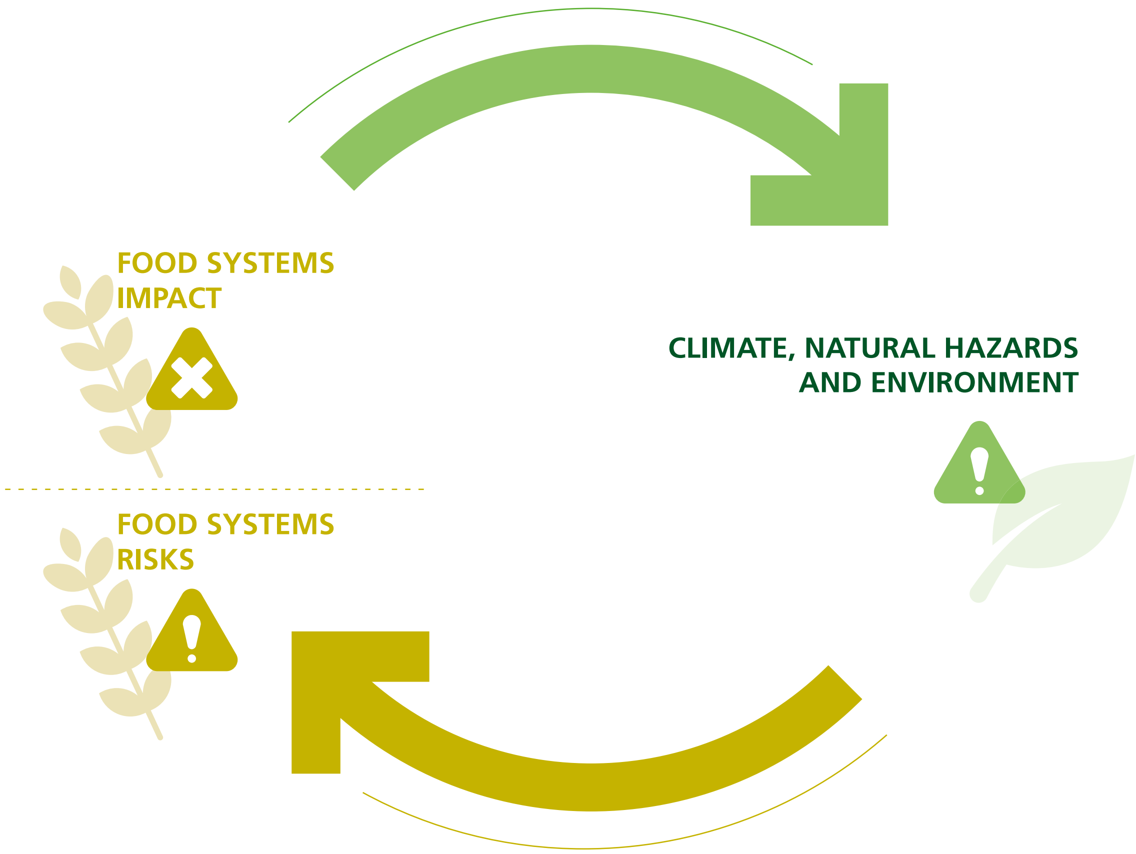
SDC Network **Climate, DRR & Environment**

Agriculture & Food Systems
SDC Thematic Network

Thematic Integration Brief (TIB)

Climate, DRR & Environment …and **Food Systems**



This Thematic Integration Brief (TIB) provides a non-exhaustive compilation of the interconnections between food systems and climate change (C), disaster risks (D), and the environment (E) at the global, regional and local levels. The brief aims to:

- enhance understanding of the interdependence between food systems – from production to consumption – and the climate/disaster/environment risks (C/D/E)
- highlight both the positive and negative impacts of the global food system on the climate and the environment, and vice versa
- offer practical advice on how to transform food systems to adapt to, and mitigate, C/D/E.

SDC's Climate, DRR and Environment, and Food Systems sections welcome feedback to continuously improve this Thematic Integration Brief (TIB).

