Type of the Paper (Review)

A Scoping Review of Food Consumer Aspects in Transitioning to a Safe and Just Agrifood System

Saeed Moghayer [1,*], Behrang Manouchehrabadi [1], Giulia Tiboldo[5], Hugo Ferrer-Pérez [2], Marta Kozicka[4], Michiel van Dijk[1,4], Giuditta Farina[5], Elena Castellari[5], Daniele Moro[5,6], George Philippidis [2,3]

[1] Wageningen Economic Research, Wageningen University & Research; Wageningen, The Netherlands;
[2] Centre of Agro-Food Research and Technology of Aragón (CITA), AgriFood Institute of Aragón (IA2), Zaragoza, Spain;
[3] Aragonese Agency for Research and Development (ARAID);
[4] International Institute for Applied Systems Analysis (IIASA);
[5] Università Cattolica del Sacro Cuore, Dipartimento di Economia Agro-Alimentare, Piacenza, Italy.;
[6] Università Cattolica del Sacro Cuore, Dipartimento di Scienze Economiche e Sociali, Piacenza, Italy.;

* Correspondence: saeed.moghayer@wur.nl;

Abstract: The agrifood system holds the key to identifying potential transformative pathways to achieve prosperity for all within the limits of the planet's natural resources, thereby fostering a safe and just operating system (SJOS) for future generations. The agrifood system is currently not on the right track to meet this ambition. Food-consumer processes such as preference shifts toward healthy diets and substantial reductions in food losses and waste could help to avoid severe environmental degradation and decrease overall mortality, although it remains unclear whether such transitional developments are entirely compatible with socially responsible thresholds. In this paper, we conduct a scoping review approach to map the evidence on the underlying drivers of such demand-side processes in the context of a SJOS with the aim to provide insights on how to transform the EU agrifood system. This review specifically examines how consumer aspects influence the SJOS, rather than exploring the bidirectional relationship. We used a scoping review approach to select relevant studies. The selected papers were subjected to quantitative and qualitative analyses. As a result, we extract insights and draw lessons from the role of food-consumer processes in the transition toward a more SJOS for the agrifood system.

Keywords: Dietary shifts, Food waste reduction, Scoping review, Safe and Just Operating Space

JEL classification: Q11, Q13, D11

1. Introduction

The global food system poses major challenges to environmental sustainability and social justice. It contributes heavily to climate change, resource depletion, and persistent inequalities (Raworth 2017; Dearing et. al., 2014). The Safe and Just Operating Space (SJOS) framework addresses these challenges by defining boundaries that promote both environmental health and social equity. The combined focus on safe and just spaces resulted in the definition of a SJOS , visually represented as a Doughnut (Figure 1). This Doughnut encompasses both the ecological boundaries of the Earth System, which cannot be exceeded, and the social foundations essential for humanity, which must be met. Given the extensive impact of food systems on planetary and human well-being, achieving SJOS goals is imperative.

The SJOS framework monitors critical planetary boundaries (climate change, ocean acidification, freshwater use, biodiversity loss, pollution) and social foundations.

Social foundations ensure basic human needs and rights are met, including food security, health, education, income, energy access, water access, jobs, resilience, social equity, gender equality, and voice (Raworth 2017). The environmental and social domains of the SJOS are deeply interconnected, highlighting the need for integrated solutions that promote both planetary health and human well-being.

To understand the intricate dynamics of agri-food systems, we must analyze both supply-side and demand-side factors. This scoping review concentrates on the demand side investigating how consumer choices and behaviors connect with the objectives of a Safe and Just Operating Space (SJOS). While this review identifies potential policy interventions to promote a safe and just agri-food system, it does not explicitly analyze their integration within the agri-food system transitions. The scope is deliberately limited to the impact of consumer choices on SJOS, and does not encompass the complex feedback mechanisms inherent in the bidirectional relationship between SJOS attributes and consumer behavior.

For our conceptual framework, we utilize the Doughnut model (Figure 1), which has proven effective in visualizing actions that are both environmentally sustainable and socially equitable. This model has been widely adopted by policymakers and scientists alike (e.g., Custodio et al., 2023).

This scoping review centers on two critical aspects of food-consumer aspects of the agri-food system transitions toward SJOS: 'dietary choices 'and 'food waste' patterns. To achieve SJOS targets, we must understand consumer behavior as it drives dietary choices and food waste patterns (Quested et al., 2013). Research substantiates that shifting diets towards plant-based foods significantly improves environmental health and human well-being (Tilman & Clark, 2014). Conversely, rising consumption of animal products exerts unsustainable pressure on planetary resources, exacerbating environmental challenges (Alexandratos & Bruinsma, 2012). Food waste is a significant source of inefficiency in the food system, and interventions across the food chain are vital to reduce its impact and promote the equitable use of resources (Gustavsson et al., 2011; Papargyropoulou et al., 2014).

We have selected 'climate change', 'biodiversity', 'health', and 'economy' (using local food systems as a proxy) as the primary SJOS thematic areas and indicator domains that are affected by diet. In addition, we review food waste patterns using the SJOS thematic areas and indicator domains of 'food and nutrition security', 'climate (and broader sustainability)', and 'economy'.

This review has two central aims. First, it seeks to identify and synthesize key concepts and themes emerging from studies focusing on the impact of dietary choices and food waste patterns on various sustainability dimensions. This includes examining how the relationship between food consumption and sustainability has been defined, theorized, and studied over time. Second, the review will address specific research questions: How do studies identify and measure the impacts of dietary choices and food waste? What policy interventions aim to change consumer behavior around food, and how effective is the evidence supporting them? What are the main challenges and limitations in current research on this topic? By achieving these aims, we will provide a clearer understanding of the current state of knowledge on how consumer food-related behaviors influence sustainability outcomes, and highlight areas for further research.

Our initial literature search identified a substantial volume of articles across various SJOS areas. Food waste emerged as the most prevalent topic, with over 3000 articles retrieved. Biodiversity (958 articles), climate change (2080 articles), and local food systems (305 articles) also yielded a significant number of results. Human health was represented with a smaller but still notable number of articles (167). From these initial pools, we scanned 200 biodiversity articles, 262 climate change articles, 75 local food system articles, 144 food waste articles, and 51 human health articles. Of these, we conducted a focused review process on a selection of the retrieved articles: 15 biodiversity articles, 34 climate change articles, 23 local food system articles, 96 food waste articles, and 33 human health articles. This section summarizes the identified key concepts and the major themes and trends in this in-depth review process (questions 1 and 2 from the review questionnaire presented in Supplementary material Appendix 1). The following key themes and trends emerged from the papers included in this scoping review.

Diet and Climate Change

Rising climate change concerns have pushed many countries to prioritize reducing greenhouse gas emissions (GHGEs) (Auestad & Fulgoni, 2015; García-Muros et al., 2017; Bonnet et al., 2018; Caillavet et al., 2019; Tiboldo et al., 2022). Agriculture, particularly livestock production (especially ruminants), is a major GHGEs contributor (Wirsenius et al., 2011; Caillavet et al., 2016, 2019; FAO, 2017; Bonnet et al., 2018, 2020; Tiboldo et al., 2022). Growing demand for animal products threatens to dramatically worsen agriculture's climate impact (Wellesley et al., 2015; Bonnet et al., 2018; Caillavet et al., 2019; Hedenus et al., 2014). This has led to increased focus on the environmental benefits of plant-based (PB) diets, which have lower resource intensity compared to animal-based (AB) foods (Clark & Tilman, 2017; Clune et al., 2017; Fresán et al., 2019; Bonnet et al., 2020).

Research shows a strong link between diets with lower climate impact and better nutritional profiles (Hallström et al., 2014; van Dooren et al., 2014; Xia et al., 2023). Studies consistently demonstrate that substituting AB foods with PB alternatives improves environmental performance (reduced GHGEs) without compromising nutrition. Ruminant meats have the highest environmental impact, making their reduction a key sustainability strategy. Policymakers must consider a comprehensive approach, balancing nutritional value with the total emissions of a diet (Röös et al., 2015; Burgaz et al., 2023).

To address this challenge, there's growing support for policies that discourage high-impact foods and promote nutritious, lower-emitting options. Market-based approaches (Pigouvian taxes/subsidies) and informational tools (Arrieta and González 2018; Bryngelsson et al., 2016; Deckers 2010; Huan-Niemi et al., 2020; van Dooren et al., 2018; Xiong et al., 2020) have been explored. However, informational campaigns (e.g., carbon labels) show limited long-term impact on consumption patterns and GHGEs reduction (European Commission, 2012; Edjabou and Smed 2013; Elofsson et al., 2016).

Consequently, attention has shifted to the potential of carbon taxes on food consumption to reduce GHGEs from the agri-food system (e.g., Wirsenius et al., 2011, Edjabou and Smed, 2013). However, carbon taxes can have unintended consequences on consumer health by affecting diet composition (Briggs et al., 2013; Caillavet et al., 2019). Moreover, they might be regressive, disproportionately burdening low-income consumers (García-Muros et al., 2017; Caillavet et al., 2019; Tiboldo et al., 2022). The results from the current review shed light on the complexity of achieving convergence between environmental, nutritional, and social equity goals through carbon taxation (Bonnet et al., 2020).

Diets and biodiversity

The relationship between food systems and biodiversity is a critical area of study within environmental science and sustainability research. The global food system is widely recognized as a major driver of biodiversity loss, with food production playing a significant role in shaping land use, habitat conversion, and ecosystem degradation (Campbell et al., 2017; IPCC, 2019). While there is extensive literature documenting the environmental consequences of food production systems, studies exploring the effects of consumer behavior to biodiversity loss and researching the potential of dietary shifts to reduce biodiversity loss are recent phenomena in the scientific literature.

Higher incomes and the so-called 'westernization of diets' often result in higher consumption of animal-based foods that have much larger negative environmental effects, including biodiversity impacts, as compared to plant-based foods (Díaz et al., 2019). As a result of these processes combined with the projected global population and its income growth, food demand is also likely to continue growing, especially for animal based foods (FAO, 2018; OECD/FAO, 2021) This will lead to further biodiversity loss unless there is a profound change in the food systems (Leclère et al., 2020; Visconti et al., 2016). Consequently, the potential of dietary shifts to mitigate biodiversity loss has gained attention in recent years.

Diet and Human Health

The effect of diet on human health is well established in food science. There are many longitudinal studies that monitor the diet of people and their health status over a long period of time. Global Burden of Diseases of Lancet Institute publishes meta-analysis of such studies. The outcome of these studies shows that there is a stable relationship between diet and health outcomes (Brauer et al., 2024). Elaboration on the exact relationship between diet and the health outcomes is out of scope of this paper but in the following we will point out the most important findings and trends in the literature.

The reviewed literature overwhelmingly demonstrates a global dietary shift away from minimally processed, whole foods toward highly processed, convenience-oriented food products. This trend, influenced by urbanization, income changes, and evolving employment patterns, is strongly associated with decreased consumption of nutrient-rich foods and increased reliance on animal-source products. In adolescence, this dietary shift is intertwined with complex social, cognitive, and emotional changes (Sinai et al., 2021). Research indicates that dietary patterns established at this critical stage have significant long-term health consequences, including increased risk of obesity and chronic diseases (Sinai et al. 2021; Yusuf et al., 2020).

Diet and Local Food Systems

Local food, or locally produced food, does not have a unified and highly consensual definition (Brune et al., 2023). It can refer to the food produced in the same county, region, or state where it is consumed or produced within a certain distance from the marketing outlet. It can also refer to the food that is directly purchased from farmers. In most studies, local food is the food that is produced and consumed within a certain geographical area, like a village, county, city, or state. Local food is part of the local food system LFS (Local Food Systems) which comprises production, distribution, and consumption of local foods. Another concept that rhymes similarly but is distinct is the short food supply chain (SFSC). SFSC usually refers to the reduced numbers of intermediaries between consumers and producers. It is more concerned with the distribution and sale channels and less with local food consumption as is understood.

Local food systems, which rely on small farms, are considered more reliable and resilient compared to the global food system, Stephens et al., 2020. The European Commission in the "Farm to Fork Strategy' of 2020 praises short food supply chains which rely less on long haul transportation infrastructure. Local food systems are also considered a more equitable food system compared to other ones, Allen (2010). Local food systems are believed to have socioeconomic, environmental and health benefits. From an economic point of view, consuming local foods generates a demand for local producers and therefore contributes to local employment. An increase in local employment in turn increases residents' income. The positive effect on employment has spillovers in the social safety and wellbeing of counties. Local food systems are considered to be environmentally friendly as the food travels less, consumes less energy for preservation and storage and requires less use of pesticide and fertilizer. Finally, consuming local food can be a healthy choice as local foods are usually fresher and less processed than imported foods if local producers adhere to the quality standards in the production process.

