident cancer and all-cause mortality in UK adults. *One Earth*. 2023;6:1726-1734. https://doi.org/10.1016/j.oneear.2023.11.002.
72. Toledo E, Salas-Salvadó J, Donat-Vargas C, et al. Mediterranean diet and invasive breast cancer risk among women at high cardiovascular risk in the PREDIMED trial: a randomized clinical trial. *JAMA Intern Med*. 2015;175:1752-1760. https://doi.org/10.1001/jamainternmed.2015.4838.
73. Wongprawmas R, Mora C, Pellegrini N, et al. Food choice determinants and perceptions of a healthy diet among Italian consumers. *Foods*. 2021;10:318. https://doi.org/10.3390/foods10020318.
74. Alcorta A, Porta A, Tárrega A, Alvarez MD, Vaquero MP. Foods for plant-based diets: challenges and innovations. *Foods*. 2021;10:293. https://doi.org/10.3390/foods10020293.
75. Kozicka M, Havlík P, Valin H, et al. Feeding climate and biodiversity goals with novel plant-based meat and milk alternatives. *Nat Commun*. 2023;14:5316. https://doi.org/10.1038/s41467-023-40899-2.
76. Bublitz MG, Catlin JR, Jones AC, Lteif L, Peracchio LA. Plant power: SEEDING our future with plant-based eating. *J Consum Psychol*. 2023;33:167-196. https://doi.org/10.1002/jcpy.1328
77. Piracci G, Casini L, Contini C, Stancu CM, Lähteenmäki L. Identifying key attributes in sustainable food choices: an analysis using the food values framework. *J Clean Prod*. 2023;416:137924. https://doi.org/10.1016/j.jclepro.2023.137924.
78. Ammann J, Arbenz A, Mack G, Nemecek T, El Benni N. A review on policy instruments for sustainable food consumption. *Sustain Prod Consum*. 2023;36:338-353. https://doi.org/10.1016/j.spc.2023.01.012
79. Abe-Inge V, Aidoo R, Moncada de la Fuente M, Kwofie EM. Plant-based dietary shift: current trends, barriers, and carriers. *Trends Food Sci Technol*. 2024;143:104292. https://doi.org/10.1016/j.tifs.2023.104292.
80. Purvis B, Mao Y, Robinson D. Three pillars of sustainability: in search of conceptual origins. *Sustain Sci*. 2019;14:681-695. https://doi.org/10.1007/s11625-018-0627-5.
81. Fanzo J, Bellows AL, Spiker ML, Thorne-Lyman AL, Bloem MW. The importance of food systems and the environment for nutrition. *Am J Clin Nutr*. 2021;113:7-16. https://doi.org/10.1093/ajcn/nqaa313
82. James-Martin G, Baird DL, Hendrie GA, et al. Environmental sustainability in national food-based dietary guidelines: a global review. *Lancet Planet Health*. 2022;6:e977-e986. https://doi.org/10.1016/S2542-5196(22)00246-7.
83. Smetana S, Ristic D, Pleissner D, Tuomisto HL, Parniakov O, Heinz V. Meat substitutes: resource demands and environmental footprints. *Resour Conserv Recycl*. 2023;190:106831. https://doi.org/10.1016/j.resconrec.2022.106831.
84. Fresán U, Mejia MA, Craig WJ, Jaceldo-Siegl K, Sabaté J. Meat analogs from different protein sources: a comparison of their sustainability and nutritional content. *Sustainability*. 2019;11:3231. https://doi.org/10.3390/su11123231
85. Aschemann-Witzel J, Gantriis RF, Fraga P, Perez-Cueto FJA. Plant-based food and protein trend from a business perspective: markets, consumers, and the challenges and opportunities in the future. *Crit Rev Food Sci Nutr*. 2021;61:3119-3128. https://doi.org/10.1080/10408398.2020.1793730.