Interconnections at a Glance

Agriculture and food systems are crucial for the food and nutritional security of populations, and play a key economic role in many countries. They are, however, highly sensitive and highly exposed to climate change, disaster risks and environmental degradation. Additionally, they are leading contributors to environmental degradation, deforestation, and biodiversity loss. Nevertheless, food can be one of the biggest levers to mitigate biodiversity loss and contribute to habitat and species protection.

Climate change risks for food systems

Current climate trends – **rising global temperatures, more heatwaves, disrupted precipitation patterns, and more droughts** – are reducing agricultural yields, diminishing agrobiodiversity and livestock productivity, and affecting fisheries and agroforestry in areas already vulnerable.

- Warmer air contains more moisture, resulting in heavier and more frequent rainfall, which can lead to **soil erosion**, increased risk of landslides and mudslides, and loss or damage to farmland and infrastructure.
- More and longer droughts contribute to the **loss of biodiversity** and accelerate **desertification**, leading to the loss of productive agricultural areas.
- High-latitude areas are increasingly exposed to the risk of **permafrost thawing**, which affects hydrology and biodiversity, and generates erosion and landslides.
- Unstable and unpredictable yields can create **volatility in food prices and disruptions in global food value chains**. The consequences – diminished quality, quantity and diversity of food consumed – can lead to food and nutrition crises.
- Climate change-induced reductions in yields and land productivity are likely to **increase pressure on land and natural resources**.

Other human-related risks, such as armed conflict and political, economic and health crises, and the influence of global politics can have an impact on food systems and amplify the environmental and climate risks.

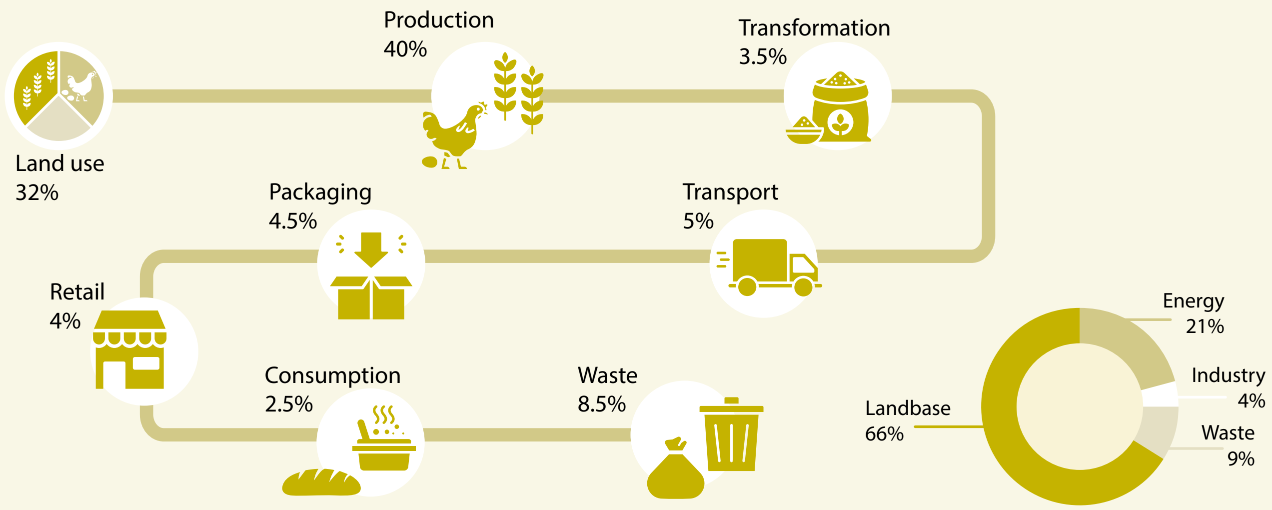
Climate change opportunities

Although the effects of climate change on food systems are primarily negative, certain **climatic zones** may experience changes that could increase farm and forest productivity due to longer growing seasons, more or less rainfall, changes in pest and disease pressures, and increased carbon sink capacity.

- High-latitude continental areas, such as parts of Canada, Russia, and Scandinavia, could benefit from **longer growing seasons**.
- Temperate zones in the northern hemisphere, notably parts of Europe, the United States, and East Asia, could benefit from longer and more intense vegetation periods, higher carbon sink capacities, and **positive changes in biodiversity**.
- Semi-arid and arid regions, such as parts of the south-western United States and the Mediterranean, could benefit from **new rainfall patterns** that could affect water availability and pest and disease pressures, and could influence agricultural productivity and biodiversity.
- The expansion of shipping routes in polar regions may reduce food transportation costs between the Eastern and Western Hemispheres, and **increase economic opportunities**.

