



MOVING FOOD FORWARD

How could global food systems better sustain our planet and its people by 2040?

White paper series in collaboration with EY-Parthenon

Foreword

Global food systems have more than an essential role in feeding, nourishing, and promoting social well-being for humanity. However, the Earth's ecological and humanity's social boundaries are under increasing pressure, particularly due to climate change, loss of biodiversity, nitrogen and phosphorus loading, and land conversion¹, which deplete the natural resources necessary to provide humanity with the food it requires. These pressures are closely related to various social and economic challenges, such as hunger, malnutrition, obesity, and food insecurity, which are already prevalent in too many parts of the world.

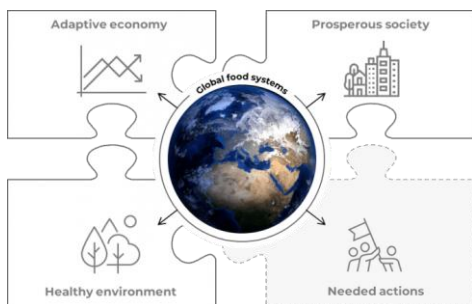
The planet needs to feed and nourish 9.2 billion people by 2040² (i.e. 1.2 billion more than today), while humanity needs to achieve significant reductions in greenhouse gas (GHG) emissions as well as delivering improvements in the planet's ecological conditions to sustain future generations. Global food systems play a crucial role in achieving this through a transition to more ecologically, socially, and economically viable conditions. This transition requires us to reimagine the 'art of the possible' by bringing policymakers, businesses, communities, and consumers on a transition journey that is safe and just throughout its milestones.

The transition requires transformation across geographies and all parts of the value chain. Therefore, this paper takes a comprehensive view of global food systems and determines three critical issues and five objectives that need to be achieved to better sustain planet and its people in a 'preferred future' by 2040. The paper then focuses on the question of 'what would have to be true' to attain these outcomes by outlining three global focus areas and collective actions to inspire organisations and their decision-makers to advance the transition.

The goal of Tetra Pak is to contribute to the transition through food processing technologies and packaging solutions, driven by four pathways:

- 1) Enabling transition towards more sustainable dairy
- 2) Innovating for new food sources
- 3) Reducing food loss and waste
- 4) Scaling access to safe nutrition via sustainable food packaging

Tetra Pak white paper series: Actions to drive the transition



This white paper is the first part of a series that aims to convene a discussion on how global food systems could better sustain our planet and its people. Our intention is to gather feedback for further iterations to ensure a full integration of sustainability focus areas within the food systems transition.

Our following publications will focus on Tetra Pak's four pathways and how they contribute to the transition.

White paper	Global focus areas and collective actions to drive safe and just transition
1. Pathway paper	Enabling transition towards sustainable dairy
2. Pathway paper	Innovating for new food sources
3. Pathway paper	Reducing food loss and waste
4. Pathway paper	Scaling access to safe nutrition via sustainable food packaging

Contents

Contents

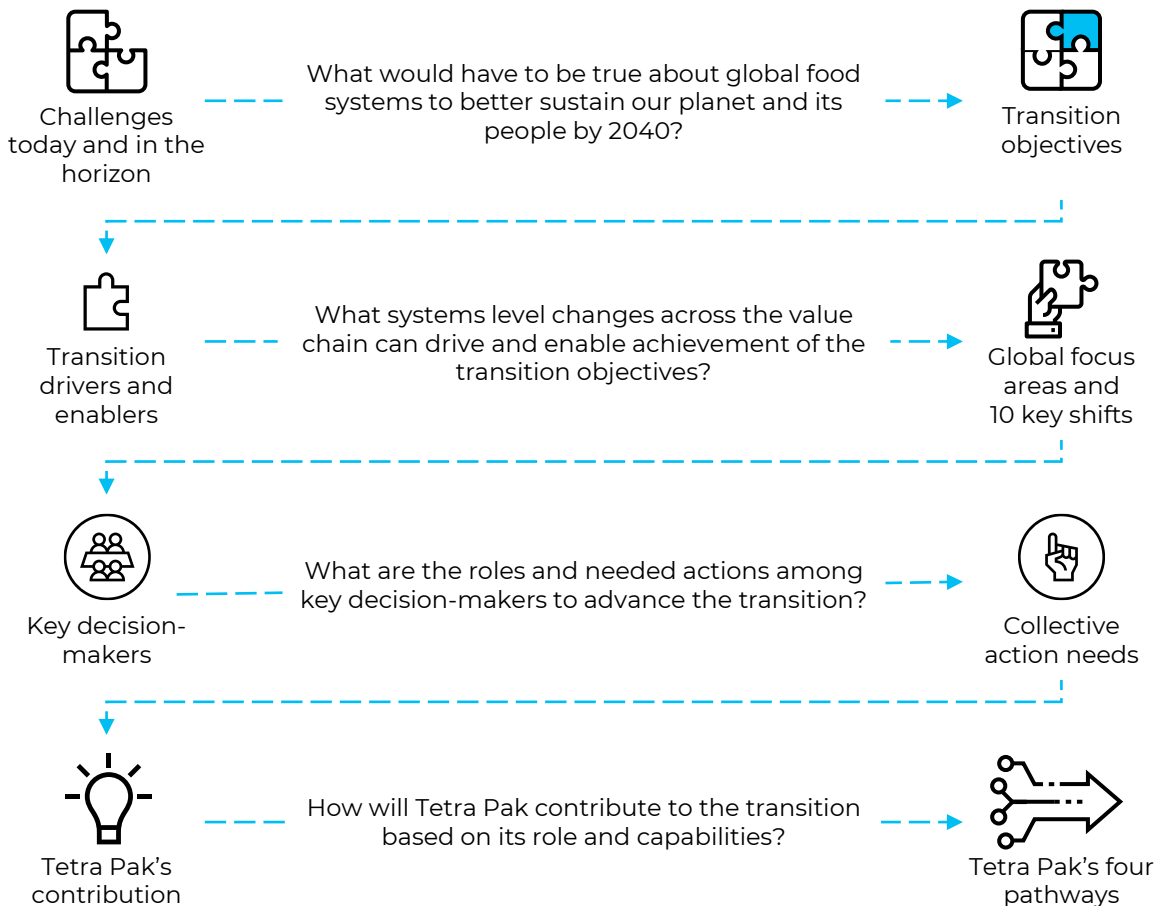
1. Executive summary.....	4
2. Introduction and approach.....	12
3. Safe and just transition to 2040: Three global focus areas.....	20
A. Healthier diets and better food safety for improved human well-being.....	21
B. Regenerative and circular value chains to achieve resilient food systems.....	27
C. Decarbonising to support climate change adaptation and mitigation.....	33
4. Collective actions to advance the transition.....	39
5. Appendix	45

Reader's guide to executive summary

Background

Key question

Outcome



1. Executive summary: The global challenge

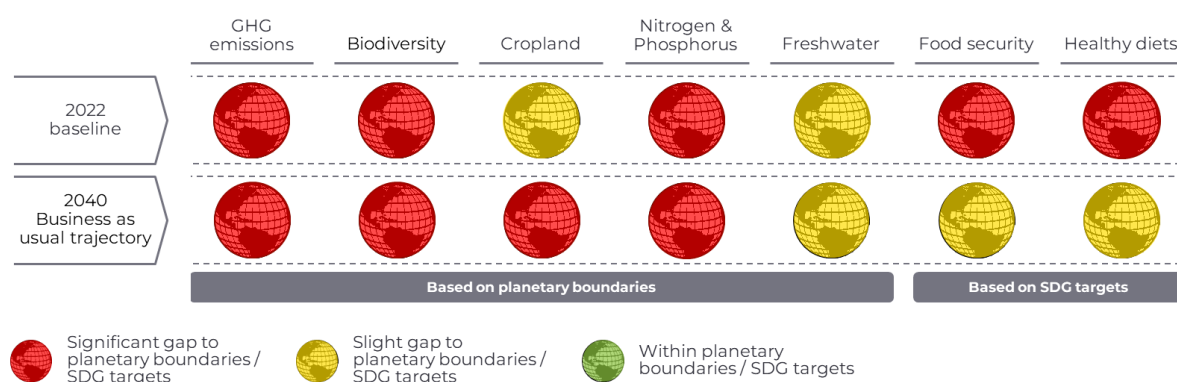
Current food systems cannot sustain our planet and its people in the long term. A safe and just transition is urgently needed to ensure a healthy and thriving environment for future generations.