Despite many advantages, local food systems have their own limitations. First and foremost, local food systems might not always be viable in terms of capacity and affordability. For example, Kinnunen et al., 2020 estimate that only about 11-28 percent of the global population are able to acquire their demand for specific crops from a 100 kilometer radius. The reason is that large food producers with global reach often outcompete local and small food producers in terms of price and availability. In addition, local fresh food is not necessarily superior to processed food in terms of nutritional value (Miller and Knudsen (2014); Rickman et al., 2007). Finally, relying on local food systems might result in over extraction of natural resources such as fresh water and land resources.

Overall, local food systems are a promising venue that positively contributes to the local communities but cannot be regarded as a substitute for non-local food systems.

Diet and Food waste

Researchers use various terms like "postharvest loss," "food loss," "food waste," and "food loss and waste" (FLW) to describe various aspects of a shared issue (Schuster and Torero, 2016). This lack of a unified definition complicates measurement, comparisons, and policy recommendations (Xue et al., 2017, Corrado and Sala, 2018). FLW occurs throughout the food supply chain,threatening food security, sustainability, and raising moral concerns, with the largest proportion occurring at the consumption level (Reynolds et al., 2020). In both developed and developing countries, it contributes to hunger, lower income, reduced food quality and safety, and the depletion of natural resources.

The issue of food waste has become multifaceted, attracting scholars from various disciplines who seek to understand its causes, quantify its magnitude, and explore its consequences .In the context of a SJOS framework, addressing food waste at the household consumption level becomes crucial. Consumer-level food waste directly impacts several planetary boundaries, including climate change, land use, freshwater use, and biochemical flows, by contributing to unnecessary greenhouse gas emissions, inefficient land use, water wastage, and excessive nutrient flows (FAO, 2013). Moreover, food waste exacerbates social issues such as food insecurity and inequality. Addressing household food waste is very important within the SJOS framework, ensuring that human activities do not surpass environmental limits while promoting social equity and food security.

The rest of the paper is organized as follows. Section 2 details the methodology employed for the search and review of relevant articles. Section 3 presents the primary findings from the review process regarding the relationship between diet and the selected SJOS indicator domains. Section 4 discusses the key interpretations of the overall results, research limitations, future directions, policy implications, and recommendations. Finally, Section 5 offers a concise summary and the main conclusions drawn from the review.

2. Methods

We used a scoping review approach to systematically synthesize the literature on impact of dietary choices and food waste patterns on a selection of SJOS indicator domains (see Section 1). This review employs a unidirectional analytical approach, specifically investigating how consumer choices affect various SJOS dimensions. The bidirectional relationship, wherein SJOS attributes influence consumer preferences, falls outside the scope of this analysis. The aim of a scoping review is to determine the size, extent and nature of the literature related to a given topic as well as to determine possible gaps in that literature (Tricco et al., 2018). This method is especially valuable for studies like ours, where the goal is to provide an overview of evidence within a diverse research area. Traditional systematic reviews, which focus on answering a specific research question, are less suitable for such heterogeneous fields (Munn et al., 2018).

We used the methodological framework proposed by Peters et al., (2015) to organize our scoping review. Our approach involved five steps: (1) definition of research questions, search strategy and exclusion criteria, which were described in a research protocol (Supplementary material Appendix 1); (2) search for relevant studies, (3) screening and selection of studies, (4) data extraction and (5) analysis (see Figure 2). The scoping review was limited to studies published between the years 2000 and 2023.

The research team was divided into five groups, four groups worked on the impact of dietary change on 'climate', 'biodiversity', 'health', and 'economy' and one group focused on food waste impacts on 'biodiversity and climate', 'food security', and 'economy'. For each team, a search query in Web of Science was prepared to identify relevant literature (see protocol/annex for details). We followed Grames et al., (2019), who suggested an automated approach to identify search terms for systematic reviews. In the first step, each research team identified several key papers based on their expertise. This set of key papers are then used to extract potential keywords using the R package litsearch. This package implements the Rapid Automatic Keyword Extraction (RAKE) algorithm (Rose et al., 2010) and keyword co-occurrence networks to identify a first set of key words that best describe the identified set of key papers. The key words were subsequently screened, checked, and revised by the research group and used to build the search query in the Web of Science database to identify relevant articles.

Next, each group reviewed the result of search queries to check (a) whether the number of returned articles was manageable (i.e., less than 200) and (b) if the key papers were among the articles that were returned by the query. In addition, the research groups occasionally used citation snowballing techniques to avoid missing important articles. Finally, each research group used a review research questionnaire (Supplementary material Appendix 1) to extract information from all the selected articles in a structured manner.

3. **Results**

This section presents the more in-depth results of this scoping review. We will examine definitions, theories, and the evolution of research on this topic. Policy interventions and their outcomes will be analyzed, along with methodologies, evidence types, and the potential for cross-disciplinary perspectives to address these complex challenges.

4.1. Diet and Climate Change

Overall, the present review investigating the relationship between diet and climate change analyzes 34 studies, including 22 studies that assess the impact of alternative diets on climate change and 12 analyses of the effects of carbon taxes on food consumption. Focusing on the first strand of literature calculating the impact of different dietary patterns on climate change, these studies were published between 2010 and 2023. Only one focused on a developing country (n=1), while all the others had either a multi-country or global approach (n=5) or focused on single developed countries (n=16). All analyzed studies presented empirical results. Few analyzed past consumption patterns and their impact on climate indicators (n=2). The majority used modeling strategies based on real consumption data to simulate alternative dietary patterns and evaluate their impact on climate indicators (n=20). Moreover, most of the studies explored the impact of shifting to a diet increasingly reliant on PB products (n=21), while the remainder analyzed the differences between a diet composed of imported versus domestic foods, i.e., the environmental performance of a local diet (n=1). The most commonly used indicator to measure climate change in the included papers was GHGEs (n=22), followed by land use (n=11), water footprint (n=7) - either green or blue water footprint or both - energy use (n=3), and more specific indicators such as nitrogen and phosphorus application (n=1), atmospheric acidification and marine eutrophication (n=1), and nitrogen footprint (n=1). Most studies analyzed both the environmental and nutritional outcomes of the dietary patterns under investigation (n=15). Not all studies considered distributional factors to differentiate the dietary impact on climate change across population groups. The studies that did consider these factors included socio-demographic characteristics (n=5) - such as gender, age, educational level, income, employment status - or lifestyle habits (n=1).

Focusing on the literature assessing the impact of carbon taxation on food consumption, we identify 12 empirical studies which were all published between 2011 and 2022. Most studies focus on European countries at the aggregate level (n=1) or at the country level, such as the United Kingdom (n=3), France (n=3), Spain (n=1) and the Catalonia region (n=1), Denmark (n=1) and Sweden (=1), while only one study focuses on extra-EU countries (i.e., the U.S). All the studies under analysis used a similar empirical framework to derive the impacts of interest. As carbon taxation brings about a general increase in the price of foods, the price elasticities of demand are the key parameters of interest to carry out the simulations of different carbon tax scenarios. Therefore, the analyzed studies use real food consumption data augmented with GHGEs and nutritional data obtained from official statistics or proprietary data to estimate consumers' demand for different food categories and derive the own-price and cross prices elasticity values. Demand estimation is carried out using a system of demand equations approach, such as the Almost Ideal Demand System (AIDS) also in its linear approximation (LA/AIDS) or quadratic form (QUAIDS) (n=7) (Deaton & Muellbauer, 1980; Moschini, 1995; Banks et al., 1997), or the Exact Affine Stone Index (EASI) model (n=4) (Lewbel & Pendakur, 2009). Only one study uses a random coefficient logit demand model approach (Berry et al., 1995) to estimate demand for animal products (Bonnet et al., 2018). Most of the studies under analysis analyze different tax scenarios, for instance in terms of the food groups subject to taxation (e.g., all foods, only animal-products, only meat) (n=10) or based on the tax scheme design, especially focusing on the potential differences in the outcome variables of interest between uncompensated and compensated (i.e., revenue-neutral) carbon taxes (n=6), or also, using different tax rates which vary with the estimated social cost of carbon (n=5). Also in this case, the most used indicator to measure the environmental impact of food consumption is represented by GHGEs (n=12) measured in terms of carbon-dioxide equivalents (CO2-eq). On the other hand, some studies also separately account for the other environmental impacts, such as acidification (sulfur dioxide emissions, SO2) and marine eutrophication (nitrogen dioxide emissions (n=3), or land use (n=1). The degree of GHGEs reduction depends on the foods taxed, compensation schemes, and the applied social carbon cost. Uncompensated taxes on all foods achieve the greatest GHGEs abatement (up to -20%) (Edjabou & Smed, 2013; Revoredo-Giha et al., 2018), and the mitigation potential increases with the estimated social cost of carbon (Bonnet et al., 2018; Caillavet et al., 2019).

Given the potential unintended consequences of carbon taxes on food on population-wide nutritional outcomes and social equity, ongoing research also examines nutritional and distributional impacts of these fiscal policies across population groups, especially focusing on the most vulnerable socio-economic groups (Kehlbacher et al., 2016; Caillavet et al., 2019; García-Muros et al., 2017; Tiboldo et al., 2022). While all studies assess the impact of carbon taxes on foods on GHGEs from the food system, only some of them also analyze the unintended nutritional consequences of these fiscal policies, either in terms of changes in key macro-nutrients (e.g., total calories, lipids, carbohydrates and proteins) and micro-nutrients intake (e.g., cholesterol, saturated fats, sugars, calcium and fiber) with respect to country-level recommendations and dietary guidelines (n=7), or by using specific indexes developed to evaluate the nutritional quality of the diet, such as the Mean Adequacy Ratio (MAR) and the Mean Excess Ratio (MER) (n=3) (Revoredo-Giha et al., 2018). The distributional implications of carbon taxes on foods, are also investigated in some papers (n=7), especially focusing on the potential differential effects of these fiscal policies on the most vulnerable population sub-groups (e.g., low-income households or households with children). In detail, some studies evaluate the differential impact on food consumption and expenditure (n=1) or in terms of changes of purchasing power across socio-economic groups (n=3). On the other hand, other studies (n=3) use specific indexes to measure the potential regressivity (e.g.,) or redistributive effects (e.g., the) of carbon taxes, such as the Kakwani index and the Reynolds-Smolensky index (García-Muros et al., 2017). To enable a more thorough comparison across scenarios, some studies (n=3) investigate the distributional implications of carbon taxes on food both from a budgetary and a nutritional standpoint.

All studies in the literature agree that a diet consisting solely or mainly of PB products has a lesser impact on climate change. The greater the share of PB products in a diet, the more environmentally sustainable the diet is, based on indicators such as GHGEs, land use, and energy use. The water footprint indicator yields mixed results. For instance, when assessing a pescatarian diet (Kim et al., 2020) the water footprint increases. The same is sometimes true when substituting animal products with PB ones, as they require more freshwater (Philippidis et al., 2021; Springmann et al., 2018). Primarily PB diets have been shown to have less impact on the environment and to be more affordable. Starting from this point, Grabs (2015) analyzed the rebound effects of re-spending the money saved from adopting a vegetarian diet. The author demonstrated that when the money saved is re-spent according to current preferences (i.e., current consumer demand for food and nonfood products), the environmental benefits of shifting to a vegetarian diet would be entirely lost. Individuals could miss 96% of potential energy savings and 49% of greenhouse gas emission savings. Hence, to maintain the environmental benefits of a primarily plant-based diet, it is crucial to allocate the saved money efficiently. From a distributional perspective, Grabs (2015) demonstrated that individuals with higher incomes tend to save more in GHGs and energy even after re-spending. They are more likely to use their savings for less polluting goods (i.e., luxury goods or services), as opposed to individuals with lower incomes who would re-spend their saved money on more polluting goods or services (i.e., gasoline for their cars). Instead, the study by Seconda et al. (2018) - the only other study that uses income as a discriminating factor across individuals - did not find any differences in diet emissions among different population sub-groups. Regarding gender, studies agree that women consume diets with lower emissions compared to men (Seconda et al., 2018; van Dooren et al., 2018; Yue et al., 2022).

Overall, the results from the current review show that achieving convergence between environmental, nutritional, and social equity goals through carbon tax design is complex (Bonnet et al., 2020). However, taxing meat with subsidies for PB foods offers potential to reduce GHGEs, improve diet quality, and mitigate regressive effects (Edjabou & Smed, 2013; Springmann et al., 2016; Caillavet et al., 2019; Tiboldo et al., 2022). Interestingly, while financially regressive, carbon food taxes may be progressive from a health perspective. Policies such as consumer education and awareness-raising through information provision, including labeling and promotion of national dietary guidelines, may also support this shift towards more sustainable diets (Arrieta & González, 2018; Deckers, 2010; Huan-Niemi et al., 2020; van Dooren et al., 2018; Xiong et al., 2020). Policies such as consumer education and awareness-raising through information provision, including labeling and promotion of national dietary guidelines, may also support this shift towards sustainable diets (Arrieta & González, 2018; Deckers, 2010; Huan-Niemi et al., 2020; van Dooren et al., 2018; Xiong et al., 2020).