Negative food system impacts on climate and the environment

Food systems are responsible for significant environmental impacts, including **a third of global greenhouse gas emissions**, 90% of deforestation, and 60% of biodiversity loss. However, they received only 3.4% of the USD 115.9 billion in climate finance mobilized in 2022. Agricultural production, including livestock farming, is responsible for 40% of the emissions related to food systems, and land use for 32%, mainly as a result of carbon losses from deforestation and soil degradation. Food systems account for about 35% of the anthropogenic sources of methane emissions. And about 8–10% of global GHG emissions are attributable to food waste. 14% of food is lost before reaching consumers and 17% is wasted at the retail or consumer level.



Source: Nature Food study, EDGAR-FOOD and FAOSTAT (2021)

The loss of arable land leads to the intensification of activities on the remaining land and over-exploitation of natural resources, with a negative impact on biodiversity, water quality, and soil health.

- The agricultural **expansion into areas of high-value biodiversity** – forests, pastures, and wetlands – is likely to increase.
- **Intensive farming practices** damage the soil structure and the microbial soil environment, leading to the release of carbon dioxide and nitrous oxide and to the reduction of the quality of the soil.
- The **excessive use of pesticides** is killing natural pollinators, leading to a reduction of biodiversity.
- **Intensive livestock-rearing practices** on an industrial scale do not respect the carrying capacity of the land, and depend on major external inputs such as intensively grown fodder, concentrated feed, and antibiotics.
- Climate change can have a negative effect on biodiversity, which, in all its complexity, is important for soil health, crop pollination, and pest control.

Positive impacts of food systems on climate and the environment

Soils represent **the largest reservoir of terrestrial organic carbon**. The carbon sequestration capacity is highly dependent on geophysical conditions, climate, and land use and agricultural practices. Large quantities of soil carbon stock have accumulated over the years, and sustainably managed land can maintain and increase terrestrial **carbon stocks**.

Perennial plant cover, such as forests, pastures, and wetlands have the potential to be carbon sinks, as do systems, such as crop rotation, agroforestry, sylvo-pastoralism, and low- or no-till practices.

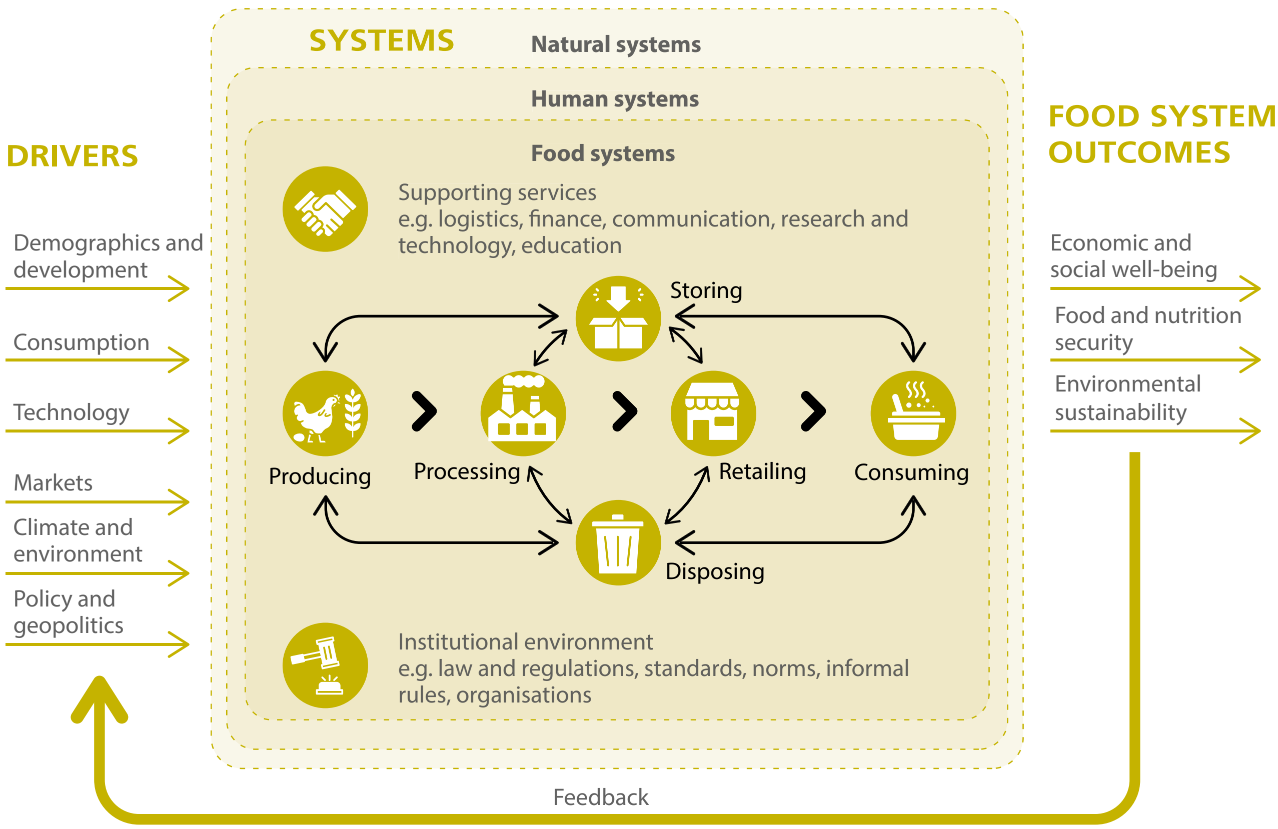
1. Interactions between food systems, climate and the environment