86. Souza Filho PF, Nair RB, Andersson D, Lennartsson PR, Taherzadeh MJ. Vegan-mycoprotein concentrate from pea-processing industry byproduct using edible filamentous fungi. *Fungal Biol Biotechnol*. 2018;5:5. https://doi.org/10.1186/s40694-018-0050-9.
87. Wikandari R, Tanugraha DR, Yastanto AJ, Gmoser R, Teixeira, JA, Manikharda. Development of meat substitutes from filamentous fungi cultivated on residual water of tempeh factories. *Molecules*. 2023;28:997. https://doi.org/10.3390/molecules28030997.
88. Zhang C, Wu X, Chen J, Zhou J. Novel fungal alternative proteins from *Penicillium limosum* for enhancing structural and functional properties of plant-based meat analogues. *Food Chem*. 2024;444:138627. https://doi.org/10.1016/j.foodchem.2024.138627.
89. Rumpold BA, Schlüter OK. Potential and challenges of insects as an innovative source for food and feed production. *Innov Food Sci Emerg Technol*. 2013;17:1-11. https://doi.org/10.1016/j.ifset.2012.11.005
90. Kurek MA, Onopiuk A, Pogorzelska-Nowicka E, Szpicer A, Zalewska M, Półtorak A. Novel protein sources for applications in meat-alternative products—insight and challenges. *Foods*. 2022;11:957. https://doi.org/10.3390/foods11070957.
91. Kouřimská L, Adámková A. Nutritional and sensory quality of edible insects. *NFS J*. 2016;4:22-26. https://doi.org/10.1016/j.nfs.2016.07.001.
92. Smetana S, Schmitt E, Mathys A. Sustainable use of *Hermetia illucens* insect biomass for feed and food: attributional and consequential life cycle assessment. *Resour Conserv Recycl*. 2019;144:285-296. https://doi.org/10.1016/j.resconrec.2019.01.042.
93. Alhujaili A, Nocella G, Macready A. Insects as food: consumers' acceptance and marketing. *Foods*. 2023;12:886. https://doi.org/10.3390/foods12040886.
94. Molitor B, Mishra A, Angenent LT. Power-to-protein: converting renewable electric power and carbon dioxide into single cell protein with a two-stage bioprocess. *Energy Environ Sci*. 2019;12:3515-3521. https://doi.org/10.1039/C9EE02381J.
95. Putri SL, Marbun CV, Utama GL. The potential of urban organic waste utilization as neo carbon food. *IOP Conf Ser Earth Environ Sci*. 2019;396:012007. https://doi.org/10.1088/1755-1315/396/1/012007.
96. Postma PR, 't Lam GP, Barbosa MJ, Wijffels RH, Eppink MHM, Olivieri G. Microalgal biorefinery for bulk and high-value products: product extraction within cell disintegration. In: Miklavčič D, ed. *Handbook of Electroporation*. Springer; 2017:2205-2224. https://doi.org/10.1007/978-3-319-26779-1_38-1.
97. Rashid N, Selvaratnam T, Park W-K. Resource recovery from waste streams using microalgae: opportunities and threats. In: *Microalgae Cultivation for Biofuels Production*. Academic Press; 2020:337-351. https://doi.org/10.1016/B978-0-12-817536-1.00021-7.
98. Post MJ, Levenberg S, Kaplan DL, et al. Scientific, sustainability and regulatory challenges of cultured meat. *Nat Food*. 2020;1:403-415. https://doi.org/10.1038/s43016-020-0112-z.
99. Chodkowska KA, Wódz K, Wojciechowski J. Sustainable future protein foods: the challenges and the future of cultivated meat. *Foods*. 2022;11:4008. https://doi.org/10.3390/foods11244008.
100. Monaco A, Kotz J, Al Masri M, Allmeta A, Purnhagen KP, König LM. Consumers' perception of novel foods and the impact of heuristics and biases: a systematic review. *Appetite*. 2024;196:107285. https://doi.org/10.1016/j.appet.2024.107285.