4.2. Diet and Biodiversity

Exploring the dietary impacts on biodiversity results in identifying several key concepts and themes. First, diet influences biodiversity directly through three main channels: agricultural expansion, intensification of agricultural practices and direct exploitation (Benton et al., 2021; Díaz et al., 2019; Jaureguiberry et al., 2022). Agricultural expansion involves the conversion of natural habitats, such as forests and grasslands, into agricultural land to meet the growing demand for food, resulting in habitat loss, fragmentation, and degradation, leading to declines in biodiversity (Foley et al., 2005). Intensification of agricultural practices refers to the increased use of inputs such as fertilizers, pesticides, and irrigation to boost crop yields. This may reduce agricultural expansion, on the one hand, but might also lead to negative environmental consequences, including biodiversity loss (Sánchez-Bayo & Wyckhuys, 2019; Tilman et al., 2011). Direct exploitation through fishing and hunting is another important driver of biodiversity loss (Brodie et al., 2015; Harrison, 2011; Su et al., 2021). Food demand is linked to all these processes in multiple ways, such as quantity, variety (e.g. meat vs. legumes) and quality of food (organic vs. conventional agriculture sourced) consumed.

The adoption of healthier and more sustainable dietary patterns, consisting of plant-based foods, has been proposed as a strategy to reduce the environmental footprint of food systems (Davis et al., 2023). Another vital component of biodiversity-friendly food consumption is avoiding overconsumption, which means significant reduction of energy intake in many high-income countries (Ganivet, 2020; Willett et al., 2019). Novel foods could also contribute to viable pathways to reducing the biodiversity impacts of food systems. For example, partial replacement of animal source foods with plant-based meat and milk alternatives could significantly reduce land use impacts associated with livestock production (Kozicka et al., 2023). Another key area of research considers interactions between land and sea use in food systems and trade-offs that might arise (Cottrell et al., 2018). For example, increasing consumption of seaweed could reduce land-based agricultural pressures and mitigate biodiversity loss (Spillias et al., 2023). However, careful assessment of the potential impacts of seaweed farming on marine ecosystems is essential to ensure sustainability. Moreover, studies have highlighted the importance of considering trade-mediated inter-regional impacts of diets on biodiversity loss (Hentschl et al., 2023; Kozicka et al., 2023).

Overall, we reviewed 15 studies that directly link diets to biodiversity impacts. Most of the studies (n=14) identify a shift towards plant-based diets as an important measure to significantly reduce land use impacts compared to diets high in animal products (e.g. Henry et al. 2019, Hentschl et al., 2023, Kok et al. 2019, Rasche et al. 2022, Willet et al. 2019). By reducing demand for agricultural land and resources, individuals can alleviate pressure on biodiversity-rich ecosystems (Poore & Nemecek, 2018). However, dietary change is considered as only a part of the broader food systems transformation, along e.g., waste reduction, sustainable intensification, land restoration, on the path to reverse biodiversity decline until 2050 (Kozicka et al. 2023, Leclère et al. 2020). For example, partial substitution of animal source foods with novel plant-based alternatives, if combined with land restoration could yield significant biodiversity impacts (Kozicka et. al 2023). The authors show that if globally 50% of the main animal products (pork, chicken, beef and milk) are substituted and spared agricultural land within forest ecosystems is restored to forest, this could contribute to 13-25% of the estimated global land restoration needs under target 2 from the Kunming Montreal Global Biodiversity Framework by 2030, and future declines in ecosystem integrity by 2050 would be more than halved. Spillias et al (2023) show that increasing seaweed use for food, feed and biofuels could have a positive impact on terrestrial biodiversity. While the impacts are modest, the authors see it as a part of a broader future strategy for terrestrial conservation.

Very few (n=1) studies considered fertilizer application and irrigation intensity changes due to changes in diets with respect to their impacts on biodiversity, with some exceptions such as Henry et al (2019). They found that changing dietary demand may have the greatest benefits for threatened species through the reduction of both agricultural land area and agricultural inputs in regions of high biodiversity. Another key area of biodiversity impacts is agricultural biodiversity. As our diets increasingly rely on only a small fraction of all edible plant species and livestock breeds, their genetic pool has been narrowing dramatically (FAO, 2019; Jones et al., 2021, UN Nutrition, 2021). Mattas et al. (2023) show that the Mediterranean diet is associated with higher levels of biodiversity due to its emphasis on diverse plant-based foods. This means the focus of biodiversity-sensitive demand should be on reducing animal source food consumption and increasing the variety of plants used as food. However, studies analyzing these impacts of diets are rare. Out-of-home food consumption and food processing overall has also received little attention (n=1) with respect to their impacts on biodiversity in general, and agricultural biodiversity in particular (Monetti et al,. 2021).

Most of the reviewed studies (n=12) are either of a global scope, or are of a general character (not specific to any region). The remaining studies focus on the Mediterranean region (n=2), or a specific country (Germany, n=1).

Interventions that may be effective at encouraging more sustainable diets range from labeling (Potter er al. 2023), to fiscal measures, such as taxes and subsidies (Latka et al.

2021). However, more research is needed on the effectiveness of these measures in various contexts. Furthermore, policy bundles could be needed to mitigate any potential trade-offs with the other SJOS dimensions.

The methods used range from LCA, footprint approaches, economic simulation modeling, and input-output analyses. As a biodiversity metric, most studies use change in species richness, often estimated as a result of change in land area via the species-area relationship. The number of metrics used usually is limited to one, with some exceptions. In Perignon et al. (2019), the land use impacts on biodiversity were calculated using country-specific global characterization factors estimated by Chaudhary et al. (2015) with the countryside species–area relationships (SAR) model and average approach. Leclère et al. (2020) use six different measures which cover several aspects of biodiversity: Extent of suitable habitat (ESH), wildlife population density (LPI), intactness of local species composition (BII), Regional extinctions (FRRS), and Global extinctions (FGRS). Kozicka et al. (2023) and Spillias et al. (2023) use only one of those, BII. It measures the local compositional intactness of local communities as impacted by land use, relative to if the region were still covered with primary vegetation and facing minimal human pressures. Rasche et al (2022) quantify the future conversion of natural intact vegetation hotspot area into agricultural land. Kok et al. (2018) use the Mean Species Abundance of original species relative to undisturbed situations (MSA) as the main indicator for biodiversity. Visconti et al. (2016) use Red List Index and Geometric Mean Abundance as measures of biodiversity in response to land-use change. Mattas et al. (2023) base their analysis on the meaning of the majorly cultivated food plants. Jones et al. (2021) use Shannon's diversity index of food items in supply of kcal per capita per day to calculate species diversity in consumption.

4.3. Diet and Human Health

Dietary patterns are undergoing significant transformations worldwide, shaped by multifaceted factors such as socioeconomic shifts, urbanization, and changing lifestyles. A vast body of research explores the complex interplay between dietary choices, health outcomes, and the potential for interventions. This extensive review integrates insights from numerous studies to provide a comprehensive perspective.

Broadly, the present examination exploring the correlation between dietary choices and human health scrutinizes 38 studies, encompassing evaluation of the influence of alternative dietary patterns on health (n=20), the implications of food system transitions (n=5), consumer behavior and policy considerations (n=4), the nutritional aspects and health effects (n=5), and the methodological considerations in nutrition research (n=4). The years of publication for the studies included in this review range from 1999 to 2022.

The geographical distribution of the studies is diverse, employing a multi-country or global methodology (n=14), targeting individual developed nations (n=23) and one paper focusing on developing nations .

The methodologies employed in these studies are varied, including qualitative food system analysis and surveys (n=18), modeling (n=6), and other data analysis methods (n=14). The latter category encompasses cross-sectional studies (n=8), panel data analysis (n=4), semiparametric modeling (n=1), and a cohort study design (n=1).

The studies address a range of relationships and effects, including correlations between dietary patterns and health outcomes (n=25), causal relationships between dietary interventions and disease risk (n=8), and the influence of socioeconomic and environmental factors on dietary choices (n=5). The metrics and indicators used in these studies span various domains, including dietary intake (n=27), nutritional status (n=12), health outcomes (n=25), economic factors (n=9), and environmental impacts (n=4).

The distributional impacts explored in these studies predominantly encompass age (n=15), gender (n=17), socioeconomic status (n=13), and education level (n=4), with a particular emphasis on the differential effects of dietary patterns and interventions across these diverse population subgroups.

Across various global contexts, urbanization, rising incomes, and women's increased participation in the workforce have driven changes in food preferences and consumption. This has led to increased demand for highly processed foods that are often high in sugar, salt, and saturated fats (Ambikapathi et al., 2022). While this dietary shift has contributed to a decrease in micronutrient deficiencies among some populations, the long-term consequences for health are substantial. Studies repeatedly show a strong association with increased risk of cardiometabolic diseases (Ambikapathi et al., 2022). It is crucial to note that dietary transitions occur unevenly among and within populations. Factors like income, food security, and local food environments strongly influence dietary choices (Ambikapathi et al., 2022; Poole et al., 2021).

A prominent trend is the declining consumption of whole, minimally processed foods, accompanied by a growing reliance on highly processed, convenience-oriented foods. These foods are often high in sugar, salt, and saturated fats (Ambikapathi et al., 2022; Sinai et al., 2021). This transition is particularly pronounced in urban environments and within adolescent populations (Sinai et al., 2021). While urbanization and rising incomes have contributed to decreased micronutrient deficiencies, this dietary shift strongly correlates with a marked increase in cardiometabolic diseases and other non-communicable chronic conditions (Ambikapathi et al., 2022).

Research consistently demonstrates the health advantages of plant-forward dietary patterns rich in fruits, vegetables, whole grains, and legumes (Gastaldello et al., 2022; Li et al., 2021; Rigi et al., 2021; Stylianou et al., 2021). These diets are associated with lower mortality, reduced incidence of cardiovascular diseases, some cancers, and other chronic conditions. Conversely, plant-based diets centered on processed foods can pose risks to health (Gastaldello et al., 2022). Importantly, even modest dietary adjustments can have substantial benefits. Studies like Stylianou et al. (2021) propose targeted substitutions of specific food categories as potent yet practical strategies to improve health without requiring complete dietary overhauls.

While the benefits of plant-forward diets are well-supported, questions remain about the ideal intake of animal-source foods and the long-term health effects of certain plant-based alternatives (Gastaldello et al., 2022). The relationship between diet and health is complex. Individual characteristics, food accessibility and affordability, as well as broader environmental factors significantly influence both dietary choices and health outcomes (Finaret et al., 2019).

Studies examining dietary patterns and their impacts employ diverse methodologies. These include principal component analysis to identify distinct dietary patterns (Sinai et al., 2021), epidemiologic assessments to evaluate long-term health outcomes associated with specific diets (Stylianou et al., 2021), case studies to analyze food systems within specific contexts (Ambikapathi et al., 2022), synthesize findings from multiple studies (Ruxton & Derbyshire 2008), and quantitative impact assessments to model the effects of policy interventions (Smed et al., 2007). While offering valuable insights, current research calls for more interdisciplinary approaches. Finaret et al.

(2019) highlight the need to integrate nutritional epidemiology with social sciences and economics to gain a deeper understanding of complex factors influencing dietary choices.

Consumer behavior plays a crucial role in shaping dietary patterns. Taste preferences, food accessibility and affordability, understanding of health information, and cultural norms all sway food choices (Finaret et al., 2019; Van Loo et al., 2017). Policies aimed at improving public health must consider these multifaceted influences.

Several potential policy interventions show promise. Examples include using consumer-friendly labels to highlight the health attributes of foods (Liu et al., 2015), promoting whole, unprocessed foods, and examining economic instruments, such as taxes and subsidies, aimed at influencing food choices and prices (Smed et al., 2007; Poole et al., 2021). Van Loo et al., (2017) advocate for integrating health and environmental sustainability goals in food policy and messaging, emphasizing the positive alignment between consumer perceptions of healthy, sustainable, and plant-based diets.

Ongoing research investigates the long-term health effects of various plant-based alternatives (Gastaldello et al., 2022; Geibel et al., 2021) and seeks to refine strategies for promoting dietary change at the individual and population levels. A particularly salient area of focus is the relationship between diet and mental health. Studies such as Banta et al. (2019) suggest a need for specialized dietary interventions for those with mental illness, especially targeting young adults, those with lower education levels, and obese individuals.