The **biosphere**, the sum of living things on Earth, and climate are inextricably bound. Through photosynthesis, plants help regulate the flow of greenhouse gases into the atmosphere. Forests and agricultural land with permanent vegetation cover – pastures, sylvo-pastoral systems, agroforestry – and the oceans act as carbon sinks and have a cooling effect on the environment through evapotranspiration and the reduction of greenhouse gases. The diversity of climatic zones on the planet has shaped **ecosystems** over time and defined the places where food can be collected or grown.

The structures created by the natural growth of living organisms **modify landscapes**, and, increasingly, so does the infrastructure built by humans. These modified landscapes influence climate, hydrology and biodiversity.

Human activity has shaped **agricultural practices and ecosystems** over time. Food is produced, processed, distributed, and consumed under different socio-economic and cultural conditions, and food systems depend on accessible natural resources, know-how, technology, and finance. Human activities and settlements in specific ecological and climatic zones have created **food cultures** that have evolved according to the availability and accessibility of resources, and that reflect the practices, beliefs, customs and traditions surrounding the production, preparation, consumption, and appreciation of food.

The concept of food systems encompasses the multitude of functions and interactions between human activities and their environments. Food systems thinking has evolved from a linear notion to a more holistic and circular understanding of complex and interwoven actions and practices that form today's global food systems.



Source: Adapted from Foresight4Food, The Dynamics of Food Systems – A Conceptual Model, 2019.

The **objectives of food systems** are to guarantee economic and social well-being, food and nutrition security, and environmental sustainability. The way food is produced, processed, distributed and consumed contributes to these objectives, but can also have **negative consequences**, such as excessive greenhouse gas emissions; water, soil and air pollution; loss of biodiversity; soil degradation; and negative impacts on human health. The negative consequences of modern food systems generate hidden costs (externalities) that reduce the planet's natural capital and human health in the medium and long terms.

This approach to food systems looks at **the links among natural and human systems and at all the elements that govern food systems** and their functions. It also considers the stakeholders. Food systems **are constantly evolving and adapting**. An understanding of **the growing risks and impacts of food systems** on the climate and the environment, and vice versa, is therefore essential to the planning of a transformation of food systems and to taking the mitigation and adaptation measures necessary to make them sustainable and resilient.

Risks related to climate change, natural hazards and environmental degradation on food systems

The following non-exhaustive list highlights how the interconnections among climate, disaster and environmental risks and the increasingly globalised agri-food systems affect the availability, accessibility, diversity, use, and safety of food products.

