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Discussion paper

NUTRITION AND THE ENVIRONMENT

Nurturing people, protecting the planet

UN Nutrition

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Nurturing people, protecting the planet

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4. Food and Agriculture Organization of the United Nations
5. World Food Programme
6. International Atomic Energy Agency
7. International Fund for Agricultural Development
8. United Nations Children's Fund
9. World Health Organization

Abbreviations and acronyms

CFS	Committee on World Food Security
CO_2e	carbon dioxide equivalents
COVID-19	Coronavirus disease 2019
DALY	disability-adjusted life year
FAO	Food and Agriculture Organization of the United Nations
FBDGs	food-based dietary guidelines
FIES	Food Insecurity Experience Scale
GHG	greenhouse gas
HLPE	High Level Panel of Experts on Food Security and Nutrition
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IPCC	Intergovernmental Panel on Climate Change
LCA	life-cycle assessment
LMIC	low- and middle-income country
NDC	nationally determined contribution
SMEs	small and medium-sized enterprises
SPP	sustainable public procurement
TCA	true cost accounting
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations Children's Fund
UNSCN	United Nations System Standing Committee on Nutrition
UPA	urban and peri-urban agriculture
UPF	ultraprocessed foods
USAID	United States Agency for International Development
WFP	World Food Programme
WHO	World Health Organization
WRI	World Resources Institute
WWF	World Wide Fund for Nature/World Wildlife Fund

Key messages

- Access to adequate food is a fundamental human right, but food insecurity and malnutrition remain critical problems around the globe. There is increasing evidence that the triple planetary crisis of climate change, biodiversity loss and pollution is exacerbating the situation, creating a vicious cycle, with the most vulnerable disproportionately affected.

- Diets and food systems are at the heart of the nutrition–environment nexus. The food we eat, how it is produced and its journey from farm to plate determine how food systems affect human and planetary health.

- Food systems are both key drivers and victims of the triple planetary crisis. They account for up to 34 percent of the anthropogenic greenhouse gas (GHG) emissions that cause climate change. Pollution from food systems is behind about 32 percent of terrestrial acidification and 78 percent of aquatic eutrophication. Just 50 crops make up 90 percent of our caloric intake. Experts predict that these impacts will increase dramatically in the coming decades thanks to increased demand for food, especially animal-source foods, if no action is taken.

- Climate change, biodiversity loss and pollution hinder our ability to produce enough nutritious food for the growing global population. Mitigating climate change, protecting biodiversity and ecosystems, and reducing pollution are essential for resilient food systems that can produce nutritious foods.

- Population growth, urbanization, economic growth and the unequal distribution of power in food systems are fuelling a transition to diets high in refined carbohydrates, fat, salt and ultraprocessed foods. These diets tend to have low nutritional quality and high environmental footprints, exacerbating both environmental and nutritional challenges.

- Cities already consume up to 70 percent of the food supply and nearly 80 percent of global energy. Consequently, urban–rural linkages must be strengthened to help achieve sustainable food systems with positive nutrition and environmental outcomes.

- A shift to diets that incorporate more nutritious food and diverse varieties, such as fruits, vegetables, legumes, nuts, seeds, small fish species and other underutilized and indigenous foods with low environmental footprints, could help improve human and planetary health.

- Dietary needs and preferences and environmental impacts are highly diverse and addressing them requires context-specific, equity-sensitive solutions.

- Efforts to address interlinked nutrition and environmental challenges should be backed by poverty reduction, livelihood support, health system strengthening, gender equality and other related assistance.

- There are many policy options to incentivize dietary shifts and support innovative, sustainable practices at every food systems stage to support both nutrition and environmental goals. Policymakers and other food systems actors should work collaboratively to develop a coherent and bold mix of policies adapted to local context. To achieve results, economists, environmentalists, nutritionists and others should work together to tackle these challenges.

- Options include improving existing agricultural production strategies and developing new technologies to reduce negative environmental impacts. It is equally important to promote simple processing techniques and innovate in food processing, storage and transportation. This will help to increase the resource efficiency of these stages and facilitate the shift to circular food systems, thereby reducing food loss and waste, contributing to food security and reducing the land use and GHG emissions associated with food systems.

- Incentives should be provided for the production/consumption of unprocessed or minimally processed nutritious food of diverse varieties. In addition, this should be backed by other incentives to make processed foods more nutritious while moving away from ultraprocessed foods.

- The development and implementation of policies with co-benefits for nutrition and the environment will require collaboration and coordination between different levels of government and different sectors, including ministries focused on agriculture, nutrition, health and other areas. It will also require the involvement of non-governmental stakeholders, including businesses, farmers, informal food actors, civil society, academic institutions, United Nations agencies and funders.

- To develop policies with co-benefits for nutrition and the environment, decision-makers need empirical evidence of the costs and benefits in each area. Innovative methods, such as true cost accounting (TCA) and life-cycle assessment (LCA), have the potential to measure the interlinked nutritional and environmental impacts of food systems, but require further development and standardization. Still, these methods can help decision-makers weigh policy options quantitatively and manage trade-offs to inform evidence-based policy solutions to support healthy people and a healthy planet.

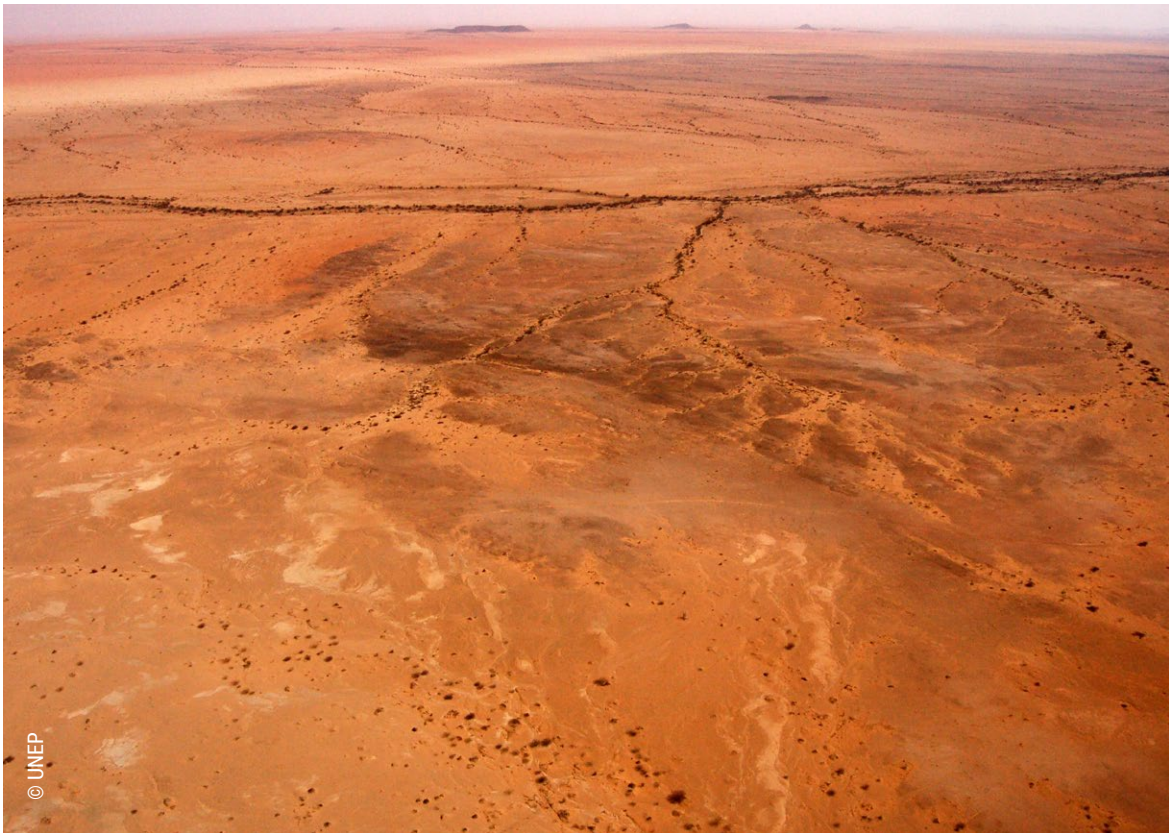
- For sustainable change, policies and actions to improve nutrition should be designed and implemented through an environmental lens. At the same time, such planet-friendly nutrition policies and actions should be included in country plans and efforts to adapt and mitigate climate change and other environmental hazards.

Executive summary

There is growing awareness of the daunting nutritional and environmental challenges the world faces. Though access to adequate food is a fundamental human right, billions of people around the world live with food insecurity, hunger and malnutrition. Meanwhile, the triple planetary crisis of climate change, biodiversity loss and pollution is worsening, threatening both human and planetary health. At the nexus of these challenges is what people eat, how food is produced, how it travels from farm to plate and the underlying imbalances of power in our current food systems.

This paper aims to foster a cross-disciplinary dialogue between those working in nutrition, agriculture, the environment and other related fields to build a common understanding of the links between nutritional and environmental challenges and how to address them. By bringing together all food systems actors in an inclusive collaborative way, we can identify potential synergies, key trade-offs and joint policy options that generate co-benefits for people and the planet.

Food systems are both key contributors to and victims of climate change, biodiversity loss and pollution. What we eat has important effects on nutritional and environmental outcomes, and the accelerating environmental crisis makes it more difficult to produce and consume healthy diets from sustainable food systems.



At the same time, our food systems and the challenges surrounding them continue to shift and trigger societal and dietary transitions. Income and population growth, urbanization and the power of food companies are driving transitions to unsustainable diets high in refined carbohydrates, sodium, fat and ultraprocessed foods. Achieving healthy diets from sustainable food systems will require shifts in what people eat and the food systems underlying our diets. However, food systems and nutritional, environmental and cultural needs vary, so efforts to change food systems and diets must also be tailored to context, geographical location and population.

In this document, we propose policy approaches with the potential to provide co-benefits for nutrition and the environment while transitioning towards healthy diets from sustainable food systems. We focus on approaches at each food systems stage – from agricultural production, food storage, distribution and processing to packaging, retail and marketing, from food environments and consumer behaviour to food loss and waste.

Policy approaches for national or subnational governments that can provide co-benefits for nutrition and the environment include:

- **In production systems:** Developing and promoting new and existing agricultural practices and technologies that reduce negative environmental impacts, with a focus on the production of diverse, nutritious foods; introducing or reintroducing locally appropriate indigenous, neglected and underutilized species; developing and adopting biofortified crops that are resilient to climatic changes; and supporting the development of urban and peri-urban agriculture. Production systems can be diversified by adopting actions for the conservation, sustainable use, management and restoration of biological diversity across agricultural sectors, expanding the limited number of species and crops on which we currently rely.

- **In food storage and distribution:** Incentivizing efficient food distribution with the goal of improving access to sustainable, nutritious foods for all, especially the most vulnerable, while reducing environmental impacts; developing technologies to improve the storage and transportation of nutritious, perishable foods; and supporting the planning and development of efficient urban and peri-urban food systems.

- **In food processing and packaging:** Developing and promoting technologies and processes to improve the quality and efficiency of food processing and supporting companies in producing nutritious processed foods, paying particular attention to small and medium-sized enterprises (SMEs); developing and implementing innovations in food packaging that can extend the shelf life of perishable foods with fewer impacts on pollution and biodiversity loss.

- **In food retail and markets:** Encouraging efficient and effective trade, especially local and regional trade, with a focus on supporting access to sustainable, safe, nutritious food in vulnerable regions as environmental pressures increase; reforming agricultural subsidies so that they support the production of a variety of nutrient-dense foods with lower environmental impacts.