4.4. Diet and Local Food Systems

The initial query "local food system" or " local food" in the Web of Science returned many articles (n=305). Screening the abstract and/or introduction identified a subset of articles relevant to our purpose (n=75). Further inspection resulted in the final selection of 23 articles. The geographical distribution of the studies is entirely on Western and developed countries . This happens because local food is more relevant for developed countries as it provides an alternative to the global food system. In underdeveloped countries, most food is local food and so the distinction between local and non-local food systems is less pronounced.

The methodological approach of the studies is empirical investigation. All papers establish a relationship between local food and one of its attributes, such as preference for local food or its nutritional value.

The most important consideration in researching the local food system is that it is not yet clearly defined. There is no standard definition for the local food system, but it is defined implicitly as food systems in which producers and consumers are close to each other. This lack of a standard definition hinders systematic analysis of local food systems. Next, most studies about local food systems center around consumer demand for local food and the determinants of preference for local food. The local food system's overall effect on food security and local and global economies are under-researched.

We briefly review the demand for local food based on evidence about consumers' characteristics that matter for a preference for and willingness to buy local food. There has been an interest in food science to test whether consumers are willing to pay a premium for local food and if so, how high that premium might be. The overall conclusion is that there seems to be a significant willingness to pay for local foods, Enthoven & Van den Broeck (2021) and Feldman & Hamm (2015). However, the willingness to pay varies across demographic and socio-economic characteristics and the location of consumers. A preference for consuming local food is reported to be positively associated with age, wealth, and food consciousness. Older people who are more embedded in their local community are more willing to pay a premium for local food. The positive effect of wealth on the willingness to pay for local food is not surprising as local food is usually more expensive than imported food. Food consciousness or food knowledge affects willingness to pay for local food. The desire for consuming unprocessed high-quality food, organic food, and environmentally friendly practices together with a preference for buying from special outlets contribute to the willingness to pay for local food, Mirosa & Lawson (2012) and Gracia & De-Magistris (2016). Finally, women are more likely to be willing to pay a premium for local food, Carpio & Isengildina-Massa (2009).

Consumers' location, rural versus urban, also matters for the demand for local food. Urbanization is negatively associated with local food consumption as urban consumers have less time for shopping, are less aware about the outlets that sell local food and are less likely to find local food in their vicinity, Khan & Prior (2010). The willingness to pay for local food is expected to be higher in urban areas because urban consumers generally have higher incomes than rural consumers. A study by Hempel & Hamm (2016) reported that German rural consumers have a lower willingness to pay for organic food compared to urban consumers.

A preference for supporting local and small farms is assumed to contribute to the willingness to pay a premium for local food. The evidence, however, is mixed with some studies reporting a positive relationship between a supporting attitude for local and small farmers and local food consumption, Meas et al. (2013), whereas another reporting the opposite, Bianchi & Mortimer (2015). In another study, Birch et al. (2018) report that for Australian consumers, food characteristics such as quality, freshness, and packaging matters more than altruistic concerns such as care for local farmers. A similar result is also reported by Raimondo et al. (2024) where for the Italian walnuts consumers, the taste elicits a higher willingness to pay compared to the product's origin. Overall, food products' specification is a stronger driver for consuming local food compared to concerns for local producers.

4.5. Food Waste

The current review examines the relationship between food waste and three key areas of the SJOS such as food security, sustainability and climate, and economy.

Food Waste and Food Security

Food loss and waste contributes to global food insecurity (Geislar, 2019). Reducing FLW could increase food availability and improve nutrition and food security (Philippidis et al., 2019; Santeramo, 2021), but the effects depend on the locations of food-insecure populations and targeted reduction efforts along the supply chain. Since the early 2010s, research on the connection between food waste and food security has increased significantly (FAO 2011, 2019; UNEP, 2021, 2024). Studies investigate the causes of food insecurity and underlying factors of food waste (e.g., Irani and Sharif, 2016), as well as the effects of reducing FLW on food security and environmental impacts within international food markets (Munesue et al., 2015).

Given that household waste is substantial (e.g., Drabik et al., 2019; Hebrok and Heidenstrøm, 2019; Lusk and Ellison, 2020), targeted studies examine the link between food waste, food insecurity, and behaviors at the consumer level (e.g., Armstrong et al., 2021; Fami et al., 2021; Althumiri et al., 2021; Garcia-Silva et al., 2017; Jereme et al., 2017). These studies aim to inform policies that reduce waste, improve food access, and promote sustainable consumption.

The connection between food waste and food security is explored in 45 studies, 32 of which are journal articles. Articles solely addressing the connections between food waste and food security were selected, 20. Additionally, 4 were included due to its relevance in the household sector. In the end, 6 of which focused exclusively on the final consumption stage of the chain, while the remainder considered the broader concept of food loss and waste, including upwards levels of the food supply chain or the impact on climate.

While the first article was published in 2009, the remaining papers were released from 2015 to 2023. Regarding country coverage, 5 are focused on developed countries (Israel, Malaysia, Saudi Arabia, Taiwan, UK, USA) and only 3 are focused on developing countries. Moreover, most of studies explored the FLW reduction as an opportunity to enhance food security (11), and the remaining offers several topics like connections with environment (4), FLW measurement (3), consumer perceptions (1), food rescue (2), value co-creation (1), food waste management strategies (2). It can also be seen that at least 7 are empirical studies either using simulation models or mass balance methodologies to measure food waste and the remaining offers a theoretical approach.

Food Waste, Sustainability and Climate

As the population grows and consumption habits change, the inefficiencies within the food system, especially food waste, have environmental consequences and exacerbate climate change. Studies addressing the impacts of FLW on sustainability and climate have surged, focusing on quantifying the impacts of food waste management using life cycle assessments (e.g., Kim and Kim, 2010; Bernstad and la Cour Jansen, 2011; Edwards et al., 2018; Slorach et al., 2019a, 2019b; Eriksson et al., 2015; Vandermeersch et al., 2014; Tong et al., 2018) and measuring climate impacts of consumption at household (e.g., Silvennoinen et al., 2022; Lusk and Ellison, 2020; Slorach et al., 2020) and out-of-home levels (e.g., Oliveira et al., 2016; Garcia-Herrero et al., 2021; Shankar et al., 2022; Nandhivarman et al., 2015). Other research themes include consumer behavior, food waste management, alternative uses, the food-waste-water-energy nexus, and the effect on water resources.

Our review of the relationship between food waste and sustainability and climate change identified 98 studies, all of which are journal articles. 40 of these articles directly address this connection. The remaining articles were excluded from further analysis due to their low citation count (less than five). The first contribution dates to 2013. Countries or regions covered in the reviewed works range from developed areas such as Australia, Belgium, China, EU, Finland, France, Hong Kong, Netherlands, Perú, Spain, Sweden, Switzerland, Taiwan, UK, USA and developing areas like India, Nigeria, Northern Africa, Pakistan, Turkey, Uruguay.

Several key areas have emerged within food waste management research. These include analyzing the impacts of food waste management using methodologies like life cycle assessment (LCA) or life cycle costing (LCC) and quantifying the climate footprint of both household and out-of-home food waste. Researchers also examine the food waste-water-energy nexus, aiming to understand the implications of food waste management on food systems sustainability. Finally, studies explore consumer behavior towards the relationship between food waste, sustainability, and climate.

Studies also explored issues of potential food waste uses such as composting or recycling and valorization options into energy (biogas or biodiesel). Additionally, the impact on water, the connection with diets and nutritional quality and understanding food waste interventions and prevention measures have become relevant topics of research.

Food Waste and Economy

The growing literature examines the economic dimension of consumer food waste, using model-based studies to analyze the costs and benefits of reduction (e.g., Rutten, 2013; Höjgår et al., 2013; Campoy-Muñoz et al., 2017; Philippidis et al., 2019; Barrera and Hertel, 2021; Ellison and Lusk, 2018). These studies identify drivers, either based on household production model or approximations (e.g., Hamilton and Richards, 2019; Lusk and Ellison, 2017; Yu and Jaenicke, 2020), or related to consumer behavior (e.g., Stefan et al., 2013; Graham-Rowe et al., 2015; Ascheman-Witzel et al., 2015; Thyberg and Jones, 2016; Stancu et al., 2016; Qi and Roe, 2016), and ways to prevent and reduce waste (e.g., Quested et al., 2013; Dou et al., 2016). Research also explores techno-economic evaluations of energy production from food waste, regulations, and circular economy models addressing food waste management.

In this context, our results show that 279 studies were found, 212 of which are journal articles. Selected articles addressing somehow the relationship between consumer food waste and economic dimension, are 41. The remaining articles were not considered relevant due to their low number of citations received (less than five citations). The first contribution dates back to 2013 and studies have examined regions and countries such as Asia, Brazil, Canada, Costa Rica, Indonesia, Italy, EU, Finland, Norway, UK, and USA.

An overview of the main themes we include food waste reduction and preventions and their corresponding analysis of economic costs and benefits, techno-economic evaluation of food waste uses to energy, analysis of the micro aspects of the behavior of consumers, identification of food waste determinants, specification of foundational economic model for food waste and the implementation of circular economic model and regulations.

5. Discussion

This scoping review reveals the substantial environmental impacts of diet on biodiversity and climate change. Climate change and biodiversity are closely linked. Policies like carbon taxes and subsidies on food can influence greenhouse gas emissions and dietary choices, but their effectiveness is complex. Plant-based alternatives can be beneficial for biodiversity, but their impact on land use and agriculture needs to be carefully considered. Further research is needed on various aspects, such as the effectiveness of policies promoting sustainable diets and the impact of diet on marine and agricultural biodiversity.

In terms of health, a diet rich in fruits, vegetables, and legumes is crucial, while processed foods high in sugar and salt are detrimental. Further research is needed on the long-term health effects of plant-based alternatives, the connection between diet and mental health, and the integration of nutritional research with social sciences and economics.

Local food systems hold potential benefits in terms of resilience and environmental impact, but their definition, impact on food security, and nutritional benefits need further clarification. Additionally, the higher cost of local food and its potential impact on global food producers and retailers need to be addressed.

Food waste is a multifaceted problem with environmental, economic, and social implications. A deeper understanding of consumer behavior leading to food waste, more research in developing countries, and the utilization of longitudinal studies to track changes and assess impacts are necessary to tackle this issue effective

Research Limitations and Future Directions

A key limitation is the unidirectional perspective adopted in this review. While we extensively analyze how consumer preferences drive SJOS outcomes, we do not delve into the complex interplay of the bidirectional relationship between SJOS factors and consumer preferences. Further research is needed to understand this dynamic feedback loop.

The effectiveness of policies and interventions fostering environmentally friendly diets emerges as a pivotal research area. Carbon taxes, while promising, warrant further scrutiny regarding their overall impact on food system actors. The adoption of novel plant-based alternatives presents opportunities for biodiversity conservation; however, potential trade-offs and unintended consequences require careful consideration.

Research gaps exist regarding other biodiversity loss aspects like nitrogen fertilizer application and out-of-home food consumption. Additionally, the focus on terrestrial wild biodiversity necessitates expanded exploration of marine and agricultural biodiversity impacts. Analyzing food demand across diverse consumer groups beyond regional differences and its link to biodiversity impacts remains crucial. Lastly, the bidirectional relationship between diet and environmental quality indicators, including the impact of GHGEs pollution and climate change on food security and dietary quality, merits further investigation.

While the impact of diet on human health is well-established, certain research gaps persist. Long-term health effects of various plant-based alternatives, interdisciplinary studies integrating nutritional epidemiology with social sciences and economics, and a deeper understanding of the diet-mental health relationship require further exploration.

The concept of local food systems, while appealing, presents open questions regarding its definition, overall impact on food security, and nutritional benefits. We can identify three topics that require further research about local food systems. First, defining local food requires more research as there is no consensual definition. This lack of an accepted definition creates substantial problems for meticulous research on the subject. Second, the overall impact of local foods on the health, economy, environment of local food systems is still under-researched. While local food systems benefit small farmers and local communities, their overall impacts on food security and natural resources are not well unknown. We need to know how the expansion of local food systems affects the overall availability and affordability of healthy foods. Third, further research is needed to explore the comparative efficiency of local food systems and identify ways to enhance both their efficiency and availability.

The multifaceted issue of food waste highlights the need for a better understanding of dietary behavior contributing to waste generation. This knowledge is crucial for tailoring interventions and policy measures across the food chain. Additionally, the current focus on developed regions in food waste studies necessitates greater attention to the unique challenges in developing countries. Longitudinal studies are essential for tracking consumer behavior changes and assessing food waste's impact on sustainability, the economy, and climate change.