Today’s food systems pose a significant challenge to the ecological health of our planet. It is estimated that 34% of global greenhouse gas (GHG) emissions³ and up to 80% of biodiversity loss⁴ originate from food systems. FAO estimates that a third of the earth’s soil is degraded and that pressures to croplands continue to increase.⁴⁴ Agriculture is the primary source of elevated concentration in nitrogen and phosphorus inputs, resulting in significant ecosystem damage and health issues from pollution as current input levels are already substantially above identified safe and just earth system boundaries.⁴⁶ In addition, the global water budget is under pressure as withdrawals from freshwater sources are already past the limit of planetary boundaries¹ with agriculture accounting for three-quarters of freshwater withdrawals.

Existing food systems are incapable of meeting the well-being needs of humanity. Today, approximately 9% of the world's population experience hunger⁵ and 30% experience malnutrition⁶ while simultaneously unhealthy diets are the greatest threat to human health from lifestyle-related diseases.³⁴ With the planet needing to feed and nourish an additional 1.2 billion² people by 2040, tackling the issues surrounding food systems has become one of the most critical and complex challenges for humankind.⁷ This challenge must be met under increasingly challenging ecological, socioeconomic, and geopolitical conditions.

An urgent shift in the trajectory of global food systems is needed to sustain our planet and its people for the long-term. The current baseline and the business as usual trajectory of the seven key dimensions demonstrate that current actions are not adequate enough to improve them, and this cannot be done without the transition of food systems due to their significant role in affecting each of the dimensions.

Baseline and outlook for the key dimensions*



Source: Adjusted from Katherine R. et al. 'Earth beyond six of nine planetary boundaries';¹ EAT-Lancet Commission Summary Report;³⁴ United Nations Sustainable Development Goals Report 2023;³⁵ UNICEF/WHO/World Bank Group – Joint child malnutrition estimates 2023³⁶

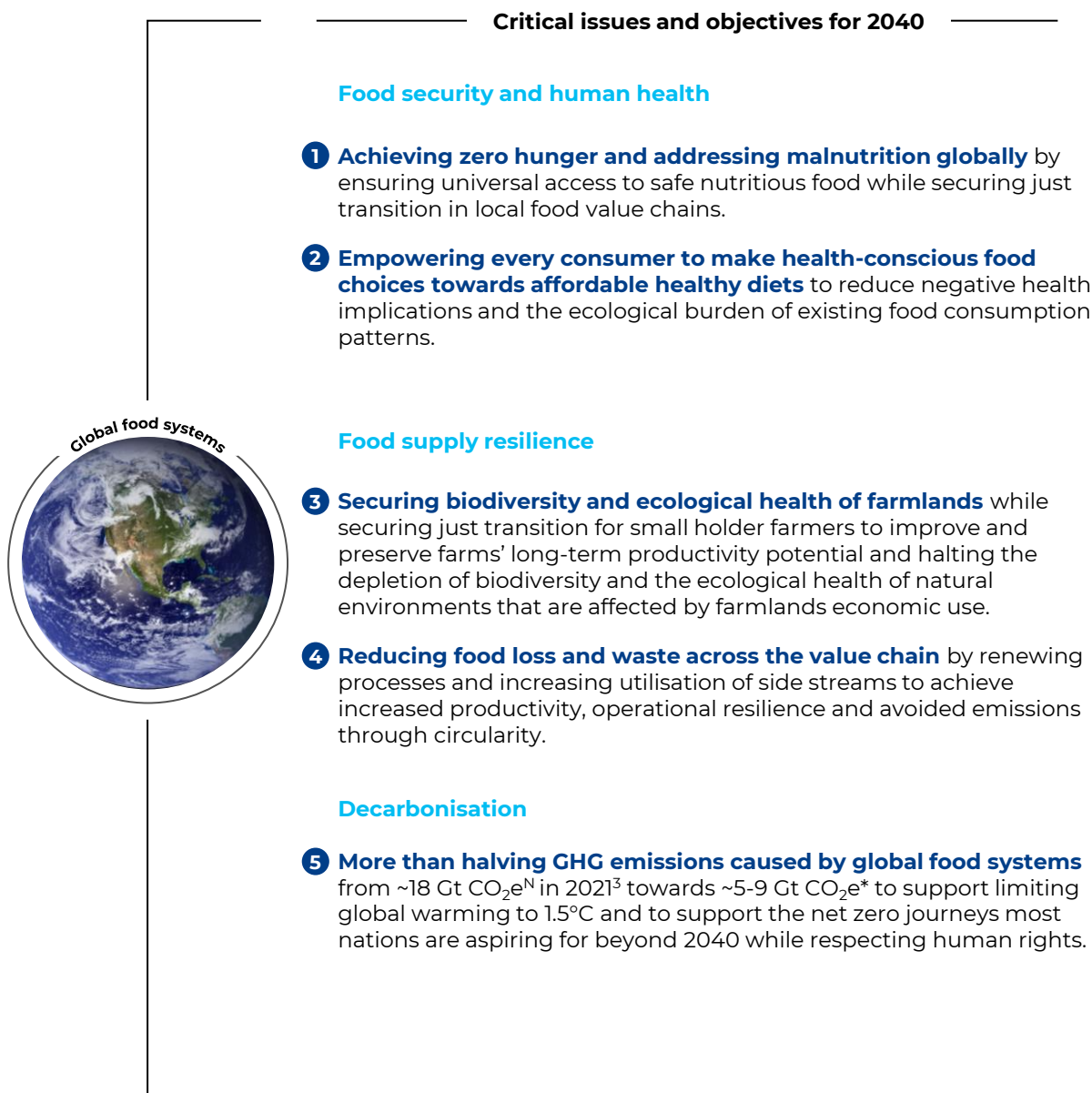
* Research approach on Chapter 2 describes how the key dimensions were selected

1. Executive summary: Transition objectives

To address the global challenge, decision-makers such as policymakers, businesses, communities, and consumers, across the world must work together to drive ecological, social, and economic improvements in parallel to achieve a safe and just transition of food systems.

This paper highlights three critical issues and proposes five objectives to be addressed by 2040.

Achieving these objectives could have significant positive impacts on the planet and its people. However, it is crucial to meet them through means that are also economically viable. Therefore, this paper outlines three global focus areas with examples of collective actions that can drive the positive development of food systems to inspire decision-makers to reimagine the art of the possible and to determine more specific objectives and actions that drive the transition forward.