- **In food environments and consumer behaviour:** Creating and adapting food-based dietary guidelines that consider nutrition and environmental sustainability together; regulating food product labelling for both environmental and nutritional attributes; limiting harmful marketing practices, especially those targeted at vulnerable populations; adapting food procurement programmes to support good nutrition and the protection of the environment; promoting transitions to cleaner fuel sources for the preparation and storage of nutritious foods in the household; and creating consumer behavioural change campaigns, including those that aim to curb food waste.

- **In food loss and waste:** Promoting innovative initiatives and partnerships between governments, farmers and businesses to reduce food loss and waste.

- **In food systems research, investment and collaboration:** Generating evidence to weigh nutritional and environmental impacts and solutions for specific contexts, populations and locations; investing in the evaluation of private-sector innovations that have the potential to reduce the environmental and nutritional impacts of foods; developing investment frameworks that help companies assess the environmental and nutritional impact of their practices and decisions; providing guidance and funding for SMEs to innovate at all stages of food systems.

Developing and implementing policies with co-benefits for nutrition and the environment will require collaborative governance. Efforts should be made by legislators and government ministries focused on different areas related to food, as well as non-governmental stakeholders, including United Nations agencies, the private sector, civil society, informal actors, and other development and financial partners. These partners must embrace compromise, weighing the trade-offs between nutrition and the environment and, most importantly, develop packages of policies that can generate synergies. Though multisectoral collaboration is not the norm in many countries, there are useful examples of successful efforts at national and subnational level. This paper explores examples of collaborative policymaking in Ethiopia, India and London.

Decision-makers need evidence to help weigh impacts across dimensions. LCA and TCA are rapidly developing methods of quantifying the impacts of diets and food systems across multiple stages and dimensions, including environmental and nutritional impacts. Although these methodologies are still being developed, standardized and expanded, they have the potential to assess comprehensively the impacts of food systems, both globally and between locations and contexts, foods and food groups, and different production systems and value chains.

Results from these analyses can inform evidence-based policy decisions, helping decision-makers to analyse synergies and trade-offs between impacts on the environment, nutrition and other dimensions when formulating policies on agriculture, climate change, food, nutrition and other related areas. To meet this potential, however, these methods must be further developed and tested to generate and examine evidence from a broader variety of contexts and populations, including different geographical areas, agricultural production systems, food value chains and cultural traditions.

No one strategy will always benefit both nutrition and the environment. Rather, approaches must be adapted to specific contexts, communities and geographical locations, taking into account trade-offs between nutrition, the environment and other dimensions. Identifying and implementing policies that can address the massive nutritional and environmental crises that our planet faces will require a departure from business as usual. Still, through collaboration, compromise and the involvement of diverse stakeholders, we can achieve food systems that support the well-being of people and our planet.

Introduction

Billions of people around the world face food insecurity, hunger and malnutrition. At the same time, the triple planetary crisis of climate change, biodiversity loss and pollution is worsening, challenging both human and planetary health (UNFCCC, 2022). At the nexus of these challenges is what people eat, how food is produced, how it travels from farms to our plates and the imbalances of power in our food systems – from production, processing and distribution to commercialization, access and consumption. Changing how food is consumed and produced has the potential to address both nutritional and environmental challenges.

In this paper, we review and synthesize a decade of literature to ascertain the current state of knowledge about interlinked nutritional and environmental challenges, identify gaps in understanding and propose potential solutions. In part I, we explore current evidence on the nexus between nutrition and the environment, with food systems and diets at its core. We focus specifically on nutrition as both a means to reduce disease risk and improve people's health and as a way to foster cultural and socioeconomic development and personal well-being. On the environmental side, we focus on the interrelated triple planetary crisis of climate change, biodiversity loss and pollution. We examine ways that food systems and diets could be changed in different contexts to lessen their impact on nutrition and the environment.

In part II, we outline policy approaches for reducing the negative environmental and nutritional impacts of diets and food systems, focusing on approaches with the potential to provide co-benefits between these dimensions. We discuss policy options at all food systems stages, as well as policies related to food systems research, innovation and collaboration.

In part III, we discuss the collaborative, cooperative approaches to governance that will be required to develop and implement policies with co-benefits for nutrition and the environment. We explore existing examples of multisectoral governance at the national and subnational level. We also discuss innovative, rapidly developing methodologies – including LCA and TCA – for quantitatively weighing up nutritional and environmental impacts to inform evidence-based policymaking.

The evidence reviewed on nutritional and environmental challenges and solutions concerns all aspects of food systems. As much past research has focused on the impacts of agricultural production, we place extra emphasis on the role of other stages, such as food processing, storage, distribution, marketing, preparation and consumption, as well as food loss and waste. Despite some gaps, the current evidence base is sufficient to call for urgent action across all dimensions of food systems to ensure greater access to and availability of sustainable, nutritious foods, generating co-benefits for people and the planet.

There is no one, single global food system, but rather many food systems that both pose and are influenced by different nutritional and environmental challenges. Food system challenges vary according to geographical location, population and context. Consequently, solutions must be tailored to different populations and groups and refined at various levels. We explore global trends in the interlinked nutritional and environmental impacts of food systems and identify case studies on how these impacts can be addressed in different circumstances.

As our diets and societies continue to change, we face dire challenges in protecting the health and well-being of people and our planet. To successfully address these challenges, it is essential that the communities leading research and policymaking on nutrition, agriculture and the environment understand the challenges faced in each of these areas, the interlinkages between them and the opportunities for successful collaboration.

This discussion paper is intended for policymakers, programme managers, programme designers, implementers and hands-on field teams from national and subnational governments, as well as United Nations entities, civil society and the private sector engaged in nutrition, agriculture, the environment and related fields.

Its objective is to foster cross-disciplinary dialogue between these audiences with a view to building a common understanding of the interlinkages between nutritional and environmental challenges and how to address them. Bringing together experts and practitioners from multiple fields can help to identify potential synergies, key trade-offs and joint policy options that can generate co-benefits for people and the planet.

We aim to lay out evidence and recommendations to facilitate and encourage intersectoral, context-specific understanding and collaboration. By bringing the nutrition and environment communities together and offering tools and insights to mutually reinforce each other's efforts, synergies can be achieved and trade-offs can be identified and managed. This will empower all food systems stakeholders, including practitioners and experts from many backgrounds — including nutrition, agriculture and the environment — to become agents of transformative food systems change.

PART 1 Interlinkages between nutrition and the environment

Challenges and trends in nutrition and diets

Food insecurity, hunger and malnutrition are critical, global problems. What we eat has significant effects on nutritional outcomes. Inability to afford and access sufficient, nutritious food contributes to hunger, food insecurity and malnutrition in all its forms (FAO *et al.*, 2022).

Healthy diets were unaffordable for an estimated 3.1 billion people globally in 2020.[1] In 2021, an estimated 702 million to 828 million people suffered from hunger, while 2.3 billion people faced moderate or severe food insecurity. In 2020, 22 percent of children under the age of five were stunted, 6.7 percent were wasted and 5.7 percent were overweight. In 2019, nearly 30 percent of women aged 15 to 49 years experienced anaemia (FAO, IFAD, UNICEF, WFP and WHO, 2022).

While most people facing hunger, food insecurity and malnutrition live in Africa and Asia, these challenges persist in marginalized populations around the world, and the number of people facing hunger and severe food insecurity has risen sharply since the beginning of the COVID-19 pandemic (FAO, IFAD, UNICEF, WFP and WHO, 2022).

At the same time, transitions to diets high in refined carbohydrates, saturated fat, sodium and ultraprocessed foods are contributing to greater prevalence of diet-related chronic diseases, such as type 2 diabetes, cardiovascular disease, hypertension and some cancers. For instance, high intake of refined sugar is associated with increased risk of type 2 diabetes and death from cardiovascular disease (Willett *et al.,* 2019).

Diets currently contribute to 6 of the top 10 risk factors of disease (Murray *et al.,* 2020). In contrast, consuming more nutrient-dense foods, often displaced by refined carbohydrates and highly processed foods, is associated with a lower risk of diet-related chronic diseases. For example, high intake of non-starchy vegetables is associated with lower risk of type 2 diabetes and high fruit and vegetable consumption is associated with lower risk of some cancers (Willett *et al.,* 2019). Increased consumption of nuts and omega-3 fatty acids, often found in fish, is associated with a lower risk of cardiovascular disease (Willett *et al.*, 2019; UN-Nutrition, 2021).

1 The definition of "healthy diet" and "cost of a healthy diet" here are based on the Cost of a Healthy Diet metric, which estimates the daily per capita cost of purchasing the least expensive locally available foods to meet requirements for energy and food-based dietary guidelines (Herforth *et al.,* 2022).

These dietary factors have a significant impact on overall morbidity and mortality. Based on data from the 2019 *Global Burden of Disease Study*, over half of diet-related deaths and two-thirds of diet-related disability-adjusted life years (DALYs), mostly from cardiovascular disease, can be attributed to high sodium intake and low intake of whole grains and fruits (Afshin *et al.,* 2019). Still, how diet contributes to chronic disease varies in different parts of the world. In sub-Saharan Africa, low fruit intake was the biggest contributor to diet-related deaths and DALYs, while in higher-income areas in the Asia-Pacific region and East Asia, high sodium intake was the biggest contributor (Afshin *et al.,* 2019).

What we do not eat also has key impacts on hunger, food insecurity and malnutrition. Globally, an estimated 14 percent of food produced for human consumption is lost during agricultural production or along the value chain up to and excluding the retail sector (FAO, 2019b), while 17 percent of food is wasted at the retail and consumer levels (UNEP, 2021a). Household food waste is a significant problem in almost every country that has measured it, regardless of country income level (UNEP, 2021a).

Nutrient-dense perishable foods, such as animal-source foods, fruits and vegetables, are particularly vulnerable to food loss along the value chain and food waste at the market and consumer levels (Fabi *et al.,* 2021; Scherhaufer *et al*., 2018). Lost and wasted food is unavailable for human consumption and has a large environmental footprint that could be avoided (Scherhaufer *et al.,* 2018). Thus, reducing food loss and waste is essential to transitioning to healthy diets from sustainable food systems. Reducing food loss and waste has significant potential to alleviate food insecurity and reduce the land use and GHG emissions associated with food systems (Searchinger *et al.,* 2019).

The triple planetary crisis

Our planet is facing a triple planetary crisis of climate change, biodiversity loss and pollution, and food systems are both key contributors to and victims of this environmental calamity. Climate change, primarily caused by human activity, is sparking persistent, long-term changes in the Earth's temperature, precipitation and other climatic conditions (IPCC, 2022a). Human activity in multiple sectors is contributing to the pollution of our planet's air, land, water and ecosystems (Willett *et al.,* 2019). Climate change, pollution and other human-caused environmental pressures, such as habitat loss and invasive species, are triggering extreme declines in biodiversity across species and ecosystems (IPCC, 2022; Owino *et al.*, 2022).

Food systems, as well as the diets that arise from them, are significant contributors to this planetary crisis. All stages of food systems contribute to the triple planetary crisis. And while most research to date on the environmental impacts of food systems has focused on the impacts of agricultural production to the farm gate, there is growing attention on and evidence of the impacts at other stages, such as packaging, processing and distribution (McLaren *et al.,* 2021; Helena *et al.,* 2022; Popkin and Ng, 2022). At the same time, environmental degradation makes it more difficult to produce and consume sufficient, nutritious, safe, sustainable food to feed a growing global population (IPCC, 2022a). Poor, rural populations in the Global South will be most impacted by climate change, but least able to adapt, which will worsen both environmental and nutritional outcomes (Fanzo *et al.,* 2018).

Box 1.
How do different stages of food systems contribute to GHG emissions?