Direct effects

Extreme hydrometeorological events:

- Rising global temperatures, high winds, storms, and changing and erratic rainfall pattern with prolonged periods of humidity and dryness— are increasingly exposing **crops to stress and shocks**.
- These developments also influence **pests and diseases**; affect plants, animals and humans; increase the risk of epidemics and epizootics; and reduce productivity and biodiversity.

Thawing of permafrost:

- High latitude areas are likely to be exposed to the thawing of permafrost with consequences that may affect hydrology and biodiversity and generate erosion and landslides in mountainous regions leading to the loss of fertile land and damage to infrastructure.

Indirect effects

Droughts:

The increase in the frequency and duration of droughts contributes to the loss of biodiversity and accelerates **desertification**, which in turn leads to soil degradation and the loss of productive agricultural areas.

Knock-on effects

Health and nutrition:

- Declines in global crop productivity generate steep increases in food prices that result in changes in nutrient levels in some foods, and affect overall caloric consumption and the **nutritional quality of diets** as people shift to cheaper, less nutrient-rich foods.

Economic and societal stress:

- Unstable and unpredictable yields encourage **speculation** on local, regional and global markets for agricultural and livestock products, and fuel inflation. High enough levels of **inflation** in staple crops can trigger social and political insecurity, and destabilise government systems.
- Food insecurity and hunger affect **human health and behaviour**, and can lead to popular uprisings or waves of migration.
- Natural events – such as floods, landslides, or pest infestations or man-made disasters – such as chemical spills or dam breaches – can lead to **market disruptions**, from the local to a global scale with interruptions in the supply of pesticides or fertilisers and the disruption of maritime routes. These events disproportionately affect vulnerable groups and undermine efforts to leave no one behind.

Impacts of food systems on climate and the environment

Food systems generate direct effects, hidden effects, and external costs that can be described as risks for the planet's climate and ecosystems. The following is a non-exhaustive list of the most significant risks and the direct and knock-on effects.

Intensive practices:

- The continuing increase in the world's population and a shifting nutrition pattern are leading to a rise in demand for food. To meet this demand, intensification and changes in land use are putting **further pressure on soil, biodiversity, and water, and increasing humanity's ecological footprint**.

- The conversion of natural ecosystems and changes in land use – from forest to agricultural land, from wetlands to farmland, from farmland to infrastructure – reduces the capacity of soils and vegetation to act as **carbon sinks**. More greenhouse gases are produced and released, contributing to rising global temperatures and affecting the biodiversity and hydrology of ecosystems.

- Agricultural practices based on increased misuse of chemical fertilisers and pesticides, often combined with large-scale **monocultures and industrial livestock systems**, increase GHGs, reduce the organic content of terrestrial soils and water storage capacity, and contribute to increased loss of soil health and biodiversity.

- Declining land productivity and crop yields are likely to **increase pressure on soil and water**. The continued expansion of agriculture in areas of high biodiversity value (forests, pastures, wetlands) is likely to increase, jeopardise pollination services, and further unbalance the planetary ecosystem.

Supply chains:

- The presence of **waste and contaminants** throughout the supply chain (fossil fuel-based energy-intensive processing, chemical products, plastic packaging) is increasing. Poor waste management (chemical releases, open dumping, wastewater releases without treatment) is contaminating soil, water, and air, and is reducing the capacity of ecosystems to provide services.

- The complex, interconnected, and **increasingly multi-tiered globalised food supply chains** increase the km per unit of food transported, and hinder the implementation and monitoring of practices related to land-water-energy use, transparency, and traceability, and disrupt competition between local markets and exports.

- **Food losses** (after harvest, during storage and transport) and **food wastage** (at the retail and consumer levels) increase GHG emissions, reduce food availability, waste energy, water, and other resources used throughout the value chain to produce the food, and affect the livelihoods of supply chain actors.

Eating habits and dietary changes:

- Suppliers may cater to consumer food preferences (including the expectation that food products will be available throughout the year) by increasing the number of **food miles**, thereby increasing the GHG emissions related to food transport.