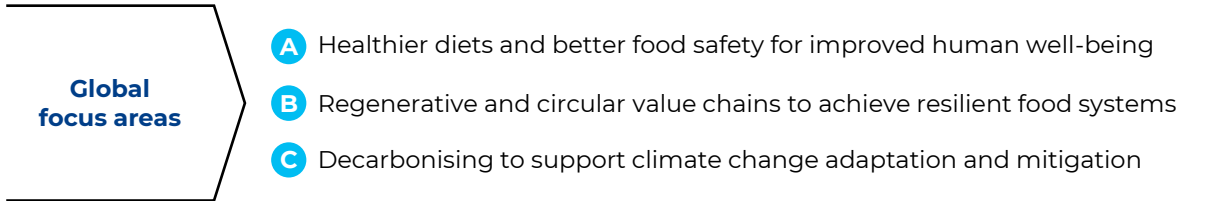


* Emission level estimate range based on interviews and proxies to decarbonise agricultural production and soil use by 2050

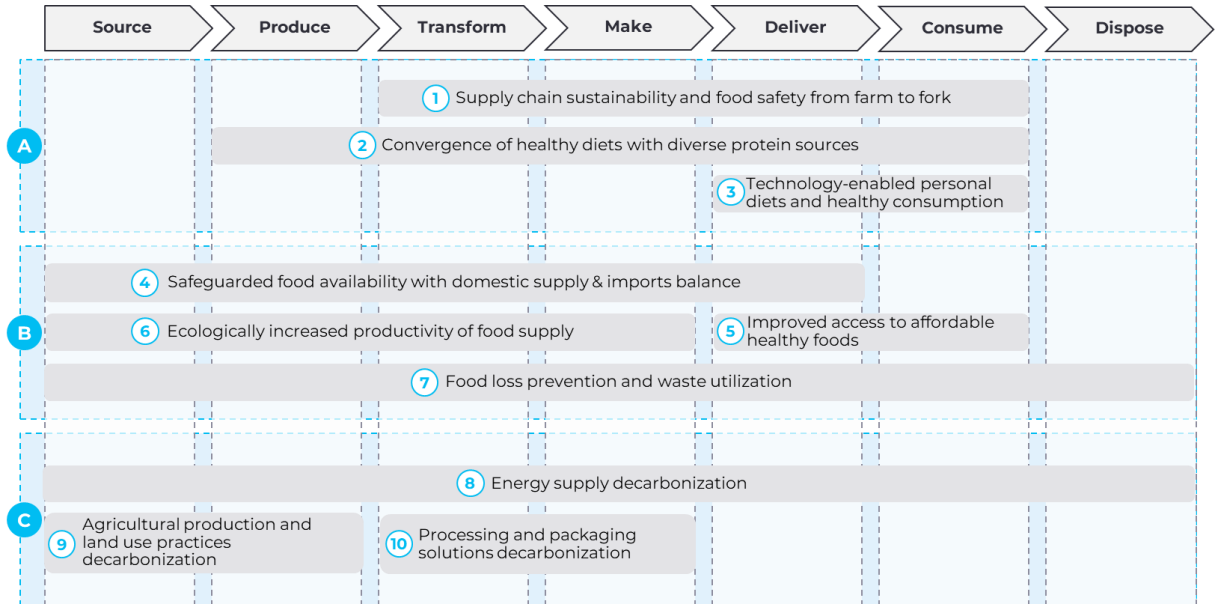
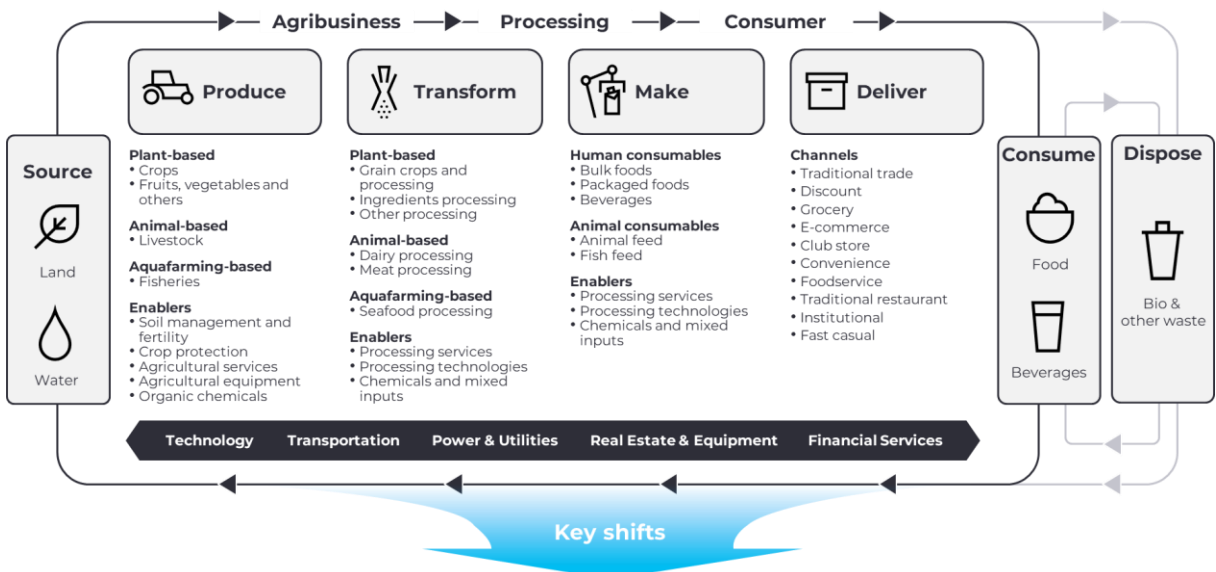
1. Executive summary: Global focus areas

Food systems need to become more regenerative and circular with low-to-no-carbon operations that advance dietary changes towards healthy and ecologically viable consumption patterns.

This paper highlights three global focus areas with 10 key shifts that are needed for the food systems' transition to meet the proposed objectives. Systems-level impacts require a holistic understanding of these interrelated shifts within global food systems. Hence, the below illustration provides a view on the emphasis of the global focus areas and the key shifts on the food systems' value chain.



Food systems value chain and key shifts illustration under global focus areas



1. Executive summary: Key shifts in brief

A Healthier diets and better food safety for improved human well-being

1 Supply chain sustainability and food safety from farm to fork

Ensuring standardised food safety practices in supply chains and at consumption, especially in regions with nascent food systems. This is needed across the entire value chain through the development and implementation of traceability, processing, packaging, storage and transportation systems that improve the nutritional quality and safety of food as well as the retention and enhancement of nutrients, combined with better preservation of perishable foods and mitigation of disease spreading. Hygiene and sanitation practices, which affect exposure to pathogens and contaminants, should become widespread, also in the consumption phase.

Enhancement of economic opportunities in vulnerable regions with extended social protections to ensure that most excluded communities get access to safe and sufficient nutrition. This shift requires timely interventions, direct foreign aid, and social protection systems to break the cycles of childhood mortality and food-borne diseases together with economic empowerment of small holder farmers.

2 Convergence of healthy diets with diverse protein sources

Moving food consumption preferences and patterns towards more ecological and healthier foods requires the transition towards more balanced diets while considering the planetary boundaries and social justice. The specific changes that are needed depend on individuals and regions, as for example, regions where lifestyle-related diseases are common due to e.g. overnutrition and obesity, have different change needs from regions with undernutrition.

Wider use and availability of diverse protein sources from e.g. precision fermentation, cellular agriculture, insects, and plant-based alternatives provide opportunities for balancing diets if cultural, behavioural, and consumption preferences move towards them.

Supporting the movement via policy interventions and business actions towards consumption of healthier and more environmentally sustainable options. Businesses can adjust their product portfolios and formulations while policy interventions, such as national dietary guidelines, can consider the negative social and environmental externalities of foods in recommendations to consumers, schools and other organisations.

3 Technology-enabled personal diets and healthy consumption habits

Increasing consumers health awareness and ability to make conscious dietary decisions through the support of digital services. Although technology cannot solve everything it can greatly support the transition as continuous increases in data and digital services enable food systems to empower individuals with greater knowledge about their food choices, including negative externalities for the environment, social aspects along supply chains, and their personal health.

Advancement of personalised diets based on available services and data, can drive individual consumers to adopt highly personalised diets that are customised to their purchasing power, local offerings and individual health conditions. Brands and businesses can leverage personalisation by taking part in consumers' personal health and sustainability journeys. With the digitalisation of healthcare and emergence of more advanced wearables, larger numbers of consumers can reduce their health risks such as chronic diseases from the overconsumption of unhealthy foods.