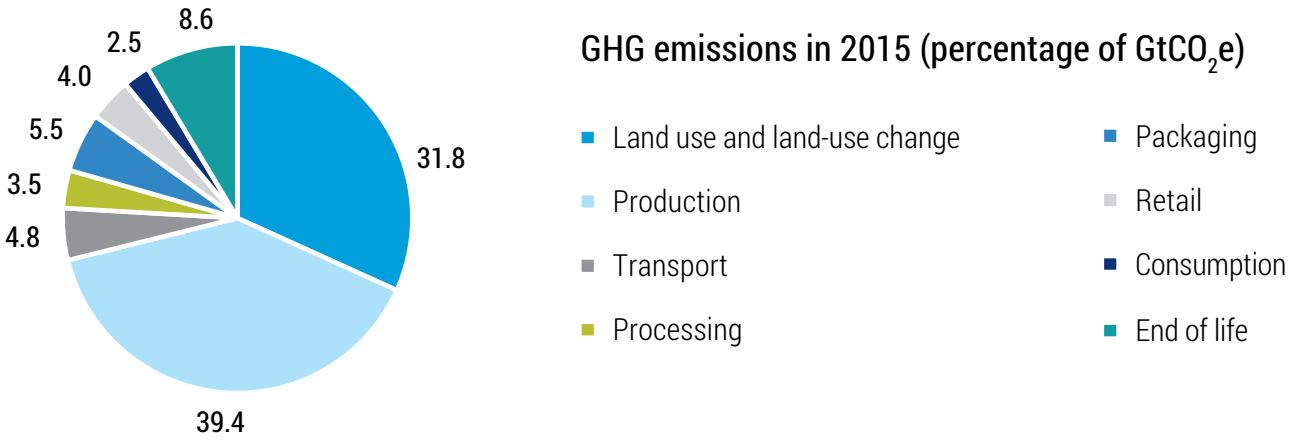
GHGs are emitted through a variety of mechanisms related to food production. Some of the major contributors to GHG emissions include:

- **Carbon dioxide (CO_2):** The deforestation of land for agriculture emits CO_2 into the atmosphere by releasing stored carbon through burning and other processes.
- **Methane (CH_4):** Methane is released through the enteric fermentation that happens when ruminants like cattle and sheep digest food, emitted from manure storage facilities and produced by methane-emitting bacteria in flooded rice paddies.
- **Nitrous oxide (N_2O):** Nitrous oxide is emitted from synthetic fertilizers applied to farmland and pasture and from livestock manure (Lamb *et al.,* 2021).

Other parts of food systems – including processing, packaging, transportation, retail, consumption, waste and fuel – also contribute significantly to GHG emissions:

- The materials needed to package and transport food, such as plastics, pulp, paper, metal and glass, and the processing and packaging of foods contribute to GHG emissions.
- Energy is also required to transport food and produce related inputs and materials. Energy for food distribution – often called "food miles" – contributes about 5 percent of food systems emissions, primarily through CO_2 emissions from fuel combustion.
- Food storage and retail also contribute to GHG emissions. Refrigeration, both in households and food businesses, accounts for about 5 percent of food systems emissions. Hydrofluorocarbons are released from the use and disposal of some common refrigeration technologies and CO_2 is emitted when fossil fuels are burned to produce electricity for refrigeration (Crippa *et al.,* 2021).
- Food that is lost along the value chain or wasted at the retail or consumer levels accounts for an estimated 8 percent to 10 percent of GHG emissions (UNEP, 2021a).

Figure 1.
Food systems-related GHG emissions by stage, 2015



Source: Adapted from Crippa, M., Solazzo, E., Guizzardi, D., Monforti-Ferrario, F., Tubiello, F.N. & Leip, A. 2021. Food systems are responsible for a third of global anthropogenic GHG emissions. *Nature Food*, 2(3): 198–209. https://doi.org/10.1038/s43016-021-00225-9

Food systems account for as much as 34 percent of the anthropogenic GHG emissions that cause climate change. Most food systems-related GHG emissions (71 percent) can be attributed to agricultural production and land-use change, though other parts of the food chain – such as transportation, processing and storage – also play a significant role (Figure 1) (Crippa *et al.,* 2021). If no action is taken, GHG emissions from the food system, water use and pollution will increase dramatically in the coming decades due to greater demand for food, especially demand for animal-source foods (UNSCN, 2020; Springmann *et al.*, 2018a).

Food systems also contribute to the pollution of our land, air and waterways in various ways. For instance, pesticides and fertilizers play important roles in maintaining and increasing agricultural productivity. However, the inefficient and excessive use of pesticides and fertilizers, especially in intensive agricultural production systems, contributes to environmental pollution. Pesticides and pesticide residues contaminate agricultural soils, surface water and groundwater and can be harmful to both human and environmental health. Run-off from excess fertilizer use contaminates drinking water and contributes to aquatic eutrophication (UNEP, 2022).

Indeed, food systems account for about 32 percent of terrestrial acidification and 78 percent of aquatic eutrophication (Poore and Nemecek, 2018). The contamination of soil and waterways jeopardizes human health and nutrition, reduces agricultural productivity and damages key ecosystem services, such as pollinator habitats, that are essential to food production (UNEP, 2022; UNSCN, 2020).

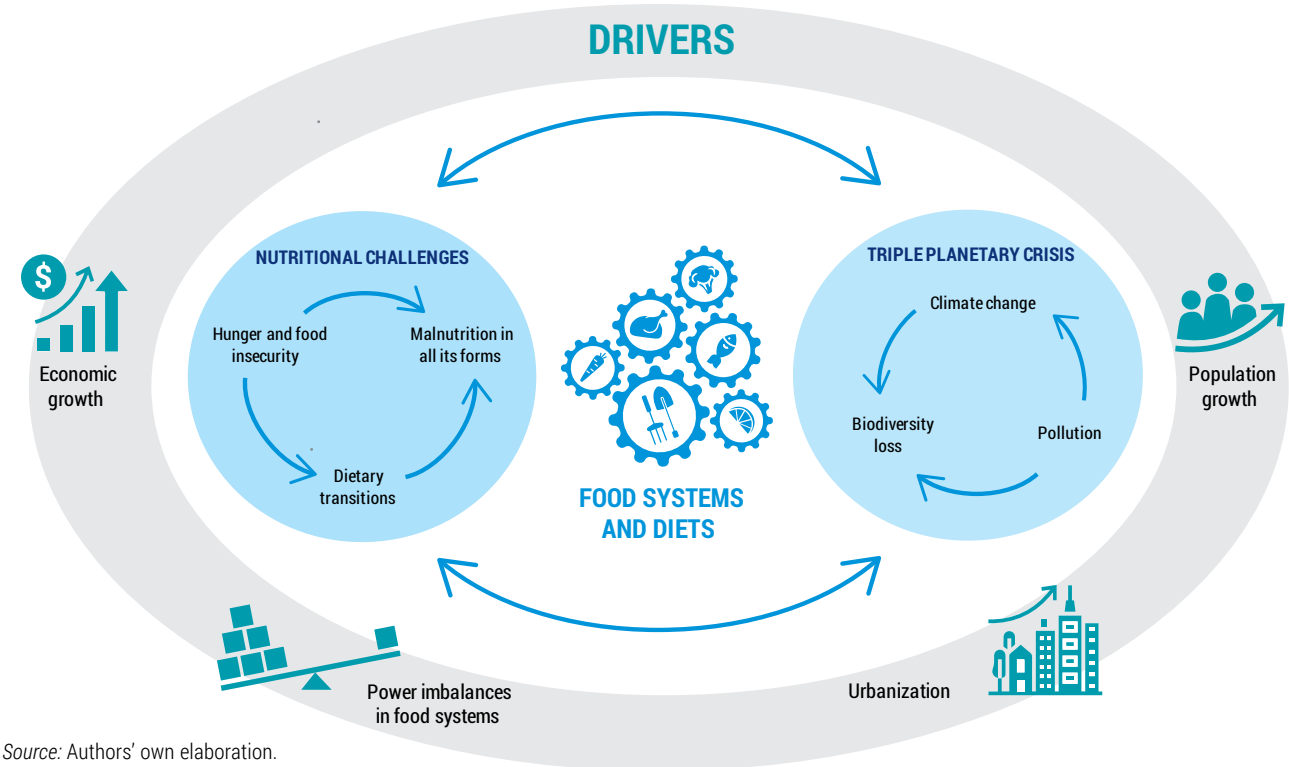
Food systems are also key contributors to biodiversity loss (IPCC, 2022; Benton *et al.*, 2021). Currently, around 25 percent of species globally face extinction (IPBES, 2019). Land-use change, intensive agricultural production and the exploitation of waterways for agriculture are key drivers of species loss (IPBES, 2019; Dudley and Alexander, 2017). In fact, land-use change for agriculture and forestry accounts for almost 60 percent of the loss of terrestrial mean species abundance (Kok *et al.,* 2018).

Protecting biodiversity and protecting and restoring ecosystems is essential for resilient food systems that can produce nutritious foods (IPCC, 2022a). More diverse agroecosystems are more resilient to the climatic shocks that will only worsen as climate change advances (Altieri *et al.,* 2015; Benton *et al.,* 2021). For example, for small island nations, the predicted loss in marine and terrestrial biodiversity as climate change continues poses challenges for traditional agriculture and food systems (IPCC, 2022a).

Interlinkages between nutritional and environmental challenges

Unsustainable diets and food systems foster hunger, food insecurity and malnutrition in all its forms and are significant contributors to the triple planetary crisis. In turn, the triple planetary crisis makes it more difficult for us to sustainably produce and consume enough nutritious, safe, accessible food to support the health and well-being of people around the world now and into the future (Figure 2) (FAO, 2021; Owino *et al.,* 2022; UNSCN, 2017).

Figure 2.
Interlinkages between nutritional challenges, the triple planetary crises and food systems and diets



Source: Authors' own elaboration.

Just as food systems contribute to GHG emissions, climate change affects our ability to produce and consume healthy diets from sustainable food systems. GHG emissions, the increased frequency and intensity of extreme weather events and changes in environmental and economic conditions are reducing agricultural yields, disrupting food value chains and reducing the stability of food prices (Ebi and Loladze, 2019; IPCC, 2019; Wiebe, Robinson and Cattaneo, 2019; Vermeulen *et al.,* 2012; Sims, Gorsevski and Anenberg, 2015; Saxena *et al.*, 2019; West *et al.*, 2006). In addition, greater atmospheric CO_2 concentration is forecast to decrease the protein and micronutrient content of some crops, such as wheat and rice, reducing the global availability of key nutrients, such as protein, iron and zinc (Beach *et al.,* 2019; Ebi and Loladze, 2019; Loladze, 2014).

Although increased CO_2 concentration in the atmosphere due to GHG emissions can increase the photosynthetic rate of some plants, which may increase crop yields, climate change is still expected to have a net adverse impact on crop yields (Ebi and Loladze, 2019; Wiebe, Robinson and Cattaneo, 2019). Taking into account the multiple impacts of increased atmospheric CO_2 concentration – including higher yields, lower nutrient content and related climate impacts – growth in global protein availability is expected to decrease by 19.5 percent, iron by 13.6 percent and zinc by 14.6 percent by 2050 (Beach *et al.*, 2019). The impacts are particularly significant in regions where the availability of these nutrients is already low and deficiencies are more common, such as south Asia and sub-Saharan Africa (Beach *et al.*, 2019).

Furthermore, shifts in climatic conditions can increase food safety concerns. Climate change is projected to increase mycotoxin contamination in plant foods and toxins from algal bloom in marine food systems, fuel the emergence of new fungal plant diseases and intensify the prevalence of bacterial and viral food-borne pathogens, such as *Salmonella* and *Campylobacter*, commonly found in animal foods (Vermeulen, Campbell and Ingram, 2012). The contamination of food and agricultural commodities increases food loss and waste, which contributes to food insecurity (UNEP, 2021a).