- Rising per capita incomes, combined with urbanisation, are replacing traditional diets of starch, pulses, and vegetables with energy-intensive ultra-processed food products that are high in refined sugars, fats, and oils. These diets are often higher in meat content, have a **higher carbon footprint**, and given that malnutrition is a major driver of noncommunicable diseases, can be harmful to health.

2. Main areas of action

The need for agri-food systems to adapt to climate change is unavoidable given global warming trajectories and scenarios based on scientific data. At the same time, and given the considerable contribution of food systems to greenhouse gas emissions and biodiversity loss, a number of measures need to be put in place to mitigate and reduce these negative impacts.

Reducing the impact of food systems on climate and the environment

The IPCC Sixth Assessment Report estimates the overall potential for reducing GHG emissions from the food sector in the medium and long terms at 44% by 2050, representing the fourth highest reduction potential (after electricity, transport and infrastructure)[1].

Supply-side options:

- The options with the highest potential for reducing food system emissions between now and 2030 are:
  - Reducing the conversion of natural ecosystems
  - Increasing carbon capture and sequestration in agriculture through practices such as agroforestry or agroecology
  - Restoring ecosystems, including through afforestation and reforestation.
- Developing and supporting perennial crops to replace the annual crops – mainly cereals – that occupy around 80% of the world's harvested area would make it possible to reduce GHG emissions from agriculture, and even turn crops into carbon sinks, while reducing soil erosion and the loss of nutrients, and increasing moisture retention.

Demand-side options:

- Shifting to diets with a **higher share of plant protein** and moderate intake of animal-sourced foods can reduce food-related GHG emissions while generating significant co-benefits in terms of human health. The policy instruments need to consider country contexts, cultural values, social acceptance, and inequalities, and may include:
  - Public procurement protocols
  - Health insurance
  - Awareness raising campaigns
  - Public health guidelines
  - Restrictions on marketing to children
  - Nutrition labelling and the reformulation of products.

Value chains and governance:

- **Integrated production systems**, which combine diverse farming practices such as crop rotation, agroforestry, and mixed livestock-crop systems, **with a broad range of genetic resources**, including different crop varieties and traditional plant breeds, can reduce risks and dependencies while enhancing food system resilience to climate change and global shocks.
- **Local territorial food systems** can reduce GHG emissions generated between food production and consumption.

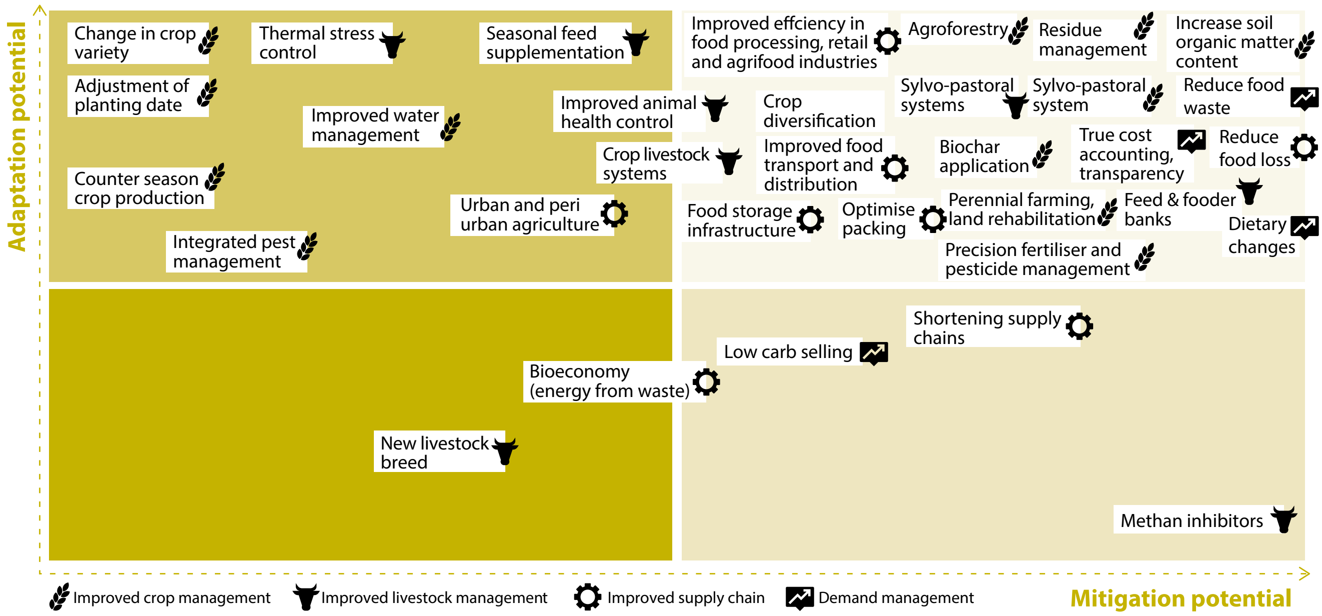
Developing specific value chains that are aligned with environmental sustainability, fairness and localisation of markets calls for efforts to convince the private sector to reduce its environmental footprint and to assist in the transition.