1. Executive summary: Key shifts in brief

B Regenerative and circular value chains to achieve resilient food systems

4 Safeguarded food availability with domestic supply & imports balance

Promoting an adequate diversity of nutritious food sources and crops that can adapt to different agroecological conditions to maintain a balance between domestic supply and imports to meet the population's demand. The key focus area should be in securing sufficient domestic food availability, while having strategic imports to act as a buffer during times of scarcity, mitigating potential production shortfalls or disruptions in domestic supply. Additionally, climate adaptation and just transition play an important role in this shift.

5 Improved access to affordable healthy foods

Achieving fair and stable access to nutritious food for all people, especially the poor and vulnerable, who are most affected by food price shocks and food insecurity. This requires focus on:

- (1) The physical availability of food among local food providers, as well as the transportation and infrastructure that facilitates the distribution from production to consumption.
- (2) The economic affordability of food, influenced by the income and purchasing power of consumers, as well as the prices of and subsidies for food products.
- (3) The social acceptability of foods reflecting the cultural norms, values, beliefs, and traditions that shape the food choices and preferences of people.
- (4) Nutritional adequacy of food, which refers to the quality and diversity of food that meets the dietary and health needs of people, especially those who are most vulnerable.

6 Ecologically increased productivity of food supply

Improving the efficiency and productivity of food systems with circularity and regenerative practices. This involves the ability to produce higher quantities with less energy and fewer resources, resulting in the optimisation of natural resource use, while minimising the negative environmental impacts to e.g. farmlands and adjacent nature.

Advancing food system innovations are needed to advance the regenerative and circular changes in the food systems. The innovations need to aim towards better supply resilience, productivity, quality, safety, accessibility, and living incomes.

7 Food loss prevention and waste utilisation

Preventing food loss and utilising waste by promoting principles of circular economy. For example, major purchasers, such as retailers, can make defective products (e.g. vegetables without the ideal shape, colour etc.) available for consumers. Shelf-life of highly perishable foods can be increased with the adoption of innovative technologies and practices from production to consumption, while consumer education and awareness campaigns can reduce food loss and waste at the household level. Focus on this shift can lead to:

- (1) Saving more food for human consumption.
- (2) Generating economic savings for businesses and consumers.
- (3) Reducing the environmental and climate impacts of food production and consumption.

1. Executive summary: Key shifts in brief

C Decarbonising to support climate change adaptation and mitigation

8 Energy supply decarbonisation

Adopting affordable and widely available low-to-no carbon energy supply to cut emissions drastically across the food value chain. This shift is heavily reliant on the progress made in the global energy transition towards decarbonisation, which encompasses the increased adoption of renewable and carbon free energy sources, e.g. solar, wind, and nuclear power. Additionally, low-carbon fuels (e.g., biofuels and green hydrogen), and electrification, facilitated by the development of robust energy storage technologies play an important role in enabling the transition.

Especially within transportation, energy supply decarbonisation enables the widespread adoption of low-carbon and electrified transportation solutions, thus further contributing to the overall decarbonisation efforts in the food supply chain. In addition, more focus is needed to ensure that the energy transition takes place with respect for human rights.

9 Agricultural production and land use practices decarbonisation

Focusing on tailored “fit-for-local-purpose” methods to reduce emissions from agricultural production and land use practices. These methods should be developed for economically viable scale, such as soil carbon sequestration through practices like agroforestry and reforestation, livestock decarbonisation through efforts such as improved manure management, and the adoption of lower carbon inputs and methods, which include e.g. reduced synthetic fertiliser use and precision agriculture.

Identifying and understanding the ‘method-location fit’ of available alternatives for the best cost-impact ratio, along with implementing economically viable long-term policies and programmes that support transition plans, financing options and producer education are the pivotal factors enabling transformative change and tackling certain key challenges such as the lack of easily accessible and area-specific knowledge on the best-fit methods to support decision-making, the costs of necessary investments, and a lack of suppliers and technological knowhow to implement changes.

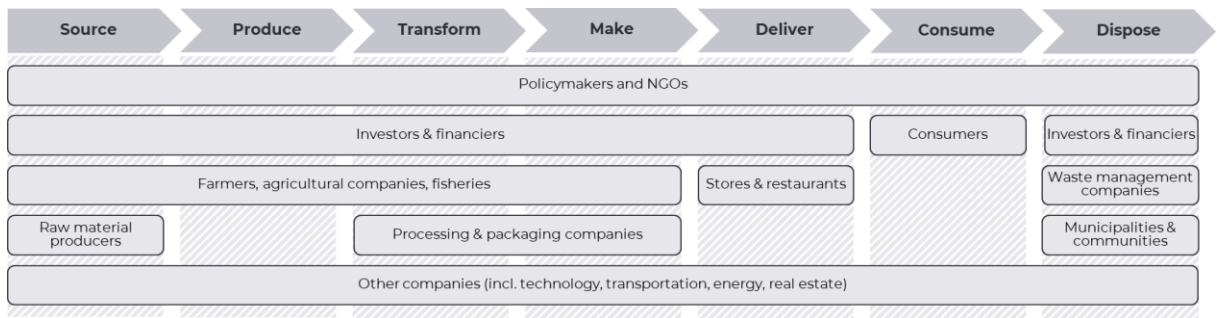
10 Processing and packaging solutions decarbonisation

Low-emission technologies and operations enabled through processing and packaging activities that support the decarbonisation efforts across the value chain. For example:

- 1) Upstream: Shortening supply chains and transportation requirements by implementing smaller, near-farm processing and packaging facilities. Additionally, technologies can be leveraged to gather data, for example to monitor emission impacts of farming.
- 2) Processing and packaging sites: Enabling of data-driven emissions tracking and optimising of production planning through developing and employing energy-efficient technologies. These efforts include the utilisation of side streams for heat, reuse, and upcycling, as well as the adoption of low-carbon inputs for packaging materials or non-fossil based chemicals in processing.
- 3) Downstream: Circular end products such as packaging, as well as the necessary data assets for traceability of ‘climate-friendly’ consumables can be facilitated through the development of technologies and digital solutions tailored to food systems and supported by policies and programmes aimed at fostering circular systems.

1. Executive summary: Collective actions needed

Key decision-makers across the value chain



Role and actions in multi-stakeholder collaboration* towards food systems transition*



Policy-makers

Policy-makers need to provide enabling legislative ambitions and actions to drive ecological improvements. A level playing field is also needed for businesses, via practices such as True Cost Accounting, to better account for environmental and social costs, as well as providing safeguards for vulnerable communities and small holder farmers. It is important that efforts to address ecological issues related to food systems respect human rights to secure a just transition.

This can be done by mitigating transition costs (including through investments in social security and re-training for those left behind) and by promoting economic opportunities for sustainable business models to encourage businesses to accelerate their transition journeys while promoting awareness, understanding, and adaptation readiness within society.



Businesses

Businesses must understand actual and potential impacts on people and the environment. This requires identification of their baseline, followed by opportunity identification and ambition setting to drive transition actions. For instance, businesses can align their objectives with the UN SDGs, UNGPs, and global sustainability standards.

Businesses with limited resources can seek support and best practice sustainability knowledge through available national initiatives such as the local UNGC networks.



NGOs & civil society

Some Non-governmental organisations (NGOs) need to play an active role in challenging policymakers and businesses to critically evaluate their goals and actions against environmental, social, and economic aspects based on scientific evidence and lifecycle thinking. Additionally, other NGOs play an important role to develop and co-create policies that guide sustainable development. To aid vulnerable populations NGOs could seek to establish partnerships with public and private organisations to drive on-the-ground action in areas where resources are insufficient.

Civil society movements towards expecting and demanding more ecological food systems as well as a safe and just transition should be supported.