Biodiversity loss also affects our ability to produce and consume healthy diets from sustainable food systems. Biodiversity is essential to maintaining the ecosystem services that support resilient productive agricultural systems (Dudley and Alexander, 2017). Furthermore, biodiversity loss influences the diversity of plants and animals cultivated for human consumption.

Food systems increasingly lack diversity in the agricultural commodities and ingredients that comprise commonly consumed foods and food products. While thousands of species have been domesticated for food production, only a handful of plant and animal species make up most of the kilocalories consumed by humans (Owino *et al.,* 2022). In fact, though there are thousands of edible plants, just 50 crop commodities make up 90 percent of caloric intake globally (Khoury *et al.,* 2014).

Ultraprocessed foods, which make up a large portion of caloric intake in higher-income countries such as Australia, France and the United States of America and an increasing portion of intake in lower-income countries, are largely made from ingredients derived from maize, wheat, soy and oilseeds. Biodiversity loss reduces the number of species available for cultivation, while the large demand for foods made from just a few crops reduces overall agrobiodiversity. In addition, harmful practices in the intensive monocultural production of these crops, such as high fertilizer use and deforestation, contribute to biodiversity loss and pollution (Owino *et al.,* 2022).

Furthermore, low diversity in the plant and animal species produced is often linked to a decrease in cultivation and the availability of indigenous and traditional food varieties (IPBES, 2019). Many indigenous and underutilized crops are more nutrient dense than non-indigenous alternatives (Mustafa, Mabhaudhi and Massawe, 2021; Nyadanu and Lowor, 2015). These crops are also an important reservoir for crop varieties and genetic traits that are resilient to climatic changes. As climate change continues to advance, community seed banks that preserve the genetic diversity of indigenous, underutilized and other local crops are an important tool for supporting access to locally adapted crop varieties and the breeding of new climate-resilient varieties (Vernooy *et al.*, 2017).

Polluted land, air and water also hinders our ability to produce healthy diets from sustainable food systems. The contamination of agricultural soils, irrigation with polluted waters and emissions of black carbon can all reduce agricultural productivity and increase food safety risks (Dudley and Alexander, 2017; FAO and IWMI, 2017; Sims, Gorsevski and Anenberg, 2015; FAO, 2018a). Eutrophication from the accumulation of nutrients, often driven by fertilizer run-off from croplands, can reduce species diversity and the abundance of fish available in wild fisheries (FAO and IWMI, 2017). What is more, clean water is essential for preparing safe, nutritious foods in the household. Agricultural run-off can pollute nearby waterways, reducing the availability of clean water, especially for rural households (FAO and IWMI, 2017; UNSCN, 2020).

These interlinkages between environmental and nutritional challenges are driven and exacerbated by ongoing dietary and societal transitions. With increasing national incomes, countries around the world are experiencing continued population growth and urbanization. As these trends continue, population shifts, along with policy and economic incentives, are driving increased consolidation of power in the food industry (UNEP, 2012; IPES FOOD, 2017).

Over the past decades, income and population growth, urbanization and shifts in the private sector have driven gradual dietary transitions from monotonous diets consisting primarily of starchy staple foods towards diets higher in animal-source foods, refined carbohydrates, total fat, salt and processed foods and low in unsaturated fat and fibre (Gouel and Guimbard, 2019; Popkin and Ng, 2022; Smith, Ng and Popkin, 2013).

In their early stages, many dietary transitions are characterized by increased consumption of overall kilocalories and nutrient-dense foods, such as animal-source foods, which can reduce chronic hunger and malnutrition. As transitions continue, the consumption of foods high in refined carbohydrates, sodium and saturated fats, including ultraprocessed foods, increases (Baker *et al.,* 2020b; Popkin and Ng, 2022). Dietary transitions tend to occur first and most rapidly in urban areas, although they are also happening in rural areas (Hawkes, Harris and Gillespie, 2017). Furthermore, cities consume up to 70 percent of the food supply and nearly 80 percent of global energy, making them, including urban–rural linkages, a crucial part of the nutrition–environment equation (FAO, 2019c; Reardon *et al.*, 2014; 2015).

They are typically accompanied by shifts towards more sedentary lifestyles and a higher prevalence of diet-related chronic diseases. Past dietary and nutritional transitions occurred mostly in higher-income countries and are now taking place in low- and middle-income countries (LMICs) (Popkin and Ng, 2022). The consumption of sweet and salty snacks and packaged desserts, for example, has increased significantly in LMICs over the past decade (Popkin and Ng, 2022).

Dietary transitions influence the amount and types of food produced. At the same time, food systems themselves, along with increasing population growth, urbanization and the market share concentration of large food companies, fuel dietary transitions and influence how and to what extent our diets affect the environment. As dietary transitions continue, populations tend to consume more animal-source foods and ultraprocessed foods (UPFs), which tend to have higher environmental impacts than plant-based and less processed foods. In addition, food-related industries are becoming ever more consolidated, with just a few companies controlling the market in many areas. This concentration encourages intensive production practices and exacerbates the environmental impacts of food systems (IPES FOOD, 2017).

In recent years, the COVID-19 pandemic, intensifying large-scale conflicts, such as the ongoing war in Ukraine, and other global crises have only further destabilized food systems. In fragile and conflict-affected settings, environmental crises are exacerbating hunger, food insecurity and malnutrition, especially among vulnerable populations such as women and children, threatening progress on meeting the Sustainable Development Goals by 2030 (Behnassi and El Haiba, 2022; FAO, IFAD, UNICEF, WFP and WHO, 2021). Sustainable food systems have the potential to support healthy diets that foster human health, well-being and happiness. Alas, current food systems face dire challenges in producing nutritious, safe, affordable, accessible food in a sustainable way that supports the health of people and our planet.

Weighing nutrition and environmental trade-offs for healthy diets from sustainable food systems

Achieving healthy diets from sustainable food systems will require shifts in what people eat and the food systems underlying our diets. Numerous expert groups have provided guidance on transitioning to diets that are healthy for both people and planet. The FAO and WHO *Guiding Principles for Sustainable and Healthy Diets* recommend varied diets that include wholegrains, legumes, nuts, fruits and vegetables, along with moderate amounts of eggs, dairy, poultry and fish, and small amounts of red meat (FAO and WHO, 2019). They also emphasize the importance of considering the impacts of foods on GHG emissions, biodiversity and pollution, as well as the social and cultural aspects of diets.

The EAT-Lancet Commission recommends a somewhat more stringent "planetary diet" that targets co-benefits for health and the environment (Willett *et al.*, 2019). The diet suggests doubling our consumption of fruits, vegetables, nuts and legumes and halving our consumption of red meat and sugar (Willett *et al.*, 2019). Other studies at country level also suggest that shifting to diets higher in fruits, vegetables, legumes and nuts and lower in red meat would have both health and environmental benefits (Batis *et al.*, 2021; Humpenöder *et al.,* 2022; Springmann *et al.,* 2018b; Travassos, Antônio da Cunha and Coelho, 2020).

However, none of these guidelines can be applied universally. Food systems and nutritional, environmental and cultural needs and challenges vary by population group and context, so efforts to shift diets must also be tailored to each context based on assessments of both nutrition and environmental issues and opportunities.

Currently, higher-income countries account for more GHG emissions per capita than LMICs (Crippa *et al.*, 2021). In richer countries, the consumption of more than the recommended intake of animal-source foods, refined carbohydrates, saturated fat, sodium and UPFs is contributing to both an increase in the prevalence of diet-related chronic diseases and the high environmental impact of diets. Consequently, shifting to diets lower in such foods could have co-benefits for nutrition and the environment.

Per capita emissions remain low in most lower-income countries, though their populations often experience disproportionate impacts of global climate change (Crippa *et al.*, 2021). Many people in these countries cannot afford or access diets that are sufficient in kilocalories and essential nutrients, and protein and micronutrient deficiencies remain common, especially for demographic groups with high nutritional needs, such as children and women of childbearing age (FAO *et al.*, 2022).

Though they have a higher environmental impact than plant foods, animal-source foods are important sources of protein and micronutrients, particularly where overall dietary diversity is low. Thus, promoting shifts to diets lower in nutrient-rich animal-source foods in these contexts could be detrimental to nutrition and health. The unaffordability of healthy diets, as well as poor infrastructure for the safe storage and transportation of perishable foods, makes increasing the consumption of nutritious foods difficult in some settings.

Furthermore, there are trade-offs between increasing the consumption of nutritious foods and decreasing the environmental impacts of diets in some cases. For example, fruits and vegetables emit fewer GHG emissions than animal-source foods (Springmann *et al.*, 2018a). Also, meat and dairy foods contribute more to biodiversity loss than other foods (Crenna, Sinkko and Sala, 2019). However, the production of fruit and vegetables requires significant water, nitrogen and phosphorous, which can contribute to the pollution of soil and waterways and to ecosystem stresses that can lead to biodiversity loss (Springmann *et al.,* 2018a).

In addition, nutrient-dense foods sometimes have a higher environmental impact than alternatives. For example, beef is very high in key nutrients such as iron, zinc and protein. Beef production also has far higher environmental impacts – such as GHG emissions, terrestrial acidification and eutrophication – than other protein-rich foods (Poore and Nemecek, 2018). Yet, to improve nutrition globally, it is important to increase food consumption and dietary diversity in populations experiencing undernutrition and malnutrition, which may involve promoting the consumption of some nutrient-dense foods with higher environmental impacts.

When promoting nutrient-dense foods, care should be taken in selecting which foods to promote. For instance, it makes sense to promote nutrient-dense foods with high levels of bioavailable iron, such as red meat or small pelagic fish species, where iron deficiency is high in low-resource contexts. This approach is preferred over the consumption of plant-based protein foods such as tofu in such settings, even though the environmental impacts are higher on average (50 kg CO_2e per 100g of beef compared with 2 kg CO_2e per 100g of tofu) (Poore and Nemecek, 2018). Small pelagic fish, which can be consumed whole, have less environmental impact (UN-Nutrition, 2021).

In higher-income countries, where diets are sufficient in kilocalories and nutrients and already exceed recommended intakes of meat, refined carbohydrates and highly processed foods, transitioning to lower intakes of these foods is important to reduce diet-related chronic disease and the environmental impacts of diets. Some international agreements, such as the Paris Agreement, already recognize that different countries have different capacities to address environmental challenges based on their available resources and needs, acknowledging that developed countries should lead the fight against climate change (Jimenez, 2013).

Furthermore, promoting the production and consumption of specific foods and food groups does not always provide co-benefits for nutrition and the environment. Many dietary guidelines call for greater consumption of nuts because high tree-nut consumption is associated with a lower risk of chronic disease, such as cardiovascular disease. However, tree nuts tend to be an expensive source of protein and other essential nutrients. Though they often entail little processing, tree nuts require a significant amount of water to produce and are commonly grown in regions already facing water stress (Vanham, Mekonnen and Hoekstra, 2020; Willett *et al.*, 2019). Increased nut consumption can still be part of a healthy diet from a sustainable food system, though this recommendation is most appropriate in regions with higher water availability and low protein availability than in regions where nut production requires already strained water resources.

The promotion of aquatic foods deserves special attention amid a need to diversify diets to protect planetary and human health. Highly nutritious aquatic foods, especially lower-tropic species, have huge under-used potential that can be explored (UN-Nutrition, 2021). Recommendations must consider, however, the variability in nutritional and environmental impacts within food groups, as well as the cultural appropriateness of specific foods and food groups. For instance, many dietary guidelines also promote the consumption of fish and shellfish because they are good sources of bioavailable protein, polyunsaturated fatty acids and essential micronutrients. However, the environmental impacts of aquatic food production vary widely between geographic locations, species and production systems.