Ongoing research investigating long-term health effects of plant-based alternatives and strategies for promoting dietary change contributes to refining theory and practice. The relationship between diet and mental health emerges as a particularly crucial research frontier, potentially informing specialized dietary interventions.

Policy Implication and Recommendation

Our scoping review not only underscores the complexities and interdependencies inherent in creating a sustainable and equitable food system, but also points towards key areas for further research and potential avenues for intervention to promote a Safe and Just agri-food system that supports both human and environmental well-being. There is a pressing need to deepen our understanding of consumer behavior and motivations, particularly in relation to sustainable dietary choices. Empowering consumers through effective communication strategies and educational interventions is crucial for fostering informed decision-making. Research gaps persist in several areas, including the long-term health implications of plant-based alternatives, the intricate relationship between nutrition, social sciences, and economics, and the connection between diet and mental health. Addressing these gaps can contribute to a more comprehensive understanding of the multifaceted dimensions of the demand side process in transition towards a safe and just food system. While not the primary focus of this review, our findings also carry some policy implications. For instance, the potential for a carbon tax policy framework that balances environmental goals with nutritional needs and social equity concerns warrants further exploration. Additionally, we emphasize the importance of developing a universally accepted definition for local food systems and investigating their role in food security, nutrition, and economic development. Understanding dietary behaviors linked to food waste, particularly in developing countries, is also paramount for developing effective interventions.

In light of these observations, we recommend prioritizing research that delves into the complexities of consumer behavior, fills existing knowledge gaps, and explores policy interventions aimed at promoting a safe and just agri-food system that safeguards both human and environmental well-being. By focusing on these key areas, we can contribute to a food system that nourishes and sustains us all.

6. Conclusion

This scoping review delves into the relationship between food consumption patterns – encompassing dietary choices and the food waste – and the pressing need to achieve a Safe and Just Operating Space (SJOS). It highlights the role of consumer behavior in shaping a food system that is both environmentally sustainable (Safe) and socially equitable (Just).

The review reveals the potential of plant-based diets to contribute significantly to SJOS goals. By shifting towards plant-based options, we can mitigate climate change, conserve biodiversity, and enhance human health. In contrast, the escalating consumption of animal products poses a formidable challenge to sustainability objectives. Furthermore, the persistent problem of food waste, particularly pronounced at the household level, exacerbates environmental pressures and perpetuates social inequalities. The review underscores the urgent need for coordinated interventions across the entire food supply chain to address this complex issue comprehensively.

While much research exists on the environmental and health impacts of food choices, this review identifies a pressing need for more integrated approaches that encompass the social and economic dimensions of food systems. The predominant focus on developed countries in food waste studies highlights the critical importance of investigating the unique challenges faced by developing regions. Moreover, the lack of a universally accepted definition for food loss and waste hinders effective measurement and policy implementation, necessitating a standardized approach.

In conclusion, this review highlights the role of consumers in shaping a food system that operates within the boundaries of a Safe and Just Operating Space. By fostering informed and sustainable consumer choices, alongside implementing robust interventions to curb food waste, we can empower individuals to make conscious decisions and promote policies that safeguard planetary boundaries while guaranteeing access to nutritious food for all. Transitioning towards an agri-food system that aligns with the SJOS demands a collaborative effort involving consumers, producers, policymakers, and researchers to transform current practices and forge a safe and just future for both humanity and the planet.

Acknowledgements

This research received financial support from the European Union under the Horizon Europe program - Food, Bioeconomy Natural Resources, Agriculture and Environment, Grant Agreement No 101060075.

Data availability statement

This scoping review did not analyze primary datasets. While no new data was used or generated in this scoping review, we provide full search queries and source links (Supplementary Material Appendix 2) as well as the litsearch R-code (Supplementary Material Appendix 2) to ensure transparency.

References

Alexandratos, N., and Bruinsma, J., *World Agriculture towards 2030/2050: the 2012 revision*, ESA Working Paper, 12–03 (2012). Available at: www.fao.org/economic/esa.

Allen, P., 'Realizing justice in local food systems', *Cambridge Journal of Regions, Economy and Society*, 3.2 (2010), 295–308.

Ambikapathi, R., Schneider, K. R., Davis, B., Herrero, M., Winters, P., and Fanzo, J. C., 'Global food systems transitions have enabled affordable diets but had less favourable outcomes for nutrition, environmental health, inclusion, and equity', *Nature Food*, 3.9 (2022), 764–779.

Armstrong, B., Reynolds, C., Martins, C. A., Frankowska, A., Levy, R. B., Rauber, F., Osei-Kwasi, H. A., Vega, M., Cediel, G., Schmidt, X., Kluczkovski, A., Akparibo, R., Auma, C. L., Defeyter, M. A. A., Tereza da Silva, J., and Bridge, G., 'Food insecurity, food waste, food behaviours, and cooking confidence of UK citizens at the start of the COVID-19 lockdown', *British Food Journal*, 123.9 (2021), 2959–2978.

Arrieta, E. M., and González, A. D., 'Impact of current national dietary guidelines and alternative diets on greenhouse gas emissions in Argentina', *Food Policy*, 79 (2018), 58–66.

Auestad, N., and Fulgoni, V. L., 'What current literature tells us about sustainable diets: Emerging research linking dietary patterns, environmental sustainability, and economics', *Advances in Nutrition*, 6.1 (2015), 19–36.

Banks, J., Blundell, R., and Lewbel, A., 'Quadratic Engel curves and consumer demand', *Review of Economics and Statistics*, 79.4 (1997), 527–539.

Banta, J. E., Segovia-Siapco, G., Crocker, C. B., Montoya, D., and Alhusseini, N., 'Mental health status and dietary intake among California adults: A population-based survey', *International Journal of Food Sciences and Nutrition*, 70.6 (2019), 759–770.

Barrera, E. L., and Hertel, T., 'Global food waste across the income spectrum: Implications for food prices, production, and resource use', *Food Policy*, 98 (2021), 101874.

Benton, T., Bieg, C., Harwatt, H., Pudassaini, R., and Wellesley, L., *Food system impacts on biodiversity loss*, Chatham House Research Paper (2021).

Bernstad, A., and la Cour Jansen, J., 'A life cycle approach to the management of household food waste – A Swedish full-scale case study', *Waste Management*, 31.8 (2011), 1879–1896.

Berry, S., Levinsohn, J., and Pakes, A., 'Automobile prices in market equilibrium', *Econometrica*, 63.4 (1995), 841–890.

Bianchi, C., and Mortimer, G., 'Drivers of local food consumption: A comparative study', *British Food Journal*, 117.9 (2015), 2282–2299.

Birch, D., Memery, J., and Kanakaratne, M. D. S., 'The mindful consumer: Balancing egoistic and altruistic motivations to purchase local food', *Journal of Retailing and Consumer Services*, 40 (2018), 221–228.

Bonnet, C., Bouamra-Mechemache, Z., and Corre, T., 'An environmental tax towards more sustainable food: Empirical evidence of the consumption of animal products in France', *Ecological Economics*, 147 (2018), 48–61.

Bonnet, C., Bouamra-Mechemache, Z., Réquillart, V., and Treich, N., 'Regulating meat consumption to improve health, the environment, and animal welfare', *Food Policy*, 97 (2020), 101847.

Brauer, M., Roth, G. A., Aravkin, A. Y., Zheng, P., Abate, K. H., Abate, Y. H., ... and Amani, R., 'Global burden and strength of evidence for 88 risk factors in 204 countries and 811 subnational locations, 1990–2021: A systematic analysis for the Global Burden of Disease Study 2021', *The Lancet*, 403.10440 (2024), 2162–2203.

Briggs, A. D. M., Kehlbacher, A., Tiffin, R., Garnett, T., Rayner, M., and Scarborough, P., 'Assessing the impact on chronic disease of incorporating the societal cost of greenhouse gases into the price of food: An econometric and comparative risk assessment modelling study', *BMJ Open*, 3.10 (2013).

Brodie, J. F., Giordano, A. J., Zipkin, E. F., Bernard, H., Mohd-Azlan, J., and Ambu, L., 'Correlation and persistence of hunting and logging impacts on tropical rainforest mammals', *Conservation Biology*, 29.1 (2015), 110–121.

Brune, S., Knollenberg, W., Barbieri, C., and Stevenson, K., 'Towards a unified definition of local food', *Journal of Rural Studies*, 103 (2023), 103135.

Bryngelsson, D., Wirsenius, S., Hedenus, F., and Sonesson, U., 'How can the EU climate targets be met? A combined analysis of technological and demand-side changes in food and agriculture', *Food Policy*, 59 (2016), 152–164.

Burgaz, C., Gorasso, V., Achten, W. M. J., Batis, C., Castronuovo, L., Diouf, A., Asiki, G., Swinburn, B. A., Unar-Munguía, M., Devleesschauwer, B., Sacks, G., and Vandevijvere, S., 'The effectiveness of food system policies to improve nutrition, nutrition-related inequalities, and environmental sustainability: A scoping review', *Food Security*, 15.5 (2023), 1313–1344.

Caillavet, F., Fadhuile, A., and Nichèle, V., 'Taxing animal-based foods for sustainability: Environmental, nutritional, and social perspectives in France', *European Review of Agricultural Economics*, 43.4 (2016), 537–560.

Caillavet, F., Fadhuile, A., and Nichèle, V., 'Assessing the distributional effects of carbon taxes on food: Inequalities and nutritional insights in France', *Ecological Economics*, 163 (2019), 20–31.

Campbell, B. M., Beare, D. J., Bennett, E. M., Hall-Spencer, J. M., Ingram, J. S., Jaramillo, F., Ortiz, R., Ramankutty, N., Sayer, J. A., and Shindell, D., 'Agriculture production as a major driver of the Earth system exceeding planetary boundaries', *Ecology and Society*, 22.4 (2017).

Campoy-Muñoz, P., Cardenete, M., and Delgado, M., 'Economic impact assessment of food waste reduction on European countries through social accounting matrices', *Resources, Conservation and Recycling*, 122 (2017), 202–209.

Carpio, C. E., and Isengildina-Massa, O., 'Consumer willingness to pay for locally grown products: The case of South Carolina', *Agribusiness: An International Journal*, 25.3 (2009), 412–426.

Clark, M., and Tilman, D., 'Comparative analysis of environmental impacts of agricultural production systems, agricultural input efficiency, and food choice', *Environmental Research Letters*, 12.6 (2017), 064016.

Clune, S., Crossin, E., and Verghese, K., 'Systematic review of greenhouse gas emissions for different fresh food categories', *Journal of Cleaner Production*, 140 (2017), 766–783.

Corrado, S., and Sala, S., 'Food waste accounting along global and European food supply chains: State of the art and outlook', *Waste Management*, 79 (2018), 121–130.

Custodio, H. M., Hadjikakou, M., and Bryan, B. A., 'A review of socioeconomic indicators of sustainability and wellbeing, building on the social foundations framework', *Ecological Economics*, 203 (2023), 107608.

Davis, S. J., Alexander, K., Moreno-Cruz, J., Hong, C., Shaner, M., Caldeira, K., and McKay, I., 'Food without agriculture', *Nature Sustainability*, 7 (2023).

Deaton, A., and Muellbauer, J., 'An almost ideal demand system', *The American Economic Review*, 70.3 (1980), 312–326.

Deckers, J., 'Should the consumption of farmed animal products be restricted, and if so, by how much?', *Food Policy*, 35.6 (2010), 497–503.

Díaz, S., Settele, J., Brondízio, E. S., Ngo, H. T., Agard, J., Arneth, A., ... and Zayas, C. N., 'Pervasive human-driven decline of life on Earth points to the need for transformative change', *Science*, 366.6471 (2019).

Dou, Z., Ferguson, J. D., Galligan, D. T., Kelly, A. M., Finn, S. M., and Giegengack, R., 'Assessing U.S. food wastage and opportunities for reduction', *Global Food Security*, 8 (2016), 19–26.

Drabik, D., de Gorter, H., and Reynolds, C., 'A conceptual and empirical framework to analyze the economics of consumer food waste', *Resources, Conservation and Recycling*, 149 (2019), 500–509.

Edjabou, L. D., and Smed, S., 'The effect of using consumption taxes on foods to promote climate-friendly diets – The case of Denmark', *Food Policy*, 39 (2013), 84–96.

Edwards, J., Othman, M., Crossin, E., and Burn, S., 'Life cycle assessment to compare the environmental impact of seven contemporary food waste management systems', *Bioresource Technology*, 248 (2018), 156–173.

Ellison, B., and Lusk, J. L., 'Examining household food waste decisions: A vignette approach', *Applied Economic Perspectives and Policy*, 40.4 (2018), 613–631.