Consumers

Consumers with adequate purchasing power should strive to gain a better understanding and have easier access to healthy food consumption choices.

For consumers in vulnerable communities with limited access to or the ability to pay for healthy foods, it can be beneficial to be part of civil society and engage policymakers, businesses, and NGOs to find collaborative solutions that support their needs.

* Described in more detail in Chapter 4

1. Executive summary: Tetra Pak's contribution

The ambition of Tetra Pak is to collectively shape and enable the transition to more secure, sustainable and resilient food systems through our food processing technologies and packaging solutions. Following a consultative process, we have identified four key pathways to drive change. Our separate pathway papers will further elaborate on some of the key enablers and collective actions that are needed to support the transition.

Tetra Pak's pathways in brief

1.

Enabling transition towards more sustainable dairy*

Recognising the important role of dairy production and consumption in food systems, we focus on enabling the transition towards more sustainable dairy practices, by addressing the environmental impact of dairy processing, while also supporting smallholder farmers' productivity, profitability, and livelihoods.

2.

Innovating for new food sources

Working in collaboration our aim is to advance innovation in and development of alternative protein sources that require less resource-intensive supply chains than conventional proteins and to enable the scaling up of new food technologies for producing these new food sources at scale.

3.

Reducing food loss and waste

We are contributing to reducing food loss and waste by developing food processing technologies that help reduce food loss during production, including new solutions to turn side-streams into value-added products. Our aseptic packaging solutions also help reduce food waste by keeping perishable products safe for longer.

4.

Scaling access to safe nutrition via sustainable food packaging

Food packaging plays an essential role in ensuring food safety and accessibility. We are committed to scaling access to safe nutrition globally by developing and promoting sustainable food packaging solutions**, that minimise environmental impact, preserve food quality, and enhance the circulatory of resources.

More information on our pathways can be found on our [website](#)

* Sustainable dairy is defined as a dairy industry that emits less greenhouse emissions by introducing technologies, equipment and best practices in production and processing to safeguard nutrition security and sustain a billion livelihoods for tomorrow, while helping secure a future for us all.

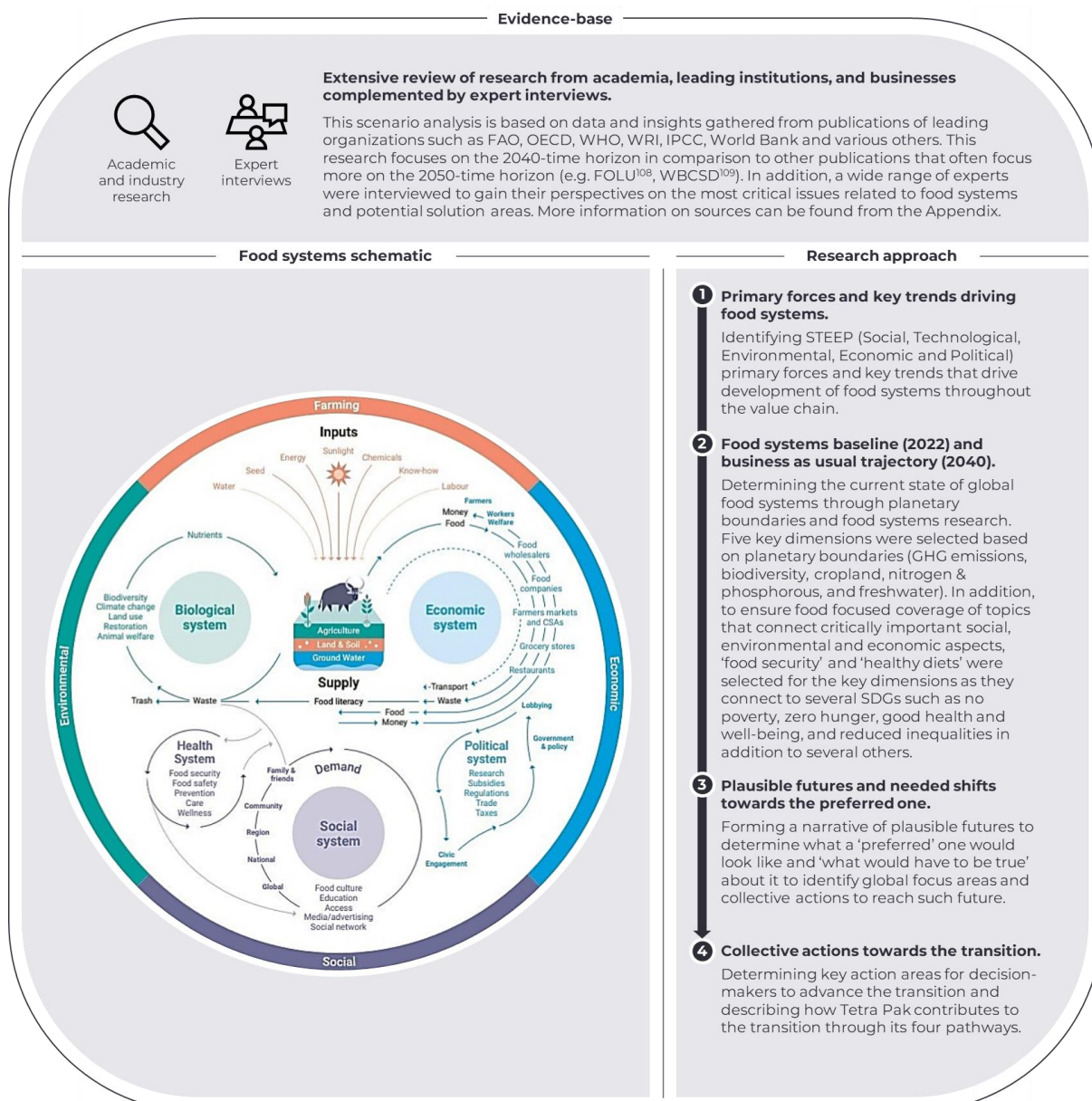
** Packaging that achieves its functional requirements with minimal environmental impact, that is made from responsibly sourced renewable or recycled materials, is recyclable, and has low carbon footprint in regards to manufacturing, shipping, and recycling

2. Introduction and approach

Global food systems are an integral component of complex biological, social, economic, political, and health-related systems that are closely linked to non-food sectors such as power and utilities, real estate, and transportation, as illustrated in the schematic below.

This paper describes key drivers, trends, challenges, and outlooks for food systems. Based on these drivers and the baseline, a narrative for plausible futures is derived, including one that is preferable, to identify key shifts and collective actions needed for an ecologically, socially, and economically viable transition. This transition is demonstrated through three global focus areas related to human health, resilience of food supply, and decarbonisation.