For instance, the production or catch of some aquatic foods, such as prawns, is associated with similar GHG emissions to terrestrial ruminants. In contrast, other aquatic foods, such as wild-caught small pelagic fish, have a comparably low environmental impact (Koehn *et al.,* 2022). These fish – for example, sardines, anchovies and herring – also tend to be more nutritious and less expensive than larger fish and shellfish and can be eaten whole, providing a good source of calcium in addition to other nutrients (FAO, 2022a). Thus, shifts towards healthy diets from sustainable food systems can include greater consumption of small fish in contexts where they are available and culturally appropriate.

The increased consumption of small fish species is just one example that could promote mutually reinforcing nutrition and environmental goals. Better harnessing the vast diversity of aquatic foods, including the promotion of underutilized aquatic foods (such as jellyfish, sea cucumbers and mussels) and aquatic plants, alongside the production of innovative aquatic food products is also crucial in the shift to sustainable food systems. Furthermore, these strategies can be complemented with other measures to promote sustainable production methods on the supply side (for example, polyculture, small-scale fisheries) and other triggers to shift consumer behaviour, such as encouraging people to opt for the "catch of the day" and by-catch on the demand side (UN-Nutrition, 2021).

As highlighted, nutrition and the environment are inextricably linked through diet. The 2019 EAT-Lancet Commission report asserted that "food can be both a lever to optimize human health and environmental sustainability and a threat to people and the planet" (Willett *et al.,* 2019). We face daunting environmental and nutritional challenges linked to our diets and food systems, but there are several strategies that may help us shift to healthy diets from sustainable food systems while progressing towards nutritional and environmental goals. We can attempt to change what people eat, moving to diets that are more nutritious and environmentally friendly. Also, we can change how food is produced and gets to consumers, by transitioning to sustainable and diverse food systems with lower environmental impact. While there are clearly strategies that can be adopted to pursue win-wins for nutrition and the environment, the two do not always align. This underscores the importance of weighing nutrition and environmental trade-offs in the pursuit of healthy diets from sustainable food systems.

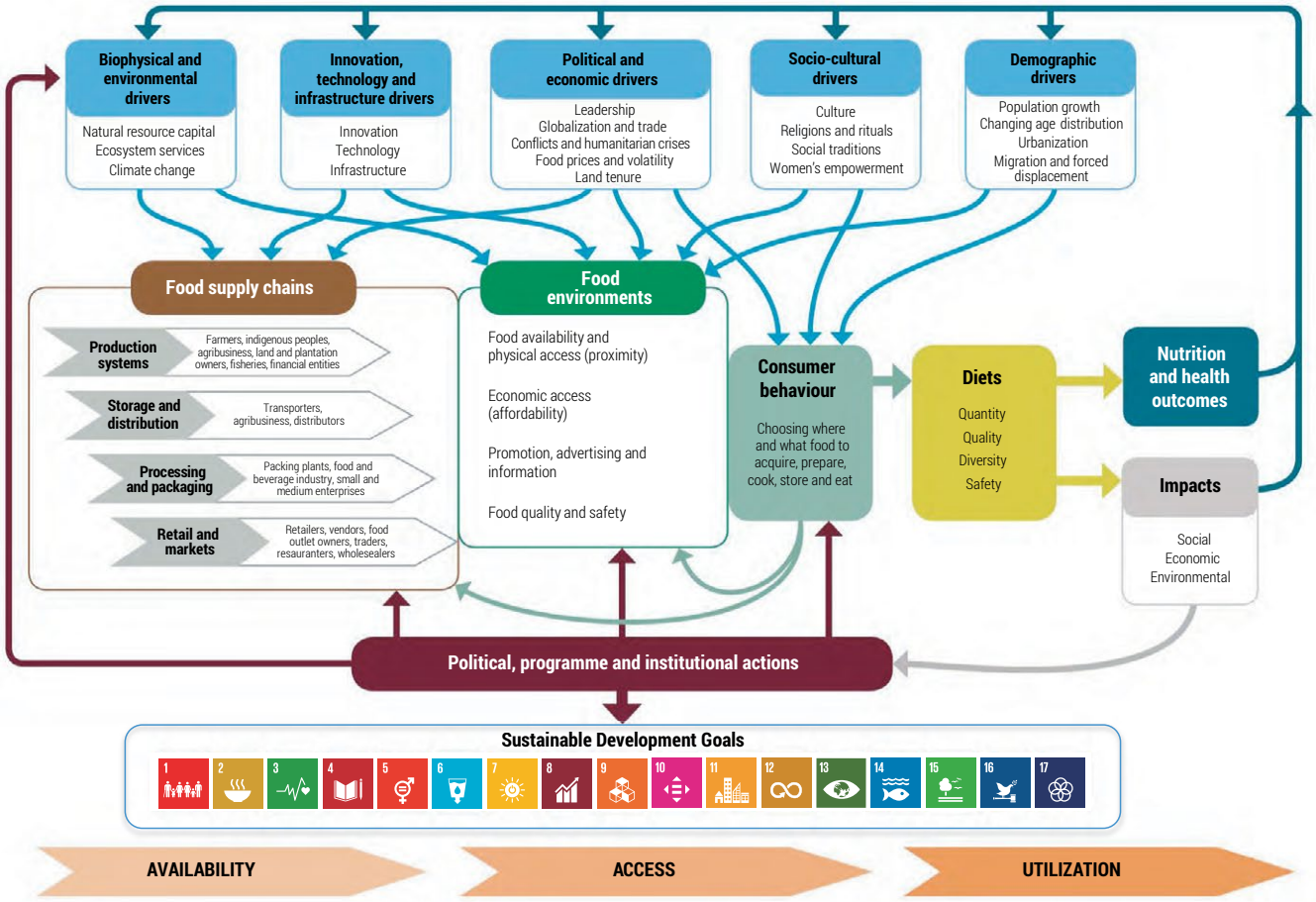
PART 2

Policy actions for promoting positive nutritional and environmental interlinkages towards healthy diets from sustainable food systems

In the following sections, we identify opportunities to develop or adapt policies for food systems transformation that can improve both nutritional and environmental outcomes. We suggest policy approaches at all food systems stages, from food production, processing, distribution, storage, marketing, the food environment and consumer behaviour to food loss and waste. The listed approaches are drawn from several literature reviews, and evidence shows that they have proven effective in several contexts.

We organize these recommendations according to the conceptual framework developed by the Committee on World Food Security's High Level Panel of Experts on Food Security and Nutrition (CFS HLPE) and further developed in the multilaterally negotiated CFS Voluntary Guidelines for Food Systems and Nutrition, adopted in February 2021 (Figure 3) (CFS HLPE, 2017; CFS, 2021). These policy recommendations do not encompass all strategies for food systems transformation. Rather, we focus on the ones with opportunities to provide co-benefits for nutrition and the environment.

Figure 3.
Conceptual framework of food systems for diets and nutrition developed by the Committee on World Food Security High Level Panel of Experts



Source:
Committee on World Food Security High Level Panel of Experts on Food Security and Nutrition. 2017. *Nutrition and food systems: A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security.* Rome.
https://www.fao.org/policy-support/tools-and-publications/resources-details/en/c/1155796/.

These approaches can be complex and will require a diverse set of strategies to bring about change in different parts of the world. No one strategy will always provide co-benefits for nutrition and the environment in every context. Rather, each strategy must be adapted to specific contexts, communities and geographical locations. While seeking to maximize synergies, we must always assess and consider trade-offs between nutrition, the environment and other dimensions. The following chapter discusses tools for evaluating potential trade-offs.

Policy recommendations: Production systems

- Support the development and adoption of **new and improved environmentally friendly agricultural technologies.** For instance, governments and researchers can invest in breeding climate-resilient, high-nutrient crops and animal varieties and in developing improved irrigation technologies that save water.

  Collaboration between governments, researchers and food companies is essential in this regard, as private companies invest significantly in agricultural research and development. Globally, private agricultural research and development is increasing faster than public spending, reaching USD 15.6 billion in 2014 (Fuglie, 2016). Most agricultural research and development occur in higher-income countries, where private spending exceeds public spending (Fuglie, 2016). Thus, funding from governments and development partners is needed to support context-specific agricultural research and development in lower-income countries.

- Governments can also promote the diversification of production systems and the wider uptake of **existing sustainable agricultural practices and technologies** to produce nutrient-rich foods with lower environmental impact, particularly traditional or indigenous practices. This could include incentives to implement environmentally friendly management practices, such as integrated pest management strategies; support for a transition to animal species that yield nutrient-rich food products with lower environmental impact, such as poultry and small fish; and gender-sensitive knowledge-sharing between farmers on how to implement environmentally friendly practices in each area. Still, shifting to new agricultural practices, such as different crops, animals or management strategies, often requires upfront monetary investment and capacity development. Especially in low-resource countries or regions, or those with weak agricultural extension systems, farmers need both technical and financial support to change their production practices.

  United Nations agencies can provide guidance for national and subnational governments to support smallholder farmers in producing diverse foods through environmentally friendly agricultural practices (UNSCN, 2017). Where possible, national and subnational governments can also support these transitions by providing access to agricultural subsidies, credit and extension services.

- Reintroduce **locally appropriate indigenous, neglected and underutilized species** to help to protect and enhance agrobiodiversity. These species often have a high nutrient content compared with other crops and animals (Hunter *et al.,* 2019; Padulosi, Thompson and Rudebjer, 2013).

- Develop and encourage the adoption of **climate-resilient, biofortified crops** that are richer in essential micronutrients – such as vitamin A, iron and zinc – than traditional varieties and adaptable to changing climatic conditions. These crops can provide higher nutritional value with similar environmental impact (Bouis and Saltzman, 2017; Kimani and Warsame, 2019).

- Develop a portfolio of **urban and peri-urban agriculture (UPA) policies**, integrated into a larger regional agricultural system and designed to support poor communities. Care should be taken to ensure that these policies are gender-sensitive and empower women, who play important roles in agriculture and nutrition. While there are trade-offs, UPA can reduce poverty and inequity, improve food security and nutrition, and offer several environmental benefits. For instance, it can provide diversified nutrient-dense food to urban and peri-urban consumers, while also lowering the distance travelled and encouraging resource circularity, such as recycling nutrients from food waste and wastewater treatment to farms (International Resource Panel, 2021).

Policy recommendations: Food storage and distribution

- Incentivize the **efficient distribution of food.** The energy used to transport food between producers and consumers – often called "food miles" – accounts for about 5 percent of food-related GHG emissions. Emissions from transportation are higher for perishable food products, such as fruits, vegetables and animal-source foods, yet safe transport of these foods is essential to support healthy diets.

  Most transport emissions come from local and regional transport on roads and railways rather than international transport by ship or air (Crippa *et al.,* 2021). Thus, improvements in the efficiency of local transportation networks, including those connecting rural and urban areas, as well as urban and peri-urban food systems, could reduce transport-related emissions. Eventually, the improvement of local trade may also reduce food miles, as people can rely more on locally produced foods.

- Develop low-cost technologies to improve the **efficiency of food storage and transportation**, especially for nutrient-dense foods. For example, refrigeration contributes about five percent of food systems-related emissions (Crippa *et al.*, 2021). This "cold chain" is essential to reducing food loss and waste by maintaining safe conditions while food is stored and distributed and is particularly important for nutritious, perishable foods, such as fruits, vegetables and animal-source foods.

  Currently, there are far fewer refrigerators per capita in lower-income countries (Crippa *et al.,* 2021). However, greater refrigeration through efficient cold chains is essential to increasing access to safe, nutritious foods, especially in areas where hunger, food insecurity and micronutrient deficiencies are prevalent. Thus, innovations in environmentally friendly and low-cost refrigeration technologies, such as energy-efficient appliances, could have both environmental and nutritional benefits.