101. Siegrist M, Hartmann C. Perceived naturalness, disgust, trust and food neophobia as predictors of cultured meat acceptance in ten countries. *Appetite*. 2020;155:104814. https://doi.org/10.1016/j.appet.2020.104814.
102. Onwezen MC, Bouwman EP, Reinders MJ, Dagevos H. A systematic review on consumer acceptance of alternative proteins: pulses, algae, insects, plant-based meat alternatives, and cultured meat. *Appetite*. 2021;159:105058. https://doi.org/10.1016/j.appet.2020.105058.
103. Principato L, Pice G, Pezzi A. Understanding food choices in sustainable healthy diets—a systematic literature review on behavioral drivers and barriers. *Environ Sci Policy*. 2025;163:103975. https://doi.org/10.1016/j.envsci.2024.103975.
104. Szejda K, Bryant CJ, Urbanovich T. US and UK consumer adoption of cultivated meat: a segmentation study. *Foods*. 2021;10:1050. https://doi.org/10.3390/foods10051050.
105. Szejda K, Stumpe M, Raal L, Tapscott CE. South African consumer adoption of plant-based and cultivated meat: a segmentation study. *Front Sustain Food Syst*. 2021;5:744199. https://doi.org/10.3389/fsufs.2021.744199.
106. Bryant C, Sanctorum H. Alternative proteins, evolving attitudes: comparing consumer attitudes to plant-based and cultured meat in Belgium in two consecutive years. *Appetite*. 2021;161:105161. https://doi.org/10.1016/j.appet.2021.105161.
107. Realini CE, Driver T, Zhang R, et al. Survey of New Zealand consumer attitudes to consumption of meat and meat alternatives. *Meat Sci*. 2023;203:109232. https://doi.org/10.1016/j.meatsci.2023.109232.
108. Stubelj M, Gleščič E, Žvanut B, Širok K. Factors influencing the acceptance of alternative protein sources. *Appetite*. 2025;210:107976. https://doi.org/10.1016/j.appet.2025.107976.

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109. Abebe GK, Ismail MR, Kevany K, Haileslassie HA, Young L, Pauley T. Factors influencing intentions to transition to plant-based protein diets: Canadian perspective. *Food Sci Nutr*. 2024;12:8903-8919. https://doi.org/10.1002/fsn3.4436.
110. Rauber F, Laura Da Costa Louzada M, Chang K, et al. Implications of food ultra-processing on cardiovascular risk considering plant origin foods: an analysis of the UK Biobank cohort. *Lancet Reg Health Eur*. 2024;43:100948. https://doi.org/10.1016/j.lanepe.2024.100948.
111. Gastaldello A, Giampieri F, De Giuseppe R, Grosso G, Baroni L, Battino M. The rise of processed meat alternatives: a narrative review of the manufacturing, composition, nutritional profile and health effects of newer sources of protein, and their place in healthier diets. *Trends Food Sci Technol*. 2022;127:263-271. https://doi.org/10.1016/j.tifs.2022.07.005.
112. Bellotti E, Panzone L. Media effects on sustainable food consumption. How newspaper coverage relates to supermarket expenditures. *Int J Consumer Stud*. 2016;40:186-200. https://doi.org/10.1111/ijcs.12242.
113. Lazzarini GA, Visschers VHM, Siegrist M. How to improve consumers' environmental sustainability judgements of foods. *J Clean Prod*. 2018;198:564-574. https://doi.org/10.1016/j.jclepro.2018.07.033.
114. Johnston RJ, Roheim CA, Donath H, Asche F. Measuring consumer preferences for ecolabeled seafood: an international comparison. *J Ag Resour Econ*. 2001;26:20-39. https://doi.org/10.22004/ag.econ.31157.