Elofsson, K., Bengtsson, N., Matsdotter, E., and Arntyr, J., 'The impact of climate information on milk demand: Evidence from a field experiment', *Food Policy*, 61 (2016), 176–183.

Enthoven, L., and Van den Broeck, G., 'Local food systems: Reviewing two decades of research', *Agricultural Systems*, 193 (2021), 103226.

Eriksson, M., Strid, I., and Hansson, P.-A., 'Carbon footprint of food waste management options in the waste hierarchy – A Swedish case study', *Journal of Cleaner Production*, 93 (2015), 115–125.

European Commission, *Policies to encourage sustainable consumption*, Technical Report-2012-061. Retrieved from: https://ec.europa.eu/environment/eussd/pdf/report_22082012.pdf (2012).

European Commission, *A Farm to Fork Strategy for a fair, healthy, and environmentally-friendly food system* (2020).

Fami, H. S., Aramyan, L. H., Sijtsema, S. J., and Alambaigi, A., 'The relationship between household food waste and food security in Tehran city: The role of urban women in household management', *Industrial Marketing Management*, 97 (2021), 71–83.

Fanzo, J., and Miachon, L., 'Harnessing the connectivity of climate change, food systems, and diets: Taking action to improve human and planetary health', *Anthropocene*, 42 (2023), 100381.

FAO, *Food wastage footprint: Impacts on natural resources*, Summary Report (2013). Available at: https://www.fao.org/4/i3347e/i3347e.pdf.

FAO, *Global food losses and food waste – Extent, causes, and prevention* (2011). Rome.

FAO, *The future of food and agriculture – Trends and challenges* (2017). Rome. Available at: https://www.fao.org/3/i6583e/i6583e.pdf.

FAO, *The future of food and agriculture – Alternative pathways to 2050* (2018). Available at: http://www.fao.org/global-perspectives-studies/food-agriculture-projections-to-2050/en/.

FAO, *The State of the World's Biodiversity for Food and Agriculture*, ed. by Bélanger, J., and Pilling, D., FAO Commission on Genetic Resources for Food and Agriculture Assessments (2019).

Feldman, C., and Hamm, M., 'Consumer willingness to pay for local food: Can we trust what consumers say?', *Journal of Food Distribution Research*, 46.1 (2015), 58–74.

Ferretto, A., Matthews, R., Brooker, R. and Smith, P., 'Planetary Boundaries and the Doughnut frameworks: A review of their local operability', *Anthropocene*, 39 (2022), 100347.

Finaret, A. B., and Masters, W. A., 'Beyond calories: The new economics of nutrition', *Annual Review of Resource Economics*, 11 (2019), 237–259.

Foley, J. A., Ramankutty, N., Brauman, K. A., Cassidy, E. S., Gerber, J. S., Johnston, M., … and Zaks, D. P. M., 'Solutions for a cultivated planet', *Nature*, 478.7369 (2011), 337–342.

Fresán, U., Mejia, M. A., Craig, W. J., Jaceldo-Siegl, K., and Sabaté, J., 'Environmental sustainability and health outcomes of vegetarian dietary patterns: A revisit of the EPIC-Oxford and Adventist Health Study-2 cohorts', *European Journal of Clinical Nutrition*, 73.1 (2019), 60–70.

Ganivet, E., 'Growth in human population and consumption both need to be addressed to reach an ecologically sustainable future', Environment, Development and Sustainability, 22.6 (2020), 4979–4998. Available at: https://doi.org/10.1007/S10668-019-00446-W/METRICS.

García-Herrero, L., Costello, C., De Menna, F., and Schreiber, L., 'Eating away at sustainability: Food consumption and waste patterns in a US school canteen', *Journal of Cleaner Production*, 279 (2021), 123571.

García-Muros, X., Casado, J. M., González, E., and Esparcia, C., 'Can taxes on consumption reduce greenhouse gas emissions? A microsimulation model for the Spanish economy', *Economic Systems Research*, 29.1 (2017), 121–142.

Garcia-Silva, B., Handler, E., and Wolfe, J., 'A public-private partnership to mitigate food insecurity and food waste in Orange County, California', *American Journal of Public Health*, 107.1 (2017), 105. Available at: https://doi.org/10.2105/AJPH.2016.303450.

Gastaldello, A., Giampieri, F., De Giuseppe, R., Grosso, G., Baroni, L., and 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 in Food Science & Technology* (2022).

Geislar, S., 'The determinants of household food waste reduction, recovery, and reuse: Toward a household metabolism', in Ferranti, P., Berry, E. M., and Anderson, J. R. (eds.), *Encyclopedia of Food Security and Sustainability* (Oxford: Elsevier, 2019), pp. 567–574.

Grabs, J., 'The rebound effects of switching to vegetarianism: A microeconomic analysis of Swedish consumption behavior', *Ecological Economics*, 116 (2015), 270–279. Available at: https://doi.org/10.1016/j.ecolecon.2015.04.030.

Gracia, A., and de-Magistris, T., 'The demand for organic foods in the South of Italy: A discrete choice model', *Food Policy*, 39 (2016), 56–62.

Graham-Rowe, E., Jessop, D. C., and Sparks, P., 'Identifying motivations and barriers to minimising household food waste', *Resources, Conservation and Recycling*, 84 (2014), 15–23.

Grames, J., Stillman, A. M., Bullock, E., and Plant, C., 'Systematic review methodologies in environmental sciences', *Environmental Modelling & Software*, 104 (2018), 223–232.

Gustavsson, J., Cederberg, C., Sonesson, U., Van Otterdijk, R., and Meybeck, A., *Global food losses and food waste*, FAO (2011). Available at: http://www.fao.org/3/i2697e/i2697e.pdf.

Hallström, E., Röös, E., and Börjesson, P., 'Sustainable meat consumption: A quantitative analysis of nutritional intake, greenhouse gas emissions and land use from a Swedish perspective', *Food Policy*, 47 (2014), 81–90. Available at: https://doi.org/10.1016/j.foodpol.2014.04.002.

Hamilton, S. F., and Richards, T. J., 'Food waste, price competition, and price dispersion in food retailing', *Journal of Retailing*, 95.2 (2019), 172–184.

Harrison, R. D., 'Emptying the Forest: Hunting and the extirpation of wildlife from tropical nature reserves', *BioScience*, 61.11 (2011), 919–924. Available at: https://doi.org/10.1525/BIO.2011.61.11.11.

Hebrok, M., and Heidenstrøm, N., 'Contextualising food waste prevention: Decisive moments within everyday practices', *Journal of Cleaner Production*, 210 (2019), 1435–1448. Available at: https://doi.org/10.1016/j.jclepro.2018.11.141.

Hedenus, F., Wirsenius, S., and Johansson, D. J. A., 'The importance of reduced meat and dairy consumption for meeting stringent climate change targets', *Climatic Change*, 124.1 (2014), 79–91. Available at: https://doi.org/10.1007/s10584-014-1104-5.

Hempel, C., and Hamm, U., 'How important is local food to organic-minded consumers?', *Appetite*, 96 (2016), 309–318.

Henry, R. C., Alexander, P., Rabin, S., Anthoni, P., Rounsevell, M. D. A., and Arneth, A., 'The role of global dietary transitions for safeguarding biodiversity', *Global Environmental Change*, 58 (2019), 101956. Available at: https://doi.org/10.1016/J.GLOENVCHA.2019.101956.

Hentschl, M., Michalke, A., Pieper, M., Gaugler, T., and Stoll-Kleemann, S., 'Dietary change and land use change: Assessing preventable climate and biodiversity damage due to meat consumption in Germany', *Sustainability Science*, 1 (2023), 1–17. Available at: https://doi.org/10.1007/S11625-023-01326-Z/FIGURES/4.

Hentschl, M., Michalke, A., Pieper, M., Gaugler, T., and Stoll-Kleemann, S., 'Dietary change and land use change: Assessing preventable climate and biodiversity damage due to meat consumption in Germany', *Sustainability Science*, 1 (2023), 1–17. Available at: https://doi.org/10.1007/S11625-023-01326-Z/FIGURES/4.

Höjgård, S., Jansson, T., and Rabinowicz, E., *Food waste among Swedish households: Much ado about nothing?*, Working Paper No: 2013:8, Agrifood Economics Center (2013).

Huan-Niemi, E., Kaljonen, M., Knuuttila, M., Niemi, J., and Saarinen, M., 'The impacts of dietary change in Finland: Food system approach', *Agricultural and Food Science*, 29.4 (2020), Article 4. Available at: https://doi.org/10.23986/afsci.95282.

Intergovernmental Panel on Climate Change, *Climate Change and Land: An IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems*, ed. by Shukla, J. M. P. R., Skea, J., Calvo Buendia, E., Masson-Delmotte, V., Pörtner, H.-O., Roberts, D. C., Zhai, P., Slade, R., Connors, S., van Diemen, R., Ferrat, M., Haughey, E., Luz, S., Neogi, S., Pathak, M., Petzold, J., Portugal Pereira, J., Vyas, P., Huntley, E., Kissick, K., Belkacemi, M. S., and Malley, J. (Cambridge: Cambridge University Press, 2019). Available at: https://doi.org/10.4337/9781784710644.

Irani, Z., and Sharif, A. M., 'Sustainable food security futures', *Journal of Enterprise Information Management*, 29.2 (2016), 171–178.

Jaureguiberry, P., Titeux, N., Wiemers, M., Bowler, D. E., Coscieme, L., Golden, A. S., Guerra, C. A., Jacob, U., Takahashi, Y., Settele, J., Díaz, S., Molnár, Z., and Purvis, A., 'The direct drivers of recent global anthropogenic biodiversity loss', *Science Advances*, 8.45 (2022), 9982. Available at: https://doi.org/10.1126/SCIADV.ABM9982/SUPPL_FILE/SCIADV.ABM9982_DATA_S1.ZIP.

Jereme, I. A., Siwar, C., Begum, R. A., and Abdul, B., 'Food wastes and food security: The case of Malaysia', *International Journal of Advanced and Applied Sciences*, 4.8 (2017), 6–13. Available at: https://doi.org/10.21833/ijaas.2017.08.002.

Jones, S. K., Estrada-Carmona, N., Juventia, S. D., Dulloo, M. E., Laporte, M. A., Villani, C., and Remans, R., 'Agrobiodiversity Index scores show agrobiodiversity is underutilized in national food systems', *Nature Food*, 2.9 (2021), 712–723. Available at: https://doi.org/10.1038/s43016-021-00344-3.

Kehlbacher, A., Tiffin, R., Briggs, A., Berners-Lee, M., and Scarborough, P., 'The distributional and nutritional impacts and mitigation potential of emission-based food taxes in the UK', *Climatic Change*, 137.1–2 (2016), 121–141. Available at: https://doi.org/10.1007/s10584-016-1673-6.

Khan, F., and Prior, C., 'Evaluating the urban consumer with regard to sourcing local food: A Heart of England study', *International Journal of Consumer Studies*, 34.2 (2010), 161–168.

Kim, B. F., Santo, R. E., Scatterday, A. P., Fry, J. P., Synk, C. M., Cebron, S. R., Mekonnen, M. M., Hoekstra, A. Y., de Pee, S., Bloem, M. W., Neff, R. A., and Nachman, K. E., 'Country-specific dietary shifts to mitigate climate and water crises', *Global Environmental Change*, 62 (2020), 101926. Available at: https://doi.org/10.1016/j.gloenvcha.2019.05.010.

Kim, M.-H., and Kim, J.-W., 'Comparison through a LCA evaluation analysis of food waste disposal options from the perspective of global warming and resource recovery', *Science of the Total Environment*, 408.19 (2010), 3998–4006.

Kinnunen, P., Guillaume, J. H. A., Taka, M., D'Odorico, P., Siebert, S., Puma, M. J., and Kummu, M., 'Local food crop production can fulfil demand for less than one-third of the population', *Nature Food*, 1.4 (2020), 229–237.

Kok, M. T. J., Alkemade, R., Bakkenes, M., van Eerdt, M., Janse, J., Mandryk, M., and van Vuuren, D. P., 'Pathways for agriculture and forestry to contribute to terrestrial biodiversity conservation: A global scenario-study', *Biological Conservation*, 221 (2018), 137–150. Available at: https://doi.org/10.1016/j.biocon.2018.03.003.

Kozicka, M., Havlík, P., Valin, H., Wollenberg, E., Deppermann, A., Leclère, D., Lauri, P., Moses, R., Boere, E., Frank, S., Davis, C., Park, E., and Gurwick, N., 'Feeding climate and biodiversity goals with novel plant-based meat and milk alternatives', *Nature Communications*, 14.1 (2023). Available at: https://doi.org/10.1038/S41467-023-40899-2.