- Support the planning and implementation of **efficient urban and peri-urban food systems**, which can improve access to nutritious foods for people who live in and near cities. These systems can also alleviate environmental degradation by reducing fuel use for food distribution, limiting urban sprawl, which contributes to GHG emissions and biodiversity loss, and reducing food waste by creating circular systems where waste is cycled back into food production systems (International Resource Panel, 2021). The characteristics of cities and peri-urban areas are highly variable, so subnational governments should support the planning of context-specific urban food systems.

Policy recommendations: Food processing and packaging

- Develop and promote existing technologies and processes that can improve the **efficiency of food processing**, especially for nutrient-dense foods with lower environmental impacts. Simple, beneficial food processing techniques, such as canning, drying and fermentation, can maintain and even improve the nutritional attributes of foods while improving shelf stability, reducing food safety risks and reducing the burden of food preparation. Support for small-scale food processing can provide economic opportunities in both rural and urban areas and accessibility in regions with inefficient road networks (USAID Advancing Nutrition, 2022).

  For example, a shift to the consumption of low-trophic aquatic species, such as bivalve molluscs, shellfish and seaweed, can provide access to key nutrients with less ecosystem disruption. However, these foods often have a limited shelf life and poor palatability. Low-trophic aquatic foods can be processed into food products such as powders, seasonings and snacks in ways that prolong shelf life and improve palatability without reducing their nutritional value (UN-Nutrition, 2021).

  In African countries, many processed foods are produced by SMEs, providing employment opportunities, especially for women (Reardon *et al.*, 2021). Governments, United Nations agencies and investors can incentivize and support SMEs in developing sustainable practices for producing nutritious processed foods.

- Develop and implement **innovations in food packaging technology**. Food packaging can play an important role in reducing food waste by preserving food quality and safety while food products are stored, distributed and marketed. This is particularly important for perishable foods, such as fruits, vegetables and animal-source foods.

  However, food packaging can also have negative impacts on human health and the environment, such as chemicals leaching from plastic packaging into food before consumption and into soil and water in waste facilities. Alternative food packaging materials, such as biosourced plastics and biopolymers, carry out similar functions and have lower health and environmental impacts (Sid *et al.,* 2021).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Policy recommendations: Food trade and markets

- Encourage **efficient and effective trade**, including local and regional trade, noting that the greatest GHG reductions can be made here. Increased climate-related shocks and burdens will hinder agricultural production and food value chains in some regions. As these burdens increase, food imports will be increasingly important to support a resilient food supply in LMICs (IFPRI, 2022).

  National governments and United Nations agencies can collaborate to implement efficient, transparent and fair-trade policies that facilitate the import of affordable, safe, nutritious foods from sustainable food systems for vulnerable populations. For example, low-income island nations can benefit from the support of both their local food systems and the availability of nutritious food through trade.

  In Pacific Island Countries and Territories, 80 percent of people rely on gardens or smallholder farms for at least some of their diets (Georgeou *et al.,* 2022). The consumption of locally caught fish is also a cornerstone of diets in these countries, but population growth and urbanization on the islands is challenging the capacity of coastal fisheries to support the populations' nutritional needs (Charlton *et al.,* 2016). Food imports are increasing, yet many imported foods are less nutritious (Charlton *et al.,* 2016; Georgeou *et al.,* 2022).

  To ensure food and nutrition security in the coming decades as the triple planetary crisis worsens, these nations will require support to strengthen their food production and distribution systems, especially in terms of diversifying agricultural production and maintaining local fisheries (Charlton *et al.,* 2016; Georgeou *et al.,* 2022). Incentives and support for the trade of more nutritious foods will also underpin food security and encourage a shift to healthy diets from sustainable food systems.

- Reform **agricultural subsidies** to support the production of nutrient-dense foods with low environmental impacts, such as fruits, vegetables, legumes, nuts and seeds. Globally, current agricultural subsidies largely distort prices and support less nutritious foods with high environmental impacts (FAO, UNDP and UNEP, 2021). Restructuring agricultural subsidies worldwide is forecast to increase the consumption of these nutritious foods and decrease associated GHG emissions (Springmann and Freund, 2022). When changing subsidies, it is important to consider potential impacts on livelihoods (Glopan, 2022).

Policy recommendations: Food environments and consumer behaviour

- Support the development of **food-based dietary guidelines** (FBDGs) that include both nutritional goals and environmental sustainability. At least 90 countries have FBDGs, yet only seven African countries do, and few countries have considered environmental sustainability in their guidelines (IFPRI, 2022; Swinburn *et al.,* 2019). Some countries, such as Brazil, Germany, Qatar and Sweden, have included environmental sustainability in their FBDGs. In these countries, key recommendations include reducing red and processed meat consumption; increasing the consumption of plant-based foods, such as fruits, vegetables, nuts, seeds and legumes; increasing the consumption of sustainable seafood; reducing the consumption of UPFs; and reducing food waste (Springmann *et al.,* 2020; UNSCN, 2017).

However, this approach has not been widely adopted and has been met with resistance in some countries, where certain policymakers, lobbyists and other stakeholders have resisted changes to nutrition policies that consider environmental impacts (IFPRI, 2022; Springmann *et al.,* 2020). FBDGs serve as a basis for both nutrition education and the implementation of other food policies and must be adapted to the food availability and nutritional needs of specific countries and populations. Collaboration between United Nations agencies, national governments and in-country research institutes is essential to creating FBDGs that are practical and tailored to context and culture.

- **Promote regulations on food product labelling**, such as nutrition fact panels or front-of-pack labelling, that indicate the nutritional content or health impacts of food products. Many food companies also use labelling to flag the environmental or social attributes of their products, and research suggests that labelling can influence consumer behaviour when it comes to nutrient intake and environmental and social responsibility (Shangguan *et al.*, 2019; Tobi *et al.*, 2019). National and subnational governments should regulate food labelling related to both nutrition and the environment to ensure accuracy and transparency of labelling and make it easier for businesses to reflect multiple dimensions of sustainability on product labels.

- **Limit harmful marketing practices** with regard to unhealthy foods and extend restrictions to consider the environmental impacts of those foods. Some national governments limit the marketing of unhealthy foods, especially to children (Taillie *et al.,* 2019). For example, the Chilean government restricts the advertising of foods high in sugar, salt, saturated fat and kilocalories in television programmes targeted at children (Correa *et al.,* 2020). National and subnational policies on food marketing can be updated to consider the nutritiousness and environmental sustainability of food products.

- **Adapt food procurement programmes**, such as **school meal programmes**, to provide nutritious foods with a low environmental impact. Food procurement programmes are included in national or subnational food policies and can provide consistent, reliable food sources for vulnerable groups through schools, hospitals and other venues.

Box 2.
Adapting guidelines for school meals to the local context

Guidelines on the content and procurement of school meals must be tailored to local settings. For example, research suggests that in the United States of America, school meal procurement guidelines could limit environmental impacts by increasing the provision of wholegrains and replacing red meat with more environmentally friendly animal and plant protein foods (Stern *et al.*, 2022). In lower-income contexts, where school meal programmes are more often linked to local smallholder producers, they can be used to incentivize environmentally friendly practices, such as the use of organic standards (Bisht, Rana and Ahlawat, 2020).

School meal programmes have the potential to influence children's diets, food preferences and nutritional knowledge. In addition, school meal programmes procure a large amount of food, so procurement guidelines can influence the environmental impacts of local and regional food systems (Molinas and de la Mothe, 2010).

National governments can use sustainable public procurement (SPP) criteria to guide the procurement of goods and services for public programmes that promote environmental, social and economic sustainability. In 2021, there were an estimated 33 countries implementing some level of SPP, mostly in Europe (UNEP, 2021b).

- Promote a **transition to cleaner fuel sources** for household and retail food storage and preparation, including support for the use of cleaner household cooking fuels. Many nutrient-dense, unprocessed foods require significant preparation in the household and the use of unclean cooking fuels, such as charcoal and biomass, has been linked to adverse environmental impacts and poor health and nutritional outcomes, especially for children (Amadu *et al.,* 2021).

Policy recommendations: Food loss and waste

- National and subnational governments, farmers and food businesses can work together to identify **context-specific approaches to reducing food loss** during food production, storage, distribution and marketing. Food loss occurs at many points along agricultural value chains and opportunities to reduce food loss are specific to context, production system and crop or food product (Searchinger *et al.*, 2019; World Bank, 2020).

- National and subnational governments can collaborate with food retailers, manufacturers, food-service venues, schools and NGOs to develop and amplify **communication and behavioural change campaigns to reduce food waste** at the consumer level. For example, in the United Kingdom of Great Britain and Northern Ireland, a campaign that combined revised food date-label regulations with food storage and preservation advice, offered through supermarket chains, lowered household food waste by 21 percent between 2007 and 2012 (Searchinger *et al.*, 2019).

Policy recommendations: Food systems research, investments and collaboration

- United Nations agencies, governments, researchers and funders should collaborate to generate and collate **context-specific evidence**, especially in lower-income countries and among vulnerable populations, to inform decision-making and identify solutions with co-benefits for nutrition and the environment (UNSCN, 2017). Much of the evidence base on nutritional and environmental challenges, as well as interlinkages between these areas, comes from higher-income countries. However, food systems, diets and nutrition concerns differ from country to country and region to region, so the extrapolation of results is not always advisable. Methods such as TCA and LCA can be used to generate evidence on and compare nutritional and environmental challenges at different stages of food systems and for different contexts, populations and locations.

- **Research and development** in the private and public sectors are producing numerous innovations to support the transition to healthy diets from sustainable food systems. For example, private food businesses have developed and marketed plant-based and lab-grown meat alternatives aimed at replacing commonly consumed meats with products that have similar nutritional profiles and lower environmental impacts.

  United Nations agencies, researchers and funding agencies can **fund and implement rigorous evaluations** of the safety, nutritional content and environmental sustainability of these private-sector innovations, especially in low-resource contexts and among vulnerable populations. LCAs comparing the environmental and nutritional value of plant-based meat alternatives with traditional animal-source food production can inform national policies and regulations related to alternative meats (Detzel *et al.,* 2021; Saget *et al.*, 2021).

- Governments, research institutes and United Nations agencies can support the development and refinement of **metrics and frameworks for investors** that link financial, environmental, nutritional and societal impacts to allow companies to prioritize business practices that provide benefits for the environment and nutrition, as well as other priorities (O'Hearn *et al.,* 2022). These metrics can be a way for companies to follow the precautionary principle by demonstrating that, along with ensuring the financial viability of their owners and stakeholders, their practices do not cause harm to the health of people and the environment.

- Funders, private companies and United Nations agencies can provide **guidance and funding for SMEs** to produce nutritious food products through environmentally conscious practices at all stages of food value chains. For instance, the United Nations Environment Programme (UNEP) supports SMEs in developing sustainable business approaches through its eco-innovation model. Its work with the Rasoda Dairy in the Democratic Socialist Republic of Sri Lanka to minimize production costs in dairy facilities while improving both farm-level productivity and milk quality is one such example (UNEP, 2014).

- National governments can include **goals related to nutrition and food systems in their nationally determined contributions** (NDCs) to the Paris Agreement on climate change. Some countries already include references to food systems emissions and the benefits for nutrition and health outcomes. For example, Kenya's NDC includes a focus on climate-smart agricultural production practices (WWF, 2020). NDCs should explicitly consider co-benefits for nutrition and the environment when outlining food systems goals. For example, promoting diversified crop systems can reduce the impacts of monocultural production on GHG emissions, biodiversity loss and pollution, and can promote the availability and consumption of more diverse diets (WWF, 2020).

Box 3.
Tailoring national and subnational food policies to specific contexts and populations

The policy directions outlined in this section have the potential to support transitions to healthy diets from sustainable food systems in many countries and regions. Still, policy approaches must be tailored to specific contexts and populations and adapted for implementation at different levels of government.