Research approach in relation to food systems schematic

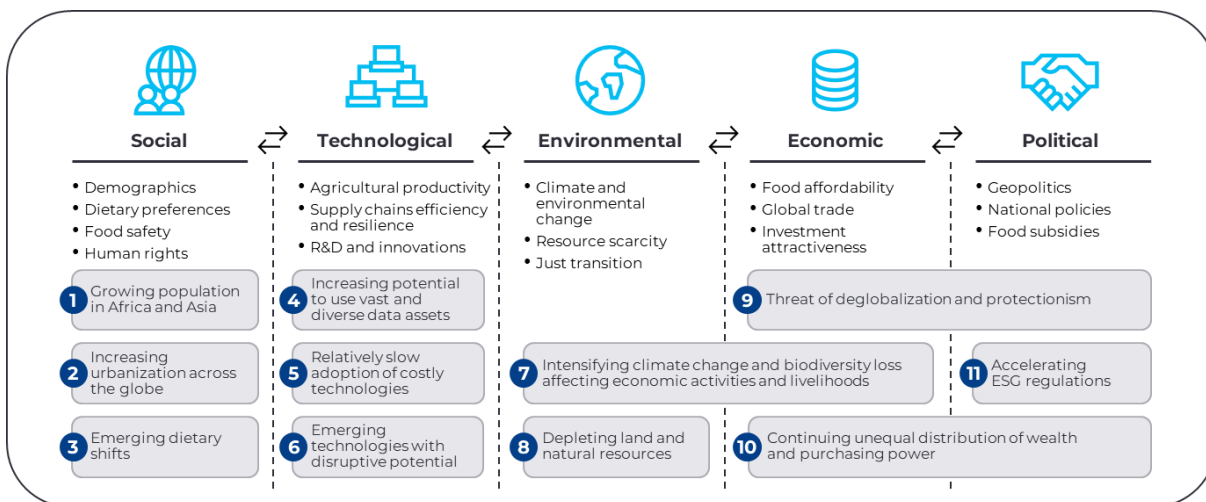


Source: Schematic from United Nations Environment Programme, 2021⁸

Primary forces and key trends driving food systems

The future of food systems depends on the drivers that affect their development over time. Through a wide scan of research papers and expert interviews, more than 100 drivers with varying scales of impact potential, from local to global, were identified. The below picture summarises the key drivers under STEEP (Social, Technological, Environmental, Economic, and Political) categories as well as some of the key trends that were identified to provide a basis for assessing the food systems baseline and potential future directions.

Key primary forces and trends



STEEP primary forces focus on fundamental drivers affecting food demand, availability, access, and affordability, as well as supply productivity and resilience on a macro-level. Based on the assessment of key primary forces, 11 key trends were identified that are expected to affect the short- to mid-term development of food systems.

1. Growing population in Africa and Asia: The global population is projected to surge to 9.2 billion by 2040, with Africa and Asia being the primary contributors to this growth. Africa's population is expected to rise by +47% to 2.1 billion; Sub-Saharan Africa is expected to account for over half of the world's population growth; and Asia's population is estimated to grow by 10% to reach 5.2 billion by 2040 compared to 2022.² This substantial population increase poses a formidable challenge, requiring a 70% boost in food production according to the FAO, straining natural resources and supply chains, and potentially exacerbating food insecurity and resource depletion in certain regions due to uneven population growth.⁹

2. Increasing urbanisation across the globe: Urbanisation is expected to continue its growth, with the global urban population reaching an estimated 6 billion by 2040, approximately 65% of the world's population, with Africa's urban population expected to grow at the fastest rate of +3.2% per annum, followed by Asia with an expected growth of +1.3% per annum.¹⁰ Rapid urbanisation is poised to profoundly affect food systems by driving shifts in dietary preferences, consumption patterns, and food production practices while also presenting challenges such as land loss for agriculture, extended supply chains, and increased food waste, particularly in regions with inadequate supply chain infrastructure such as cold chains.¹¹

3. Emerging dietary shifts: Consumers from developed nations are increasingly changing their consumption habits due to health and climate reasons. For example, European countries have undergone pronounced changes in dietary consumption patterns in the last decades towards adopting healthier dietary behaviours characterised by reductions in average reported intakes of sugar, carbohydrates, and saturated fats and increases in reported fruit and vegetable consumption.¹² Furthermore, changes in generational cohorts are also affecting consumption behaviour. Gen Z and Millennials are currently the two largest generational cohorts in the world, making up close to 50% of the world's population.¹³ Their stake in global consumer spending is expected to rise from 48% in 2020 to 69% in 2040, and they are thus poised to wield significant influence over food systems, driving a greater demand for sustainable and health-conscious products, especially in higher-income countries.¹⁴

4. Increasing potential to use vast and diverse data assets: The call for a data revolution, prompted by the 2017 Global Nutrition Report¹⁵, emphasises the growing significance and potential of harnessing diverse data resources to address complex food system challenges. Increasing investments continue to strengthen the entire data value chain, from collection and analysis to interpretation and utilisation, with expectations that data will enable improved policymaking and accountability mechanisms for food systems in the near future. While food system value chains are becoming increasingly connected through numerous layers of data and systems, there still exist significant gaps across all components of the food system, from supply chains, food environments, diets, health, and sustainability-related outcomes.¹⁶ Consumers are also increasingly pushing for greater supply chain transparency, which could be facilitated by real-time data sharing, to enable them to make more informed choices aligned with their values.¹⁷

5. Relatively slow adoption of costly technologies: Food systems-related sectors have so far been laggards in technological, particularly digital, adoption, especially in the upstream of the food value chain when compared to other sectors.¹⁸ The complexity within the value chain, coupled with insufficient policies, funding, and stakeholder education, has hindered the widespread adoption of technologies, leading to uneven implementation across different societies.¹⁹ Especially higher-income countries have had an advantage in utilising innovative, but costly, technology in food system transitions, while lower-income countries do not have the financial means to adopt crucial technologies, perpetuating significant uncertainties in achieving widespread adoption and making a substantial impact on food systems even in the coming years and decades.²⁰

6. Emerging technologies with disruptive potential: Some nascent innovations hold significant potential for expediting the transformation of food systems if they were to reach mass scale. Such key technologies, as identified by the World Economic Forum, include (1) digital building blocks such as big data, the Internet of Things, artificial intelligence, machine learning, and blockchain; (2) new physical systems such as advanced robotics, manufacturing, and materials; and (3) scientific breakthroughs in next-generation biotechnologies, genomics, and energy systems. If nascent innovations such as cellular agriculture and genome editing reach large scale, leading to cost-competitive food products, they may lead to unexpectedly fast shifts within food systems.²¹

7. Intensifying climate change and biodiversity loss affecting economic activities and people's livelihoods: Climate change-induced extreme weather events are increasingly disrupting the food supply chain and causing supply shocks. These changes threaten crop and livestock losses, declining yields, the availability of safe and nutritious foods through supply chain disruptions, and the ability to sustain a growing global population, exacerbating human exposure to climate emergencies, biodiversity loss, and mass species extinction, leading to potential mass migrations.²² The effects of climate change and increasing extreme weather events by 2040 will likely have unequal impacts between the Global South and North, and more severe impacts on the most vulnerable groups. Countries in Sub-Saharan Africa, Southern, Western, and South-Eastern Asia and Southern America are expected to bear a disproportionately heavier burden from climate change and biodiversity loss due to limited resources, weaker infrastructure, and higher vulnerability. Especially indigenous people, children, women and the elderly are vulnerable to the physical effects of climate change.¹¹²

8. Depleting land and natural resources: Globally, soil is degrading and fertility is declining, with an estimated 24 billion tonnes of fertile soil lost each year due to extensive agriculture and improper use of resources, leading to increased pressure on existing farmlands.^{24,25} Moreover, biodiversity loss, primarily focused on developing countries, is projected to escalate by 2040 due to factors such as habitat destruction, unsustainable land use, and limited resources for conservation, further exacerbated by rapid urbanisation and industrialisation.⁹ This can lead to reduced crop and livestock diversity, further increasing their vulnerability to pests, diseases, and environmental changes, ultimately endangering both food security and resilience, causing human rights challenges and negative impacts on vulnerable communities livelihoods. Water scarcity is set to exert additional pressure on food systems and the provision of clean and safe drinking water for everyone, with projections indicating that by 2050, one in every two people and approximately half of the world's grain production could be at risk from water stress.²⁶

9. Threat of deglobalisation and protectionism: Although trade in agro-food products has experienced robust growth at a rate of 7% per annum over the past two decades and has demonstrated greater resilience compared to other sectors amid global trade disruptions triggered by the Covid-19 pandemic²⁷, the proliferation of unilateral and non-tariff trade restrictions imposed by nations poses a significant threat to international trade. This situation has resulted in a diminished global food supply, leading to price shocks that disproportionately impact the most vulnerable populations²⁸, which are expected to continue due to current geopolitical trends.