Latka, C., Kuiper, M., Frank, S., Heckelei, T., Havlík, P., Witzke, H. P., and van Dijk, M., 'Paying the price for environmentally sustainable and healthy EU diets', *Global Food Security*, 28 (2021), 100437. Available at: https://doi.org/10.1016/j.gfs.2020.100437.

Leclère, D., Obersteiner, M., Barrett, M., Butchart, S. H. M., Chaudhary, A., De Palma, A., and Young, L., 'Bending the curve of terrestrial biodiversity needs an integrated strategy', *Nature*, 585.7826 (2020), 551–556. Available at: https://doi.org/10.1038/s41586-020-2705-y.

Lewbel, A., and Pendakur, K., 'Tricks with Hicks: The EASI Demand System', *The American Economic Review*, 99.3 (2009), 827–863. Available at: http://dx.doi.org.ezproxy.lib.uconn.edu/10.1257/aer.99.3.827.

Li, A., Chen, Y., Schuller, A. A., van Der Sluis, L. W., and Tjakkes, G. H. E., 'Dietary inflammatory potential is associated with poor periodontal health: A population-based study', *Journal of Clinical Periodontology*, 48.7 (2021), 907–918.

Lusk, J. L., 'Separating myth from reality: An analysis of socially acceptable credence attributes', *Annual Review of Resource Economics*, 10 (2018), 65–82.

Lusk, J. L., and Ellison, B., 'A note on modelling household food waste behavior', *Applied Economics Letters*, 24.16 (2017), 1199–1210.

Lusk, J. L., and Ellison, B., 'Economics of household food waste', *Canadian Journal of Agricultural Economics*, 68 (2020), 379–386. Available at: https://doi.org/10.1111/cjag.12256.

Meas, T., Hu, W., Batte, M. T., Woods, T., and Ernst, S., '"Local is the New Organic": Do consumers agree?', Unpublished manuscript (2013).

Melikoglu, M., and Aycin Muyesser Cinel, A. M., 'Food waste-water-energy nexus: Scrutinising sustainability of biodiesel production from sunflower oil consumption wastes in Turkey till 2030', *Environmental Technology & Innovation*, 17 (2020), 100628.

Miller, S. R., and Knudson, W. A., 'Nutrition and cost comparisons of select canned, frozen, and fresh fruits and vegetables', *American Journal of Lifestyle Medicine*, 8.6 (2014), 430–437.

Mirosa, M., and Lawson, R., 'Revealing the lifestyles of local food consumers', *British Food Journal*, 114.6 (2012), 816–825.

Monetti, S., Pregernig, M., Speck, M., Langen, N., and Bienge, K., 'Assessing the impact of individual nutrition on biodiversity: A conceptual framework for the selection of indicators targeted at the out-of-home catering sector', *Ecological*

Indicators, 126 (2021), 107620. Available at: https://doi.org/10.1016/j.ecolind.2021.107620.

Moschini, G., 'Units of measurement and the Stone index in demand system estimation', *American Journal of Agricultural Economics*, 77.1 (1995), 63–68. Available at: https://doi.org/10.2307/1243889.

Munesue, Y., Masui, T., and Fushima, T., 'The effects of reducing food losses and food waste on global food insecurity, natural resources, and greenhouse gas emissions', *Environmental Economics and Policy Studies*, 17 (2015), 43–77. Available at: https://doi.org/10.1007/s10018-014-0083-0.

Nandhivarman, M., Poyyamoli, G., Edwin, G. A., Prasath, R. A., and Boruah, D., 'Evolving and implementing energy recovering strategy from food wastes at Jawahar Navodaya Vidhyalaya (JNV) fostering campus sustainability', in Leal Filho, W., Muthu, N., Edwin, G., and Sima, M. (eds.), *Implementing Campus Greening Initiatives* (Springer, 2015), pp. 1–17. Available at: https://doi.org/10.1007/978-3-319-11961-8_1.

OECD/FAO, *OECD-FAO Agricultural Outlook 2021-2030* (Paris: OECD Publishing, 2021). Available at: https://doi.org/10.1787/B252F56F-EN.

Oliveira, B., de Moura, A. P., and Cunha, L. M., 'Reducing food waste in the food service sector as a way to promote public health and environmental sustainability', in Leal Filho, W., Azeiteiro, U., and Alves, F. (eds.), *Climate Change and Health* (Springer, 2016), pp. 151–164. Available at: https://doi.org/10.1007/978-3-319-24660-4_8.

Owino, V., Kumwenda, C., Ekesa, B., Parker, M. E., Ewoldt, L., Roos, N., Lee, W. T., and Tomé, D., 'The impact of climate change on food systems, diet quality, nutrition, and health outcomes: A narrative review', *Frontiers in Climate*, 4 (2022). Available at: https://doi.org/10.3389/fclim.2022.941842.

Papargyropoulou, E., Lozano, R., Steinberger, J. K., Wright, N., and Ujang, Z. B., 'The food waste hierarchy as a framework for more effective resource management', *Journal of Cleaner Production*, 76 (2014), 106–115.

Perignon, M., Sinfort, C., El Ati, J., Traissac, P., Drogué, S., Darmon, N., Amiot, M. J., Achir, N., Alouane, L., Bellagha, S., Bosc, P. M., and Broin, M., *Details withheld for unpublished manuscript*.

Peters, M. D., Godfrey, C. M., Khalil, H., McInerney, P., Parker, D., and Soares, C. B., 'Guidance for conducting systematic scoping reviews', *International Journal of Evidence-Based Healthcare*, 13.3 (2015), 141–146. Available at: https://doi.org/10.1097/XEB.0000000000000050.

Philippidis, G., Ferrer-Pérez, H., Gracia-de-Rentería, P., M'barek, R., and Sanjuán López, A. I., 'Eating your greens: A global sustainability assessment', *Resources, Conservation and Recycling*, 168 (2021), 105460. Available at: https://doi.org/10.1016/j.resconrec.2021.105460.

Philippidis, G., Sartori, M., Ferrari, E., and M'barek, R., 'Waste not, want not: A bio-economic impact assessment of household food waste reductions in the EU', *Resources, Conservation & Recycling*, 146 (2019), 514–522.

Poole, N., Agnew, J., Ansari, N., Bhavani, R. V., Maestre, M., Mehmood, M., and Parasar, R., 'Being realistic about the contribution of private businesses to public nutrition objectives', *Food Chain*, 9.2 (2020), 1–12. Available at: https://doi.org/10.3362/2046-1887.19-00013.

Potter, C., Pechey, R., Cook, B., Bateman, P., Stewart, C., Frie, K., Clark, M., Piernas, C., Rayner, M., and Jebb, S. A., 'Effects of environmental impact and nutrition labeling on food purchasing: An experimental online supermarket study', *Appetite*, 180 (2023), 106312. Available at: https://doi.org/10.1016/J.APPET.2022.106312.

Qi, D., and Roe, B. E., 'Household food waste: Multivariate regression and principal components analyses of awareness and attitudes among U.S. consumers', *PLoS One*, 11.7 (2016), e0159250. Available at: https://doi.org/10.1371/journal.pone.0159250.

Quested, T. E., Marsh, E., Stunell, D., and Parry, A. D., 'Spaghetti soup: The complex world of food waste behaviors', *Resources, Conservation and Recycling*, 79 (2013), 43–51.

Quested, T. E., Marsh, E., Stunell, D., and Parry, A. D., 'Spaghetti soup: The complex world of food waste behaviors', *Resources, Conservation & Recycling*, 79 (2013), 43–51.

Raimondo, M., Spina, D., D'Amico, M., di Vita, G., Califano, G., and Caracciolo, F., 'Taste matters more than origin: An experimental economics study on consumer preferences for native and foreign varieties of walnuts', *Food Quality and Preference*, 115 (2024), 105106.

Rasche, L., Habel, J. C., Stork, N., Schmid, E., and Schneider, U. A., 'Food versus wildlife: Will biodiversity hotspots benefit from healthier diets?', *Global Ecology and Biogeography*, 31.6 (2022), 1090–1103. Available at: https://doi.org/10.1111/GEB.13485.

Raworth, K., *Doughnut economics: Seven ways to think like a 21st-century economist* (Chelsea Green Publishing, 2017).

Revoredo-Giha, C., Chalmers, N., and Akaichi, F., 'Simulating the impact of carbon taxes on greenhouse gas emission and nutrition in the UK', *Sustainability*, 10.1 (2018). Available at: https://doi.org/10.3390/su10010134.

Reynolds, C., Soma, T., Spring, C., and Lazell, J. (eds.), *Routledge Handbook of Food Waste*, 1st edn (Routledge, 2020). Available at: https://doi.org/10.4324/9780429462795.

Rickman, J. C., Barrett, D. M., and Bruhn, C. M., 'Nutritional comparison of fresh, frozen and canned fruits and vegetables. Part 1. Vitamins C and B and phenolic compounds', *Journal of the Science of Food and Agriculture*, 87.6 (2007), 930–944.

Rigi, S., Mousavi, S. M., Benisi-Kohansal, S., Azadbakht, L., and Esmaillzadeh, A., 'The association between plant-based dietary patterns and risk of breast cancer: A case-control study', *Scientific Reports*, 11.1 (2021), 3391.

Röös, E., Karlsson, H., Witthöft, C., and Sundberg, C., 'Evaluating the sustainability of diets–combining environmental and nutritional aspects', *Environmental Science & Policy*, 47 (2015), 157–166. Available at: https://doi.org/10.1016/j.envsci.2014.12.001.

Rose, S., Engel, D., Cramer, N., and Cowley, W., 'Automatic keyword extraction from individual documents', in *Text Mining: Applications and Theory* (2010), 1–20.

Rutten, M. M., 'What economic theory tells us about the impacts of reducing food losses and/or waste: Implications for research, policy and practice', *Agriculture & Food Security*, 2.13 (2013), 1–13.

Ruxton, C. H. S., and Derbyshire, E., 'A systematic review of the association between cardiovascular risk factors and regular consumption of oats', *British Food Journal*, 110.11 (2008), 1119–1132.

Sánchez-Bayo, F., and Wyckhuys, K. A. G., 'Worldwide decline of the entomofauna: A review of its drivers', *Biological Conservation*, 232 (2019), 8–27. Available at: https://doi.org/10.1016/J.BIOCON.2019.01.020.

Santeramo, F. G., 'Exploring the link among food loss, waste and food security: What the research should focus on?', *Agriculture & Food Security*, 10.1 (2021), 26.

Schuster, M., and Torero, M., 'Reducing food loss and waste', in IFPRI (ed.), *IFPRI Book Chapters* (2016), 9780896295827-03.

Schuster, M., and Torero, M., *Toward a sustainable food system: Reducing food loss and waste* (2016).

Seconda, L., Baudry, J., Allès, B., Boizot-Szantai, C., Soler, L.-G., Galan, P., Hercberg, S., Langevin, B., Lairon, D., Pointereau, P., and Kesse-Guyot, E., 'Comparing nutritional, economic, and environmental performances of diets according to their levels of greenhouse gas emissions', *Climatic Change*, 148.1 (2018), 155–172. Available at: https://doi.org/10.1007/s10584-018-2195-1.

Shankar, A., Dhir, A., Talwar, S., Islam, N., and Sharma, P., 'Balancing food waste and sustainability goals in online food delivery: Towards a comprehensive conceptual framework', *Technovation*, 117 (2022), 102606.

Silvennoinen, K., Nisonen, S., and Katajajuuri, J.-M., 'Food waste amount, type, and climate impact in urban and suburban regions in Finnish households', *Journal of Cleaner Production*, 378 (2022), 134430.

Sinai, T., Axelrod, R., Shimony, T., Boaz, M., and Kaufman-Shriqui, V., 'Dietary patterns among adolescents are associated with growth, socioeconomic features, and health-related behaviors', *Foods*, 10 (2021), 3054. Available at: https://doi.org/10.3390/foods10123054.

Slorach, P. C., Jeswani, H. K., Cuéllar-Franca, R., and Azapagic, A., 'Environmental and economic implications of recovering resources from food waste in a circular economy', *Science of the Total Environment*, 693 (2019), 133516.

Slorach, P. C., Jeswani, H. K., Cuéllar-Franca, R., and Azapagic, A., 'Environmental sustainability of anaerobic digestion of household food waste', *Journal of Environmental Management*, 236 (2019), 798–814.

Slorach, P. C., Jeswani, H. K., Cuéllar-Franca, R., and Azapagic, A., 'Assessing the economic and environmental sustainability of household food waste management in the UK: Current situation and future scenarios', *Science of the Total Environment*, 710 (2020), 135580.

Smed, S., Jensen, J. D., and Denver, S., 'Socio-economic characteristics and the effect of taxation as a health policy instrument', *Food Policy*, 32.5–6 (2007), 624–639.