As public authorities and funding bodies adapt to changing conditions, they face the challenges of investing in appropriate **research and development** while balancing economic and societal interests and ensuring that they are inclusive and responsive to the needs of stakeholders and communities.

1 IPCC, Sixth Assessment Report, 2021.

Reducing the vulnerability of food systems to climate and environmental risks

Risk mitigation needs to be considered from the point of view of the food system as a whole, in line with the holistic and non-linear approach. The figure below presents a non-exhaustive set of response options from the point of view of food systems, and **covers the entire value chain** from production to consumption. These options are organised according to their mitigation and adaptation potential to climate change, and by the stage of the food system (agricultural or livestock production, processing, consumption).



Source: Adapted from the IPCC Special Report on Climate and Land, 2019.

The options in the top right-hand quadrant appear to offer the greatest added value for the sustainable transformation of food systems. These options are effective in building a climate-resilient food system while reducing climate risks.

Sustainable Land Management:

- Sustainable Land Management (SLM) supports healthy ecosystems and soils, increases agricultural productivity, and contributes to climate change adaptation and mitigation through:
  - o Water-efficient irrigation
  - o Drought-resilient crops
  - o Diversification of cropping systems
  - o Agro-forestry and agro-ecology
  - o Crop rotation, intercropping and zero tillage.

SLM also improves food and nutrition security.

Urban and peri-urban food systems:

- Urban and peri-urban agricultural enterprises such as beekeeping and horticulture are smaller in scale, but closer to consumers. The FAO considers urban and peri-urban agriculture (UPA) to be a fundamental strategy for building the resilience of city food supplies. UPA reduces the uncertainties associated with disruptions to food supply chains and provides employment opportunities.

Policy recommendations for the transformation to climate-sensitive food systems

Many signatory countries to the Paris Agreement have included mitigation and adaptation plans related to their food systems in their Nationally Determined Contributions (NDCs). Governments are paying increasing attention to the conversion of conventional agriculture towards more sustainable and climate-resilient agricultural approaches, but are paying less attention to the services and institutional frameworks – climate information services, insurance, credit – that can facilitate the transition.

Policies that operate across the food system, including those that reduce food loss and waste and influence dietary choices, enable more sustainable land-use management, enhanced food security and low-emission trajectories. Such policies can contribute to climate change adaptation and mitigation, reduce land degradation, desertification and poverty, and improve public health.

The figure below illustrates the demand- and supply-side policy areas and options for policy intervention for transforming food systems towards greater resilience and sustainability. This compilation of different families of policies and measures is not exhaustive.

	SUPPLY DRIVEN	DEMAND DRIVEN	
R&D, Agroecology, capacity building / education of farmers, sustainable intensification, transformative incentives/taxes, access to transformative investments, soil health/biodiversity programs	**Increasing agricultural efficiency**	**Reducing food waste**	Incentives, taxes, regulations, awareness & capacity building, circular economy - R&D
Land use planning for ecosystem services, payment for ecosystem services, (agro) biodiversity conservation programmes	**Land use planning**	**Reducing consumption of carbon intensive food and goods**	Carbon pricing for selected food commodities, changing food environment, access to finance, behaviour change on food choices, true cost accounting
Taxes and incentives, mandated carbon cost reporting, enable public private collaboration, insurance products, impact finance, storage facilities	**Market approaches**	**Stimulating markets for sustainability foods**	Carbon pricing for selected food commodities, true cost accounting, taxing unsustainable products
Sustainability standards, bio or green trade, taxes and incentives for ethical trade, incentives for transport and storage efficiency	**Trade**	**Combining carbon and health objectives**	Public procurement, food labelling, awareness and education campaigning, adjust subsidy structure

Source: Adapted from the IPCC Special Report on Climate and Land, 2019.