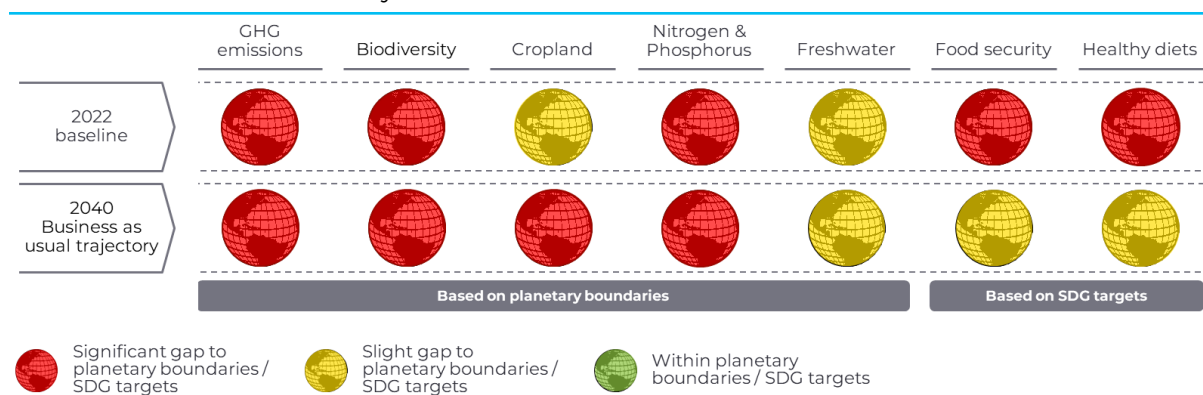
10. Continuing unequal distribution of wealth and purchasing power: Global per capita income has increased by about 1.4 times in the last three decades, but significant regional disparities persist, with emerging East Asia and the Pacific experiencing rapid growth at 7.4% annually compared to sub-Saharan Africa's much slower growth at 1.1%.²⁹ Projections suggest that global income disparities between rich and poor nations will continue to exist well beyond 2040, while in rich nations, income inequality between the richest and the poorest has seen a continuous increase, leading to growing inequalities amongst citizens with no change of course in sight.³⁰ Consequently, exposure to income, food price, and inflation shocks is expected to remain high for the lowest income groups which may worsen food poverty.

11. Accelerating ESG regulations: On the environmental side, approximately three-quarters of countries worldwide, accounting for 88% of global greenhouse gas (GHG) emissions, have conveyed their commitment to achieving net-zero emissions through either domestic legislation, policies, or high-level political commitments.³¹ The UN Food Systems Summit and the UNFCCC COP26 meetings in 2021 recognised the pivotal role of food systems in global climate discussions and solutions, marking a significant shift towards prioritising food systems in the global discourse on climate change impacts and remedies.³² However, there is a pressing need to accelerate specific actions and targets pertaining to food systems, as they currently feature limited inclusion within countries' Nationally Determined Contributions (NDCs).³³ When taking action to mitigate climate change, businesses need to respect human rights as per the UNGPs on business and human rights, to ensure a just transition that leaves no one behind. Human rights due diligence is increasingly becoming mandated, both by national law and in the coming EU due diligence directive.

Food systems baseline and current trajectory

Currently, global food systems face a multifaceted crisis that poses risks to human health and the environment. Global food production stands as the primary driver of environmental degradation and transgression of planetary boundaries, imperilling climate stability and ecosystem resilience, while unhealthy diets are the greatest threat to human health from lifestyle-related diseases.³⁴ The following key dimensions have been chosen based on adjusted findings from planetary boundaries that have been crossed, as well as key socio-economic challenges that link to multiple UN SDGs*.

Baseline and outlook for the key dimensions*



Source: Adjusted from Katherine R. et al. 'Earth beyond six of nine planetary boundaries';¹ EAT-Lancet Commission Summary Report;³⁴ UN Sustainable Development Goals Report 2023;³⁵ UNICEF/WHO/World Bank Group – Joint child malnutrition estimates 2023³⁶

* Research approach on Chapter 2 describes how the key dimensions were selected

Climate and biodiversity: The IPCC warns that the planet is expected to warm to 1.5°C by 2040 if no significant measures are taken to curb greenhouse gas emissions.³⁷ Current global policies are on track to align with the IPCC's medium or high scenarios, which could result in 2.7°C to 3.6°C of warming by 2100, well above the Paris Agreement's long-term temperature target, highlighting a substantial gap between promises and actions.³⁸ Food systems account for a third of our planet's GHG emissions³, and agriculture emissions are still on the rise, expected to more than double by 2040 without any productivity gains, leading to climate instability and the continued loss of biodiversity.³⁹ In the next few decades, depending on the climate change scenario, local ecosystems will have lost on average between 6 and 11% of their vertebrate species.⁴⁰

Cropland, nitrogen / phosphorous and freshwater usage: According to the United Nations, the depletion of fertile land is occurring at an alarming rate, as every year 12 million hectares of productive land are lost⁴¹, which is equal to losing ~85% of all current arable land in Sub-Saharan Africa by 2040.⁴² Currently, the FAO estimates that a third of the earth's soil is already degraded⁴³ and over 90% could become degraded within the next three decades as the erosion rate of farmland is 100–1000 times higher than natural erosion rates, with eroded soil leading to a loss of up to 50% in crop yields.⁴⁴ Furthermore, long-term forecasts indicate increasing agricultural pressures in crop and livestock production, increasing nitrogen and phosphorous surpluses globally (+23% N, +54% P), with the heaviest loading happening in Africa and Latin America.⁴⁵ Agriculture is the primary source of nitrogen and phosphorus inputs with elevated concentration levels, resulting in significant ecosystem damage and health issues from pollution as current input levels are already substantially above identified safe and just earth system boundaries.⁴⁶ In conjunction, the global water budget is under pressure as withdrawals from freshwater sources are already past the limit of planetary boundaries¹ with agriculture accounting for three-quarters of freshwater withdrawals. Total freshwater withdrawals are expected to remain stable or decline with overall increases in water productivity; however, regions facing strong population growth are anticipated to see an increase in their rates of water withdrawal.⁴⁷

Food security: In a business-as-usual scenario, it is anticipated that by 2040, approximately 300 million people, equivalent to 3.3% of the global population, will continue to suffer from undernourishment, partially due to food poverty, with the most affected regions being Sub-Saharan Africa and Asia West.⁴⁸ While the natural resource base may be adequate to meet global food demand, according to long-term perspective studies by the FAO, bottlenecks in food availability are expected at national levels, particularly in regions with high population growth.⁴⁹ The Near East and North Africa heavily rely on food imports (71% of total calorie availability in 2022) due to population growth and water constraints and are expected to remain heavily reliant throughout the next decade. Sub-Saharan Africa's import share, although lower at 20%, is projected to increase to 22% in the next decade due to challenges in domestic production, such as high population growth and trade infrastructure limitations.⁵⁰ The significance of trade in ensuring ample food supply and food diversity is threatened by the deteriorating global trade situation as the global food trade landscape is evolving with increasing fragmentation, hindering global trade cohesion, and growing the prominence of regional and bilateral agreements driven by national security and protectionist goals.⁵¹ The situation is exacerbated by the lagging anticipated growth in per-capita income of low-income countries²⁹, high inequality, as well as expenditure on food in low-income households, which is expected to remain at an average of 43% of total household expenditure in the next decade, likely resulting in persistently high vulnerability to income and food price shocks among the lowest income groups.⁵²