Example: *Promoting context-specific shifts to healthy diets from sustainable food systems*

Dietary guidelines and other food policies should incorporate both nutrition and environmental goals to encourage shifts to healthy diets from sustainable food systems. However, dietary recommendations should differ between and within countries based on the dietary needs of the population, location-specific environmental pressures and degradation, local food availability, and food-related cultural and religious needs and preferences. For example, in many higher-income countries, where deficiencies in protein and micronutrients are less common, recommendations may include the reduced consumption of animal-source foods, such as red and processed meats. In contexts where the consumption of animal-source foods is already low and nutrient deficiencies are common, recommendations can include an increase in the consumption of nutrient-rich foods from sustainable sources, which can include eggs, aquatic foods, dairy or meat (FAO *et al.,* 2022).

Example: *Considering trade-offs in improving infrastructure for the transportation of food and food products*

Efficient transportation networks and cold chains are essential for transporting food between farms, processing facilities and retail outlets. However, both vehicle use and refrigeration require energy use and contribute to GHG emissions (Crippa *et al.,* 2021). In regions where road networks are inadequate or in poor condition, improving road infrastructure can reduce the amount of energy needed to transport food and improve access to nutritious foods in both inaccessible rural areas and urban areas that are far from agricultural production. Efficient transportation networks and reliable cold chains are essential to increasing access to and the safety of perishable foods, such as fruits, vegetables and animal-source foods, yet increasing the use of refrigeration contributes to increased GHG emissions (Heard and Miller, 2019). Innovations that reduce energy usage in refrigeration technology may help to alleviate this trade-off. In addition, simple processing techniques, such as drying and fermenting, can also be adopted to preserve foods without necessarily requiring refrigeration.

Example: *Developing climate-adapted and nutrient-rich crop varieties for different areas and populations*

One strategy for promoting healthy diets and adapting food systems to climate change is encouraging farmers to produce nutrient-rich crops that are resilient to changes in climatic conditions. In some contexts, this approach may require breeding nutritious crops that are resistant to climatic extremes, such as drought, flooding and pest pressures. In other contexts, commercial or indigenous crop varieties already exist that are adapted to local climatic conditions. Preserving indigenous varieties is essential to maintaining a reservoir of diverse, locally adapted foods for cultivation and consumption (Vernooy *et al.,* 2017). To ensure uptake, the development and marketing of climate-adapted, nutrient-rich crop varieties must be tailored to specific geographic areas, contexts and populations and take into account the local agronomic conditions, the nutrition and dietary needs of the population, as well as the preferences of local farmers and consumers. Intersectoral collaboration is crucial for developing and testing indigenous and new crop varieties that can provide environmental, nutritional and economic benefits, including to address the needs of vulnerable populations.

PART 3 Collaborative, evidence-based governance to develop and implement policies with co-benefits for nutrition and the environment

Many of the policy recommendations outlined in part 2 have been promoted and tested by national and subnational governments and United Nations agencies in the past. That said, they are often difficult to codify (in other words, translate government decisions into law) and implement. Importantly, policies with co-benefits for nutrition and the environment are inherently cross-sectoral. Developing and implementing such policies requires collaboration, cooperation and compromise between many food systems stakeholders, including the ones traditionally excluded from the decision-making table.

Traditional policymaking processes are often siloed into government agencies and interest groups focused on specific priorities. However, policymaking efforts aimed at providing co-benefits for nutrition and the environment must engage legislators and government ministries or agencies with different expertise and priorities, such as those focused on agriculture, fisheries, health and the environment (OECD, 2021). National and subnational governments often lead intersectoral collaboration although participation, support and compromise from other stakeholders is crucial.

Successful policy development and implementation requires the engagement of stakeholders outside of government, including United Nations agencies, private-sector entities, civil society, informal food systems actors, technical and financial partners, and NGOs (Alliance of Bioversity/CIAT, UNEP and WWF, 2021). For example, United Nations agencies provide leadership in bringing together stakeholders focused on nutrition, agriculture and the environment through coordinating mechanisms, country teams and international policy discussion, such as the United Nations Climate Conference and United Nations Food Systems Summit.

Decision-makers developing multisectoral policies should focus on policy coherence, whereby policies centred on one priority area do not harm progress in other areas (OECD, 2021). In some contexts, there are often trade-offs to be made between nutritional and environmental goals. In these cases, it is necessary to build packages of policy measures using multiple policy instruments to achieve synergies across various priority areas and reach compromise between stakeholders (OECD, 2021).

Lastly, collaborative policymaking processes aimed at achieving co-benefits for nutrition and the environment must strive to amplify the voices of traditionally marginalized populations, such as youth, women and indigenous people, to ensure that the needs of the most vulnerable populations and groups are met. Amplifying these underrepresented voices often requires collaborative effort and resources, particularly to fund their participation and capacity building.

Young people are current and future food systems leaders. They bring innovative ideas to food systems discussions and have an important stake in building sustainable food systems for the coming decades. The 2021 United Nations Food Systems Summit provided a useful framework for engaging youth in high-level discussions, incorporating young people in leadership and decision-making positions through the summit process (United Nations, 2021).

Considering gender roles in each context is also essential to developing and implementing successful food systems policies (WLE, 2018). However, women are underrepresented in decision-making positions in many national and subnational governments and private entities. NGOs, researchers and United Nations agencies can collaborate to provide guidance to governments and companies on gender-sensitive policymaking.

Box 4.
Examples of collaborative governance to develop policies with co-benefits for nutrition and the environment

Multisectoral collaboration for policymaking across nutrition and the environment is not the norm in many countries. While incorporating nutritional and environmental goals into policymaking can be challenging, there are useful examples of efforts at national and subnational level in several countries at varying levels of national income. Here, we outline policymaking efforts that bring together stakeholders from multiple areas of government, as well as non-governmental actors, and include specific objectives on nutrition, the environment and other food systems dimensions.

Eat Right India

Eat Right India is a multisectoral initiative, founded in 2018, focused on sustainable food systems transformation in the Republic of India. Though it is hosted by the Food Safety and Standards Authority of India, it brings together collaborators from government agencies focused on agriculture, nutrition, the environment, education and urban planning, and engages food businesses, farmers, consumer associations, academic institutions and development partners at national and subnational level. Through dialogue, collaboration and coordination between stakeholders, Eat Right India provides inputs for policy initiatives in multiple areas, focusing on promoting safe, healthy and environmentally sustainable foods (Alliance of Bioversity/CIAT, UNEP and WWF, 2021).

London Food Board

The London Food Board, created in 2004, is a city-level collaboration focused on improving food security, nutrition and health, reducing poverty and promoting local food production and urban agriculture. Members include representatives from government, the private sector, NGOs, farmer organizations, academic institutions and civil society, and represent interests associated with agriculture, nutrition, health, the environment, trade, education and social development. Through collaborative communication and consensus-building, the London Food Board implements the London Food Strategy, which focuses on healthy food, household food insecurity, environmental sustainability, SPP, and urban farming and gardening (Alliance of Bioversity/CIAT, UNEP and WWF, 2021).

Multisectoral nutrition governance in Ethiopia

The Ethiopian government and partners have made significant investments in multisectoral policymaking. The National Nutrition Program (NNP) II, from 2015 to 2030, involves multiple federal ministries – including those focused on health, agriculture, water, energy, labour, education, and women, youth and children – as well as non-governmental partners, such as United Nations agencies, the World Bank and other organizations. The strategic objectives of the NNP II target nutrition, with a focus on food access and the health and nutritional status of vulnerable populations; the environment, with a focus on food loss and climate-smart practices; and economic and social outcomes, such as farmer income, gender equity and women's empowerment (Bach *et al.,* 2020).

These efforts at multisectoral collaboration and policymaking often face many challenges, including inadequate funding, a lack of political support, a lack of evidence and expertise to guide context-specific decisions, and limitations on the time that decision-makers can allocate to collaborative approaches (Alliance of Bioversity/CIAT, UNEP and WWF, 2021; Bach *et al.,* 2020). In addition, identifying effective leadership, managing power imbalances and achieving consensus can be difficult. Still, these examples provide a starting point for collaborative policymaking processes incorporating both nutritional and environmental goals.

Approaches to assessing and quantifying interlinked nutritional and environmental impacts

To develop policies with co-benefits for nutrition and the environment, decision-makers need evidence of the magnitude of nutritional and environmental challenges, as well as potential synergies and trade-offs between the two aspects in each context (OECD, 2021). There are many existing and commonly used methods for assessing the environmental and nutritional impacts of diets and food systems. However, fewer approaches exist to compare impacts across multiple dimensions and quantify synergies and trade-offs.

LCA and TCA are methodologies that draw upon and combine approaches from multiple disciplines and can be used to inform evidence-based food systems policies that weight both nutritional and environmental impacts. These approaches have many potential applications for governments, private companies, technical and financial partners, and other stakeholders. Still, their applications for food systems research and policymaking are developing rapidly and will require further stakeholder testing and collaboration to ensure standardization and comparability across studies.

Life-cycle assessment

Environmental LCA is a commonly used method for assessing environmental externalities at multiple stages in the creation of a product or process (McLaren *et al.,* 2021). When applied to food systems, environmental LCA allows us to quantify the impacts of food systems in terms of outcomes such as GHG emissions, biodiversity loss, pollution, water and energy use, and land use (McLaren *et al.,* 2021). For example, environmental LCA can be used to compare the environmental impacts of different agricultural production systems, such as organic versus conventional systems, for the same crop (Zhu *et al.,* 2018).

LCA methodologies can also be used to quantify the nutritional impacts of food systems. In nutritional LCAs, a newer LCA innovation, outcomes such as nutrient content, nutritional quality and health impacts are considered functions of food systems by food or food product (McLaren *et al.,* 2021). Moreover, LCA has the potential to be used to compare impacts across environmental and nutritional dimensions, though standardized protocols for this multidimensional analysis have yet to be developed. Since the methodologies, boundaries and units used are not always consistent from study to study, compiling and comparing results within and between studies is not always feasible (Ridoutt, 2021).

Box 5.
Example of integrating environmental and nutritional life-cycle assessment

Castañé and Antón (2017) quantify and compare the nutritional quality and environmental impact of two theoretical dietary patterns – a Mediterranean diet and a vegan diet – in Spain. They use the Nutrient Rich Foods Index to compare the nutritional quality of the two diets. To assess environmental impact, they estimate the global warming potential (in CO_2e per person per week) associated with the production, transportation and home cooking of the foods in each diet and the terrestrial biodiversity loss (in potential species loss per person per week) due to land use associated with the food commodities in each diet. They find that the Mediterranean diet has lower nutritional quality and higher global warming potential and biodiversity impact than the vegan diet.

Castañé and Antón extend the boundaries of traditional LCA to compare impacts between dimensions of nutrition and environmental impact. Still, the results can be difficult to compare with others that incorporate the environmental and nutritional impacts of dietary patterns. The Nutrient Rich Food Index, for instance, is just one metric for assessing dietary quality. Similarly, the metrics and system boundaries selected to quantify environmental impact can vary between studies. Assessments of vegan and Mediterranean diets using different metrics, or different locations and production systems, may have distinct findings.

In addition, a broader evidence base of environmental and nutritional impacts across food systems is needed to compare different foods, geographical locations, production systems and value chains. Food LCA literature to date has focused heavily on the environmental impacts of agricultural production to the farm gate (McLaren *et al.,* 2021). Though some studies have focused on other food systems stages, such as food packaging (Molina-Besch, Wikström and Williams, 2019), more evidence is needed to quantify the environmental and nutritional impacts of food systems beyond the farm gate, including food processing, packaging, transportation, storage, preparation and loss and waste.