115. Pomarici E, Vecchio R. Millennial generation attitudes to sustainable wine: an exploratory study on Italian consumers. *J Clean Prod*. 2014;66:537-545. https://doi.org/10.1016/j.jclepro.2013.10.058.
116. de-Magistris T, Gracia A, Barreiro-Hurle J. Do consumers care about European food labels? An empirical evaluation using best–worst method. *Br Food J*. 2017;119:2698-2711. https://doi.org/10.1108/BFJ-11-2016-0562.
117. Tansakul N, Suanmali S, Shirahada K. The impact of product labels on green preferences and perceptions of customers: an empirical study of milk products in Japan. *IJSSoc*. 2018;10:75. https://doi.org/10.1504/IJSSOC.2018.10015676.
118. Calderon-Monge E, Redondo-Rodriguez R-G, Ramírez-Hurtado JM. Narrowing the gap between consumer purchasing intention and behaviour through eco-labelling: a challenge for eco-entrepreneurism. *Br Food J*. 2020;123:3293-3308. https://doi.org/10.1108/BFJ-09-2020-0874.
119. Moscovici D, Rezwanul R, Mihailescu R, et al. Preferences for eco certified wines in the United States. *Int J Wine Bus Res*. 2021;33:153-175.https://doi.org/10.1108/IJWBR-04-2020-0012.
120. Vecchio R, Annunziata A, Krystallis A, Pomarici E. Consumers' literacy and preferences for sustainability labels: an exploratory analysis on Italian young adults. *Int J Glob Small Bus*. 2015;7:221-233. https://doi.org/10.1504/IJGSB.2015.072692
121. Grunert KG, Hieke S, Wills J. Sustainability labels on food products: consumer motivation, understanding and use. *Food Policy*. 2014;44:177-189. https://doi.org/10.1016/j.foodpol.2013.12.001.
122. Eldesouky A, Mesias FJ, Escribano M. Perception of Spanish consumers towards environmentally friendly labelling in food. *Int J Consumer Stud*. 2019;44:64-76. https://doi.org/10.1111/ijcs.12546.
123. Prell M, Zanini MT, Caldieraro F, Migueles C. Sustainability certifications and product preference. *MIP*. 2020;38:893-906. https://doi.org/10.1108/mip-12-2019-0616.
124. Rousseau S. The role of organic and fair trade labels when choosing chocolate. *Food Qual Pref*. 2015;44:92-100. https://doi.org/10.1016/j.foodqual.2015.04.002.
125. Xuan BB. Consumer preference for eco-labelled aquaculture products in Vietnam. *Aquaculture*. 2021;532:736111. https://doi.org/10.1016/j.aquaculture.2020.736111.
126. Gadema Z, Oglethorpe D. The use and usefulness of carbon labelling food: a policy perspective from a survey of UK supermarket shoppers. *Food Policy*. 2011;36:815-822. https://doi.org/10.1016/j.foodpol.2011.08.001.
127. De Bauw M, Matthys C, Poppe V, Franssens S, Vranken L. A combined Nutri-Score and 'Eco-Score' approach for more nutritious and more environmentally friendly food choices? Evidence from a consumer experiment in Belgium. *Food Qual Prefer*. 2021;93:104276. https://doi.org/10.1016/j.foodqual.2021.104276.
128. Huang Y, Yang X, Li X, Chen Q. Less is better: how nutrition and low-carbon labels jointly backfire on the evaluation of food products. *Nutrients*. 2021;13:1088. https://doi.org/10.3390/nu13041088.
129. Thaler RH, Sunstein CR. *Nudge: Improving Decisions about Health, Wealth and Happiness (Revised Edition, New International Edition)*. Penguin Books; 2009.
130. Kaljonen M, Salo M, Lyytimäki J, Furman E. From isolated labels and nudges to sustained tinkering: assessing long-term changes in sustainable eating at a lunch restaurant. *Br Food J*. 2020;122:3313-3329. https://doi.org/10.1108/BFJ-10-2019-0816.