According to the IPCC, up to twenty families of public policy areas have the potential to shape agri-food systems directly or indirectly through environmental regulations, market interventions and by influencing consumer behaviour.

Fair and equitable trade:

- Food trade and food sovereignty are complementary elements of food and nutrition security, and must be addressed together. International trade can provide a safety net by making up for shortfalls through imports, but should not come at the expense of strengthening the local and regional food systems that are crucial to local resilience.

Finance:

- Access to finance is a key element in transforming food systems. Many mechanisms are available, but the lack of knowledge about how and where to access what, and who is eligible for which mechanisms, are barriers to participation. Financial education can lower these barriers and facilitate access.

- Governments can employ subsidies and incentive taxes to promote the conversion of conventional agricultural practices to more agro-ecological practices, to recognise the value of ecosystem services, to support reforestation, and to transition away from fossil fuels.

- Climate financing should recognise food systems as a major source of GHG emissions, and should prioritise adaptation and mitigation strategies such as land restoration, more sustainable agro-ecological agri-food practices, investments in supply chains to reduce losses, and investments in production of affordable, nutritious products.

Vulnerable groups:

In the spirit of leaving no one behind, the consideration of vulnerable groups – women, men and children with disabilities; elderly people; poor people; and other groups excluded on the basis of gender or social and cultural discrimination – should inform all policy responses to C/D/E challenges in terms of access to affordable healthy and sufficient food, particularly during periods of acute shock or stress. All interventions should strive to empower marginalised groups through collective action, such as inclusive self-help groups, and should support access to inclusive education and finance, accessible food distribution and enhancement.

Tools and approaches to mainstreaming

CEDRIG (SDC) systematically integrates climate change, natural hazards and environmental issues at the project or programme level. Based on a comprehensive context analysis, the tool assesses whether or not a planned or ongoing intervention is at risk from climate change, natural hazards or environmental issues and whether the intervention may have an adverse impact on the climate or on the environment, or create new or exacerbate existing risks. The tool helps define measures to integrate Climate, DRR and Environment in project activities, programmes and strategies.

ISO standards, and environmental, social and governance (ESG) criteria for evaluating the private sector and investment products are designed to guide stakeholders in making responsible decisions in accordance with the do no harm principle.

Further reading

Centre for Food Policy, City University of London, 45 actions to orient food systems towards environmental sustainability: co-benefits and trade-offs, 2023.

FAO, Achieving SDG 2 without breaching the 1.5 °C threshold: A global roadmap, 2023.

FAO & GAIN, Climate Action and Nutrition - Pathways to impact, 2023.

FAO, Sustainable Development Goals: Sustainable Food Systems - Publications and Tools, 2024.

FAO, Agrifood systems; Livestock systems – Resources, 2024.

FAO, Urban and peri-urban agriculture, 2024.

FAO, Making climate-sensitive investments in agriculture - Approaches, tools & experiences, 2021.

GAIN, Greening Nutrition Programmes, 2023.

GIZ/Alliance Bioversity-CIAT, Climate Risk Planning & Managing Tool for Development Programmes in Agri-food Systems (CRISP-Tool), 2022.

High-Level Panel of Experts on Food Security and Nutrition (HLPE-FSN), Policy recommendations

IPCC, Special Report on Climate and Land, Chapter 5: Food Security, 2019.

IPCC, Working Group III, Climate Change 2022: Mitigation of Climate Change, 2022.

IPES-Food, Food from somewhere – food security and resilience through territorial markets, 2024.

SDC, Climate, environment and disaster risk reduction integration guidance (CEDRIG).

The Swiss National Committee CNS-FAO, Position papers and documentation.

OHCHR, Policy Guidelines for Inclusive Sustainable Development Goals – Food and Nutrition (OHCHR Thematic Brief), 2020.

WWF, Food Forward NDCs (Nationally Determined Contributions), guidance, 2024.

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