Spillias, S., Valin, H., Batka, M., Sperling, F., Havlík, P., Leclère, D., Cottrell, R. S., O'Brien, K. R., and McDonald-Madden, E., 'Reducing global land-use pressures with seaweed farming', *Nature Sustainability* (2023). Available at: https://doi.org/10.1038/s41893-022-01043-y.

Springmann, M., Godfray, H. C. J., Rayner, M., and Scarborough, P., 'Analysis and valuation of the health and climate change cobenefits of dietary change', *Proceedings of the National Academy of Sciences*, 113.15 (2016), 4146–4151. Available at: https://doi.org/10.1073/pnas.1523119113.

Springmann, M., Wiebe, K., Mason-D'Croz, D., Sulser, T. B., Rayner, M., and Scarborough, P., 'Health and nutritional aspects of sustainable diet strategies and their association with environmental impacts: A global modelling analysis with country-level detail', *The Lancet Planetary Health*, 2.10 (2018), e451–e461. Available at: https://doi.org/10.1016/S2542-5196(18)30206-7.

Stefan, V., Van Herpen, E., Tudoran, A. A., and Lähteenmäki, L., 'Avoiding food waste by Romanian consumers: The importance of planning and shopping routines', *Food Quality and Preference*, 28.1 (2013), 375–381.

Stephens, E. C., Martin, G., Van Wijk, M., Timsina, J., and Snow, V., 'Impacts of COVID-19 on agricultural and food systems worldwide and on progress to the sustainable development goals', *Agricultural Systems*, 183 (2020), 102873.

Stylianou, K. S., Fulgoni III, V. L., and Jolliet, O., 'Small targeted dietary changes can yield substantial gains for human health and the environment', *Nature Food*, 2.8 (2021), 616–627.

Su, G., Logez, M., Xu, J., Tao, S., Villéger, S., and Brosse, S., 'Human impacts on global freshwater fish biodiversity', *Science*, 371.6531 (2021), 835–838. Available at: https://doi.org/10.1126/SCIENCE.ABD3369/SUPPL_FILE/ABD3369_SU_SM.PDF.

Thyberg, K. L., and Tonjes, D. J., 'Drivers of food waste and their implications for sustainable policy development', *Resources, Conservation & Recycling*, 106 (2016), 110–123.

Tiboldo, G., Boehm, R., Shah, F., Moro, D., and Castellari, E., 'Taxing the heat out of the U.S. food system', *Food Policy*, 110 (2022), 102266. Available at: https://doi.org/10.1016/j.foodpol.2022.102266.

Tilman, D., and Clark, M., 'Global diets link environmental sustainability and human health', *Nature*, 515.7528 (2014), 518–522.

Tilman, D., Balzer, C., Hill, J., and Befort, B. L., 'Global food demand and the sustainable intensification of agriculture', *Proceedings of the National Academy of Sciences*, 108.50 (2011), 20260–20264.

Tong, H., Shen, Y., Zhang, J., Wang, C.-H., Ge, T. S., and Tong, Y. W., 'A comparative life cycle assessment on four waste-to-energy scenarios for food waste generated in eateries', *Applied Energy*, 225 (2018), 1143–1157.

Tricco, A. C., Lillie, E., Zarin, W., O'Brien, K. K., Colquhoun, H., Levac, D., and Straus, S. E., 'PRISMA extension for scoping reviews (PRISMA-ScR): Checklist and explanation', *Annals of Internal Medicine*, 169.7 (2018), 467–473.

United Nations Environment Programme (UNEP), *Food Waste Index Report* (Nairobi, Kenya: United Nations Environment Programme, 2021).

United Nations Environment Programme (UNEP), *Food Waste Index Report 2024: Think Eat Save: Tracking Progress to Halve Global Food Waste* (2024). Available at: https://wedocs.unep.org/20.500.11822/45230.

van Dooren, C., Keuchenius, C., de Vries, J. H. M., de Boer, J., and Aiking, H., 'Unsustainable dietary habits of specific subgroups require dedicated transition strategies: Evidence from the Netherlands', *Food Policy*, 79 (2018), 44–57. Available at: https://doi.org/10.1016/j.foodpol.2018.05.002.

van Dooren, C., Marinussen, M., Blonk, H., Aiking, H., and Vellinga, P., 'Exploring dietary guidelines based on ecological and nutritional values: A comparison of six dietary patterns', *Food Policy*, 44 (2014), 36–46. Available at: https://doi.org/10.1016/j.foodpol.2013.11.002.

Van Loo, E. J., Hoefkens, C., and Verbeke, W., 'Healthy, sustainable and plant-based eating: Perceived (mis)match and involvement-based consumer segments as targets for future policy', *Food Policy*, 69 (2017), 46–57.

Vandermeersch, T., Alvarenga, R. A. F., Ragaert, P., and Dewulf, J., 'Environmental sustainability assessment of food waste valorization options', *Resources, Conservation & Recycling*, 87 (2014), 57–64.

Visconti, P., Bakkenes, M., Baisero, D., Brooks, T., Butchart, S. H. M., Joppa, L., and Rondinini, C., 'Projecting global biodiversity indicators under future development scenarios', *Conservation Letters*, 9.1 (2016), 5–13. Available at: https://doi.org/10.1111/CONL.12159.

Wellesley, L., Happer, C., and Froggatt, A., 'Changing climate, changing diets', in *Chatham House Report*, Wier, M., Birr-Pedersen, K., and Jacobsen (2015). Available at: https://planet4-eu-unit-stateless.storage.googleapis.com/2018/08/ac718383-ac718383-chhj3820-diet-and-climate-change-18.11.15_web_new.pdf (last accessed: 31 January 2024).

Willett, W., Rockström, J., Loken, B., Springmann, M., Lang, T., Vermeulen, S., Garnett, T., Tilman, D., DeClerck, F., Wood, A., Jonell, M., Clark, M., Gordon, L. J., Fanzo, J., Hawkes, C., Zurayk, R., Rivera, J. A., De Vries, W., Majele Sibanda, L., and Murray, C. J. L., 'Food in the Anthropocene: The EAT–Lancet Commission on healthy diets from sustainable food systems', *The Lancet*, 393.10170 (2019). Available at: https://doi.org/10.1016/S0140-6736(18)31788-4.

Wirsenius, S., Hedenus, F., and Mohlin, K., 'Greenhouse gas taxes on animal food products: Rationale, tax scheme and climate mitigation effects', *Climatic Change*, 108.1 (2011), 159–184. Available at: https://doi.org/10.1007/s10584-010-9971-x.

Xia, S., Takakura, J., Wu, W., Blanchard, J. L., Heneghan, R. F., Yamakawa, T., Tsuchiya, K., Hasegawa, T., Fujimori, S., and Takahashi, K., 'Potential environmental and nutritional benefits of replacing ruminant meat with forage fish', *Sustainable Production and Consumption*, 40 (2023), 265–276. Available at: https://doi.org/10.1016/j.spc.2023.07.005.

Xiong, X., Zhang, L., Hao, Y., Zhang, P., Chang, Y., and Liu, G., 'Urban dietary changes and linked carbon footprint in China: A case study of Beijing', *Journal of Environmental Management*, 255 (2020), 109877. Available at: https://doi.org/10.1016/j.jenvman.2019.109877.

Xue, L., Liu, G., Parfitt, J., Liu, X., Van Herpen, E., Stenmarck, Å., O'Connor, C., Ostergren, K., and Cheng, S., 'Missing food, missing data? A critical review of global food losses and food waste data', *Environmental Science & Technology*, 51 (2017), 6618–6633.

Yu, Y., and Jaenicke, E. C., 'Estimating food waste as household production inefficiency', *American Journal of Agricultural Economics*, 102 (2020), 525–547. Available at: https://doi.org/10.1002/ajae.12036.

Yue, W., Tan, Z., Zhang, J., Zeng, J., Xu, M., Rong, Q., Xu, C., and Su, M., 'Optimization of residents' dietary structure with consideration of greenhouse gas mitigation and nutritional requirements', *Sustainable Production and Consumption*, 32 (2022), 424–435. Available at: https://doi.org/10.1016/j.spc.2022.04.030.

Yusuf, S., Joseph, P., Rangarajan, S., Islam, S., Mente, A., Hystad, P., Brauer, M., Kutty, V. R., Gupta, R., Wielgosz, A., and PURE investigators, 'Modifiable risk factors, cardiovascular disease, and mortality in 155,722 individuals from 21 high-income, middle-income, and low-income countries (PURE): A prospective cohort study', *The Lancet*, 395 (2020), 795–808.

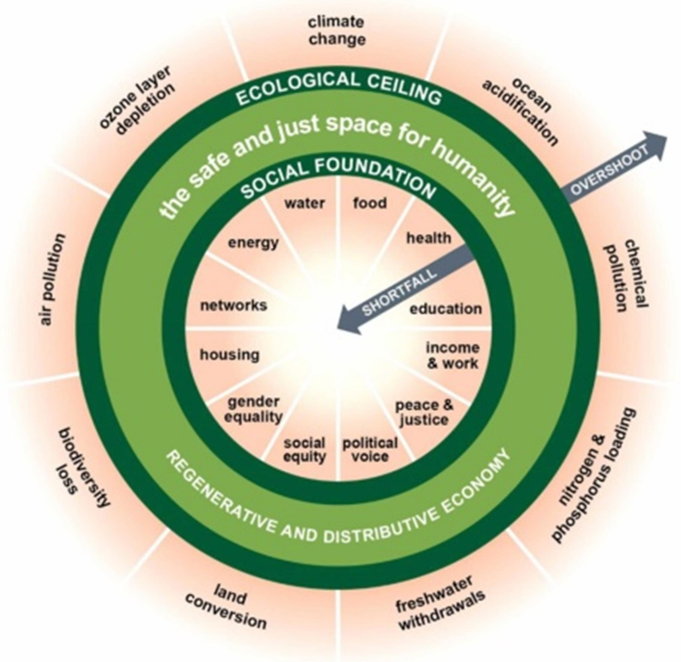

Figure 1: The safe and just operating space for humanity. The green area represents the safe and just operating space, bounded by the environmental ceiling (outer ring) and the social foundation (inner ring). Source: Ferretto et al., 2022.

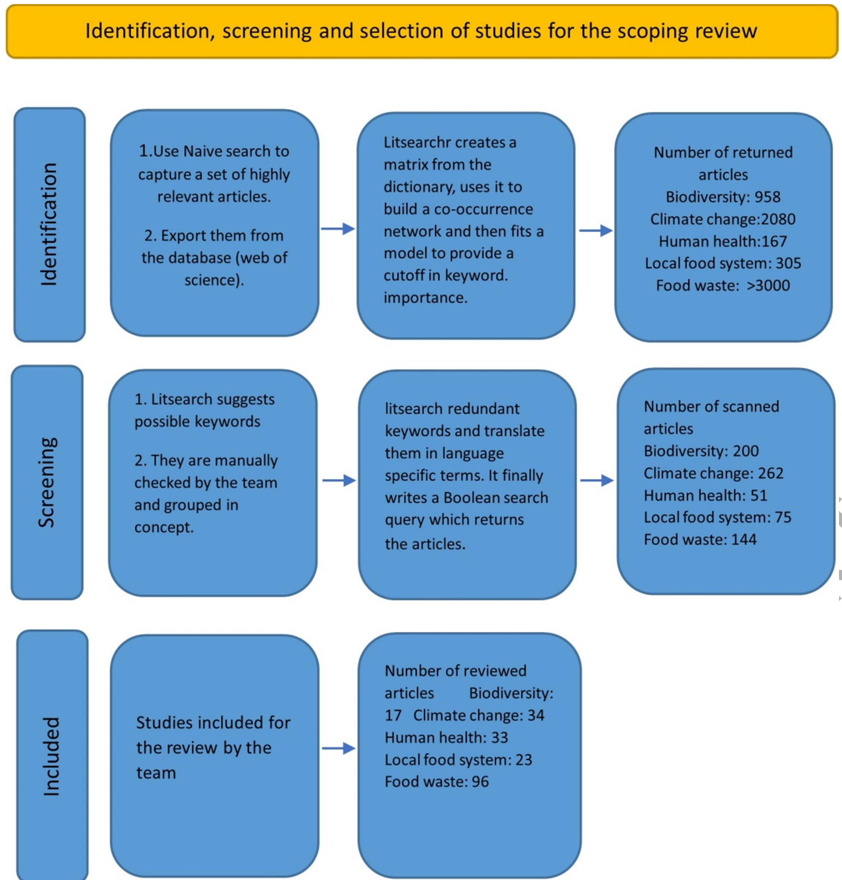

Figure 2: The process of identification of studies for the scoping process.