131. Burgaz C, Van-Dam I, Garton K, et al. Which government policies to create sustainable food systems have the potential to simultaneously address undernutrition, obesity and environmental sustainability? *Global Health*. 2024;20:56. https://doi.org/10.1186/s12992-024-01060-w.
132. Couto VDCS, Louzada MLDC, Jaime PC. Translating the Brazilian Dietary Guidelines into clinical practice: innovative strategies for healthcare professionals. *Arch Endocrinol Metab*. 2025;69:e240142. https://doi.org/10.20945/2359-4292-2024-0142.
133. Sinclair M, Combet E, Davis T, Papies EK. Sustainability in food-based dietary guidelines: a review of recommendations around meat and dairy consumption and their visual representation. *Ann Med*. 2025;57:2470252. https://doi.org/10.1080/07853890.2025.2470252.
134. Engelhardt H, Wilke A, Kitz L, Piweck L, Ehrenreich C. Policy strategies and instruments for the promotion of a plant-based diet in Europe. NAHhaft e. V., Berlin; 2024. Accessed May 7, 2025. https://www.foodsystemchange.org/fileadmin/NAHhaft_Website/2_Projekte/PlantEurope/240222_PlantEurope_AP4_ENG.pdf
135. Kurotani K, Shinsugi C, Miyoshi M, Takimoto H. Overviews of *Shokuiku* promotion. *Jpn J Nutr Diet*. 2020;78:S50-S59. https://doi.org/10.5264/eiyogakuzashi.78.S50.
136. Bartsch S, Büning-Fesel M, Johannsen U, et al. Nutrition education in the context of sustainable development. Recommendations for professionals, the education system and policymakers. *Ernahrungs Umschau*. 2024;71:2-9. https://doi.org/10.4455/eu.2024.002.
137. Bryant C, Couture A, Ross E, Clark A, Chapman T. A review of policy levers to reduce meat production and consumption. *Appetite*. 2024;203:107684. https://doi.org/10.1016/j.appet.2024.107684.
138. Dagevos H, Onwezen MC. Toward consumer-focused food policies: a toolbox for encouraging the protein transition. *Sustain Sci Pract Policy*. 2025;21:2454060. https://doi.org/10.1080/15487733.2025.2454060.
139. Springmann M, Dinivitzer E, Freund F, Jensen JD, Bouyssou CG. A reform of value-added taxes on foods can have health, environmental and economic benefits in Europe. *Nat Food*. 2025;6:161-169. https://doi.org/10.1038/s43016-024-01097-5.
140. Fanzo J, Rose A. Climate change and food systems interactions: ensuring resilient and healthy diets. Field Actions Science Reports [Online], Special Issue 27, 2025. Accessed April 29, 2025. http://journals.openedition.org/factsreports/7713
141. Papies EK, Davis T, Farrar S, Sinclair M, Wehbe LH. How (not) to talk about plant-based foods: using language to support the transition to sustainable diets. *Proc Nutr Soc*. 2024;83:142-150. https://doi.org/10.1017/S0029665123004858.
142. Barbour L, Lindberg R, Woods J, Charlton K, Brimblecombe J. Local urban government policies to facilitate healthy and environmentally sustainable diet-related practices: a scoping review. *Public Health Nutr*. 2022;25:471-487. https://doi.org/10.1017/S1368980021004432.
143. MUFPP, school meals: the transformative potential of urban food policies, The Milan Urban Food Policy Pact. 2024. Accessed May 07, 2025. https://www.milanurbanfoodpolicypact.org/wp-content/uploads/2024/03/MUFPP-SCHOOL-MEALS-Report-2024_light.pdf
144. The Milan Urban Food Policy Pact (MUFPP). Our cities. Accessed May 7, 2025. https://www.milanurbanfoodpolicypact.org/our-cities

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