Moreover, most food-related LCA research has focused on a small number of foods, mainly those derived from staple and high-value crops in higher-income countries (McLaren *et al.,* 2021). LCA data from a given country or region cannot necessarily be applied accurately to explain environmental and nutritional impacts in other areas, as agricultural production systems, food value chains, food and environmental policies and nutritional challenges vary significantly between and within countries. Studies in lower-income countries, studies comparing locally produced versus imported foods, and studies on a wider variety of foods, especially nutrient-dense foods such as fruits, vegetables, nuts and legumes, as well as on whole diets and dietary patterns, would create a better understanding of the global impacts of food systems and inform policymaking in multiple contexts.

True cost accounting

TCA is a holistic method of accounting for the true value of foods, including both costs and benefits, across multiple dimensions. It aims to quantify and compare the monetary value of environmental, economic, social, health and nutritional costs and benefits (Baker *et al.,* 2020a; Gemmill-Herren, Baker and Daniels, 2021; Hendricks *et al*., 2021). Moreover, there are often trade-offs between nutritional and environmental costs and benefits. TCA provides a framework for quantifying and comparing the costs and benefits of different foods or food systems for nutrition, the environment and other dimensions.

Though TCA for food systems is a relatively new approach, these methods have been used to compare the costs and benefits of agricultural practices, foods and food products, and policy options, as well as to guide business and investment decisions (Baker *et al.,* 2020). For instance, Bandel and Nerger (2018) quantify the external costs and benefits of the GHG emissions, carbon sequestration, water pollution, water use, erosion, soil build-up and biodiversity loss associated with maize production in three production systems in Zambia. Through this analysis, they estimate that the true cost of maize is 2 to 2.5 times higher than the actual cost (Bandel and Nerger, 2018).

TCA frameworks have also been developed to assess the global impacts of food systems across multiple dimensions. For example, Hendricks *et al.* (2021) applied a TCA approach to global food systems impact data to estimate that food is about one-third cheaper than it would be if negative health, environmental and economic externalities were included in market prices. This framework included estimates of the value of a variety of these externalities, including pollution, GHG emissions, land use, the overuse of renewable resources, soil depletion, the use of scare resources, water use, animal welfare, child and forced labour, discrimination and harassment, high and variable prices, training, underpayment and underearning, antimicrobial resistance, undernutrition, unhealthy diet composition, zoonoses, food waste and tax evasion (Hendricks *et al.,* 2021).

TCA is ultimately intended to be used to inform policies – often referred to as true pricing – that incorporate the market and non-market benefits and costs of foods to promote co-benefits across multiple dimensions (Hendricks *et al.,* 2021). For example, true pricing could include market-based policies, such as changing food prices to reflect a product's true value; regulatory policies, such as requiring transparency on non-market impacts; taxes and subsidies guided by the true value of a product or food; environmental restoration efforts based on food system impacts; or income policies, such as requiring fair wages for workers in the food system (Baker *et al.,* 2020a; Hendricks *et al.*, 2021). To date, true cost and true pricing policies remain largely theoretical. Several publications have described frameworks for understanding and addressing the true cost of food production, agricultural production systems and food value chains (Baker *et al.,* 2020; Rockefeller Foundation, 2021; Sandhu, Jones and Holden, 2021).

TCA for food systems draws on and combines existing methods from multiple fields. There are multiple approaches to costing non-market impacts, such as the environmental, health and social impacts of food systems, and for valuing and weighing impacts in an integrated framework. Furthermore, some impacts of food systems, such as cultural or religious impacts, may not be quantifiable, but should be considered when weighing policies and other decisions. This lack of standardization limits comparability between studies.

In addition, comprehensive TCA for food systems is hindered by a lack of data to quantify impacts on multiple dimensions, for diverse foods and food production methods and across countries and regions. Notably, few studies have addressed the nutritional and environmental impacts of the middle part of food systems – food processing, storage, distribution and marketing – so current TCA studies often do not include estimates for these stages. Still, TCA is a promising approach for informing policies that support sustainable food systems and helping governments and other decision-makers to weigh trade-offs between different domains of impact (Hendricks *et al.,* 2021; Rockefeller Foundation, 2021).

While these assessment methods are promising, this is an area that requires further exploration and joint work by United Nations agencies and partners.

Next steps and conclusion

The urgent environmental and nutritional crises we are facing are closely interlinked. Diets and food systems sit at the nexus of these challenges. While there are often difficult trade-offs to be made between them, this paper shows it is possible to find synergies and pursue solutions that bring co-benefits for nutrition and the environment.

Promoting healthy diets based on a diversity of nutritious foods can encourage the diversification of food production and support biodiversity. This includes stimulating consumer and public institutional demand for healthy diets to drive more diverse, environmentally sustainable food systems. Likewise, promoting greater biodiversity in food production can support the diversification of diets and bring health benefits, reducing malnutrition and diet-related non-communicable diseases.

Progress on healthy diets from sustainable food systems requires the cooperation and collaboration of numerous stakeholders. There are many policy options to incentivize dietary shifts and support innovative, sustainable practices at every stage of food systems to support both nutrition and environmental goals. Policymakers and other food systems actors should work collaboratively to develop a bold mix of coherent and effective policies, adapted to local context. To achieve immediate results, economists, environmentalists, nutritionists and other food systems stakeholders must work together.

These options include improving existing agricultural production strategies and developing new technologies and approaches. It is equally important to innovate and promote simple low-cost food processing, storage and transportation. This will help to increase the resource efficiency of these stages while reducing food loss and waste, contributing to food security and the reduction of land use and GHG emissions associated with food systems.

To develop policies with co-benefits for nutrition and the environment, decision-makers need empirical evidence of the costs and benefits of interventions in each area. Methodologies such as TCA and LCA have the potential to measure the interlinked nutritional and environmental impacts of food systems, but require further development and standardization. Still, they can already help decision-makers weigh policy options quantitatively and manage trade-offs to inform evidence-based policymaking.

For sustainable change, policies and actions to improve nutrition should be designed and implemented through an environmental lens. At the same time, planet-friendly nutrition policies and actions should be included in country plans and efforts to adapt and mitigate climate change and other environmental hazards. Likewise, environment-related policies and commitments, such as the NDCs to the Paris Agreement, should consider food systems and nutrition goals in their formulation and implementation.

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Glossary

Cellular agriculture: The process of manufacturing agricultural products from cells and tissues without using whole organisms (Eibl *et al.,* 2021).

Cost of a healthy diet: The cost of purchasing the least expensive locally available foods to meet requirements for energy and FBDGs per person, per day (Herforth *et al.,* 2022).

Disability-adjusted life year (DALY): A time-based measure of the burden of disease in populations. One DALY is equivalent to the loss of one year of full health, considering both the years of life lost due to premature mortality and the years lived with a disability (WHO, 2022).

EAT-Lancet Commission: A group of scientists with expertise in human health, agriculture, political sciences and environmental sustainability that produced the EAT-Lancet report in 2019 (Willett *et al.,* 2019).

Ecosystem services: The benefits that people obtain from ecosystems, such as food, water, fibre, flood control, climate regulation, coastal protection, nutrient cycling, recreation and religious and spiritual benefits (WRI, 2005).

Food-based dietary guidelines (FBDGs): Context-specific, evidence-based advice and principles on healthy diets and lifestyles, typically through a set of recommended foods, food groups and dietary patterns that provide essential nutrients, promote health and prevent chronic diseases (FAO, 2022b).

Food environments: The contexts experienced by people as they acquire, prepare and consume food, including the cost, accessibility, availability, convenience and desirability of different foods and meals, which vary by context, location and person (UNSCN, 2019).

Food Insecurity Experience Scale (FIES): An experience-based food security scale used to produce a measure of access to food at different levels of severity that can be compared across contexts (FAO *et al.,* 2022).

Food loss: Food lost along the food supply chain up to, but not including, the retail, food-service and household sectors (UNEP, 2021a).

Food security: When all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (FAO *et al.,* 2022).

Food waste: Food and the associated inedible parts of foods removed from the human supply chain through the retail, food-service and household sectors (UNEP, 2021a).

Moderate food insecurity: The level of food insecurity at which people face uncertainties about their ability to obtain food and have been forced to reduce at times during the year the quality and/or quantity of food they consume due to a lack of money or other resources, based on the FIES (FAO *et al.,* 2022).

Life-cycle assessment (LCA): A method for quantifying the impacts associated with all or multiple stages of the creation of a product or process (McLaren *et al.,* 2021).

Nutrient Rich Foods Index: This metric scores foods, meals or diets according to their nutritional content, specifically taking into account protein, fibre, vitamins A, C and E, calcium, iron, magnesium, potassium, saturated fat, sodium and added sugar. It is predicated on the notion that people should be encouraged to consume the first nine nutrients and to limit the latter three (Drewnowski, 2009).

Nutritious foods: Safe foods that contribute essential nutrients, such as vitamins and minerals (micronutrients), fibre and other components, to healthy diets that are beneficial to growth, health and development and which guard against malnutrition. In nutritious foods, the presence of nutrients of public health concern, including saturated fats, free sugars and salt/sodium, is minimized, industrially produced trans fats are eliminated and salt is iodized (FAO *et al.,* 2022).

Percentage of undernourishment: An estimate of the proportion of the population that lacks enough dietary energy for an active, healthy life (FAO *et al.,* 2022).

Processed foods: Foods, other than raw agricultural commodities, that have been altered in any way from their natural state (USAID Advancing Nutrition, 2022).

Severe food insecurity: The level of food insecurity at which people have likely run out of food, experienced hunger and, at the most extreme, gone for days without eating, putting their health and well-being at grave risk, based on the FIES (FAO *et al.,* 2022).

Stunting: Height-for-age less than two standard deviations below the WHO Child Growth Standards median in children under five years of age (FAO *et al.,* 2022).

Sustainable food system: A food system that delivers food security and nutrition for all in such a way that the economic, social and environmental bases to generate food security and nutrition for future generations are not compromised (FAO, 2018b).

Triple planetary crisis: The interlinked challenges of climate change, pollution and biodiversity loss that must be resolved to ensure a viable future on Earth (UNFCCC, 2022).

True cost accounting (TCA): A holistic method for accounting for the true value of foods, including costs and benefits across multiple dimensions, such as environmental, economic, social, health and nutrition (Baker *et al.,* 2020a; Gemmill-Herren *et al.,* 2021; Hendricks *et al.,* 2021).

Ultraprocessed foods (UPF): Foods that are made up of ingredients formulated through industrial techniques and processes, such as soft drinks, packaged snacks, candies and reconstituted meats. UPF is the designation for the most highly processed foods under the NOVA Food Classification System (Monteiro *et al.,* 2019).

Undernourishment: The condition in which an individual's habitual food consumption is insufficient to provide the amount of dietary energy required to maintain a normal, active, healthy life. For the purposes of this paper, hunger is synonymous with chronic undernourishment (FAO *et al.,* 2022).

Wasting: Weight-for-height less than two standard deviations below the WHO Child Growth Standards median in children under five years of age (FAO *et al.,* 2022).

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Nutrition and the environment − Nurturing people, protecting the planet.

Corrigendum

19 May 2023

The following corrections were made to the PDF of the report after it went to print.

Page	Location	Text in printed PDF	Text in corrected PDF/ Notes
ii – Copyright page	Required citation	UN-Nutrition. 2023. *Nutrition and the environment − Nurturing people, protecting the planet*. Rome, FAO. https://doi.org/10.4060/cc5757en	UN-Nutrition. 2023. *Nutrition and the environment − Nurturing people, protecting the planet*. Rome, FAO on behalf of UN-Nutrition. https://doi.org/10.4060/cc5757en
iv	Paragraph 2		Martina Otto,[2]

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UN Nutrition

Discussion paper

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