Healthy diets: Global progress towards nutrition targets is falling short, with five of the six maternal, infant, and young children nutrition (MIYCN) goals being off-track, including stunting, wasting, low birth weight, anaemia, childhood overweight, and diet-related non-communicable disease targets, which include salt intake, raised blood pressure, adult obesity, and diabetes. Unhealthy diets persist globally and have not improved over the last decade, with fruit and vegetable consumption at 50% below recommended levels, severely insufficient intake of legumes and nuts, and excessive consumption of red and processed meats. No region adheres to healthy diet recommendations, but regional disparities persist as lower-income countries lack essential foods and struggle with underweight, while higher-income nations consume high-impact foods, leading to overweight and obesity.⁵³ While there has been some reduction in childhood stunting and wasting over the past two decades, it is not happening quickly enough to meet the Sustainable Development Goals (SDG) by 2040, according to a joint report by UNICEF, WHO, and the World Bank Group.³⁶

Plausible futures and transition scenarios towards the preferred one

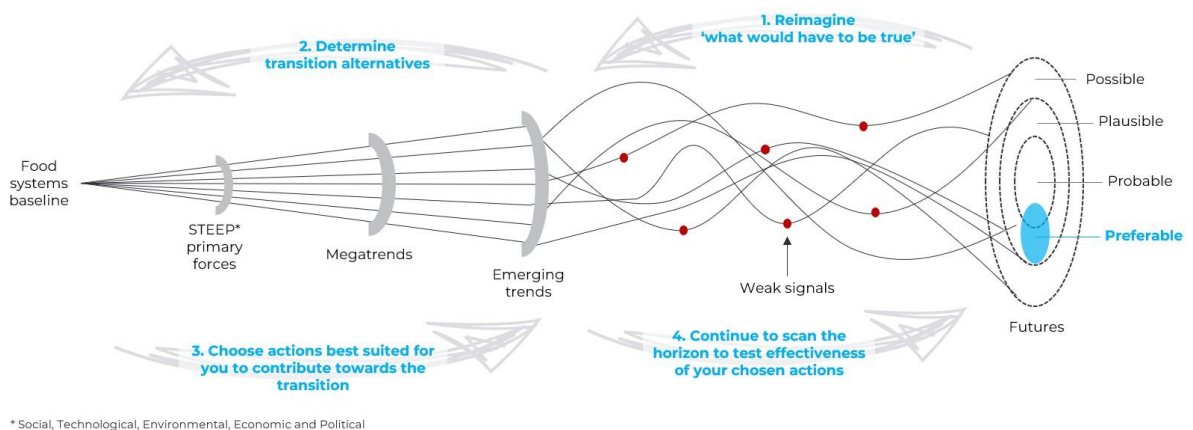
While the food systems baseline provides an understanding of the key challenges today and projections on what might happen if they were to continue on the current trajectory, the number of uncertainties is too high for anyone to predict, with a reasonable certainty, what food systems will look like in 2040. Hence, the use of scenario analysis provides more suitable tools to reach actionable outcomes for identifying potential future directions.

The scenario approach used in this paper (illustrated in the below visual) considers what is:

- 1) **Possible:** What can occur or be achieved without violating the laws of physics
- 2) **Plausible:** What is reasonable, believable, and somewhat likely based on available information
- 3) **Probable:** What events have high likelihood or a strong possibility of occurring or being true
- 4) **Preferable:** What would be beneficial for people and the planet

With these differences in mind, the paper assesses the primary forces, trends, and signals to identify plausible futures with regards to ecological, social, and economic viability of food systems and describes the determinants of a 'preferred future' to provide a way to reimagine improved state of food systems and how the transition towards it might take place.

Scenario analysis approach



Plausible future scenarios in the horizon

As illustrated in the matrix below, there are four plausible future directions to which countries and regions may move towards in the coming decades. These scenarios are dependent on the global community's response to the climate and ecological crises (the ecological axis), as well as actions taken to address social injustice (the socio-economic axis).



Key characteristics of plausible future scenarios



Prosperity on a narrowing edge

Wealthy societies have made significant strides in improving people's well-being and quality of life with access to extensive food options, education, healthcare, and economic opportunities that have become more equitable, leading to widespread social and economic prosperity.

However, these improvements come at the expense of the planet's ecological well-being. Despite advancements in technology and resource management, the world faces escalating environmental challenges via intensified climate change, increased pollution, and unprecedented biodiversity loss.

The planet's ecosystems are strained as human activities continue to exert pressure on natural resources, leading to less trade and collaboration as privileged nations, mostly part of the Global North, turn to protectionism, while climate change impacts worsen the access to food and better livelihoods in less wealthy regions like the Global South



'Green' by any means

Ecological conditions have improved significantly across the globe through ambitious decarbonisation efforts across energy and food systems, while also effectively curbing biodiversity loss. Pollution has drastically reduced, and natural habitats have improved, having positive affects on human health.

However, the achievements come with a stark trade-off. The financial burden of ecological improvements falls disproportionately on marginalised communities, while societies experience increased economic disparities due to the unequal distribution of the financial burdens of the achieved transition.

The world grapples with the challenge of reconciling ecological health with the need for equitable socio-economic well-being as loss of livelihoods and deteriorating standards of living destabilise countries and weaken the food supply across the Global North and the Global South.



Dual Deficits Crisis

Most nations find themselves in a precarious state where both ecological boundaries and societal foundations have been severely compromised.

Ecological degradation has led to widespread problems, including rapid biodiversity loss, escalating pollution, and extreme climate events. Simultaneously, socio-economic disparities have widened, as marginalised populations experience significant shortfalls in access to education, healthcare, nutritious foods, and human rights due to lack of just transition.

The unsustainable exploitation of resources exacerbates these challenges, leaving societies grappling with urgent crises. This leads to getting close to a point of no return that cannot be reversed in generations, causing political fragmentation and protectionism benefiting the very few and privileged while accelerating mass migrations to those few prospering nations.

Focus of this paper



Preferred future

Most nations are on a trajectory to balance economically thriving food systems, ecologically healthy environments, and widespread human well-being due to just transition. Large proportions of costs that originated from the transition were mitigated through market developments that moved consumer demand towards ecologically and socially responsibly produced foods, which businesses shifted to deliver, resulting in reshaped markets across the food systems value chain.

Those communities that had human rights challenges and limited means to participate in the transition were supported by programmes from public, private, and civil society organisations. They funded investments and education that enabled sustained food security and local food supply chains in nations impacted by climate change, especially in regions such as the Global South.

Aiming to reach the preferred future is the only viable option. The plausible futures blueprint demonstrates the risks associated with balancing between socio-economic human well-being and ecological health. Although all four future scenarios are plausible, only the 'preferred future' provides an option to improve global food systems with a safe and just transition in mind. It is important to note that the other three scenarios fail to protect people and the planet on a global scale. Therefore, this paper reimagines food systems from the preferred future's perspective.

Determinants of preferred future for 2040

To sharpen the vision of the 'preferred future', three critical issues on a global level were identified, followed by asking the question 'what would have to be true' about them by 2040. This approach led to five critical objectives that provide direction towards the aspired progress. To reach the preferred future, all three issues should be addressed simultaneously by applying transition means that complement each other.

Critical issues and objectives for 2040

Food security and human health

- 1 **Achieving zero hunger and addressing malnutrition globally** by ensuring universal access to safe nutritious food while securing just transition in local food value chains.
- 2 **Empowering every consumer to make health-conscious food choices towards affordable healthy diets** to reduce negative health implications and the ecological burden of existing food consumption patterns.

Food supply resilience

- 3 **Securing biodiversity and ecological health of farmlands** while securing just transition for small holder farmers to improve and preserve farms' long-term productivity potential and halting the depletion of biodiversity and the ecological health of natural environments that are affected by farmlands economic use.
- 4 **Reducing food loss and waste across the value chain** by renewing processes and increasing utilisation of side streams to achieve increased productivity, operational resilience and avoided emissions through circularity.

Decarbonisation

- 5 **More than halving GHG emissions caused by global food systems** from ~18 Gt CO₂e^N in 2021³ towards ~5-9 Gt CO₂e* to support limiting global warming to 1.5°C and to support the net zero journeys most nations are aspiring for beyond 2040 while respecting human rights.

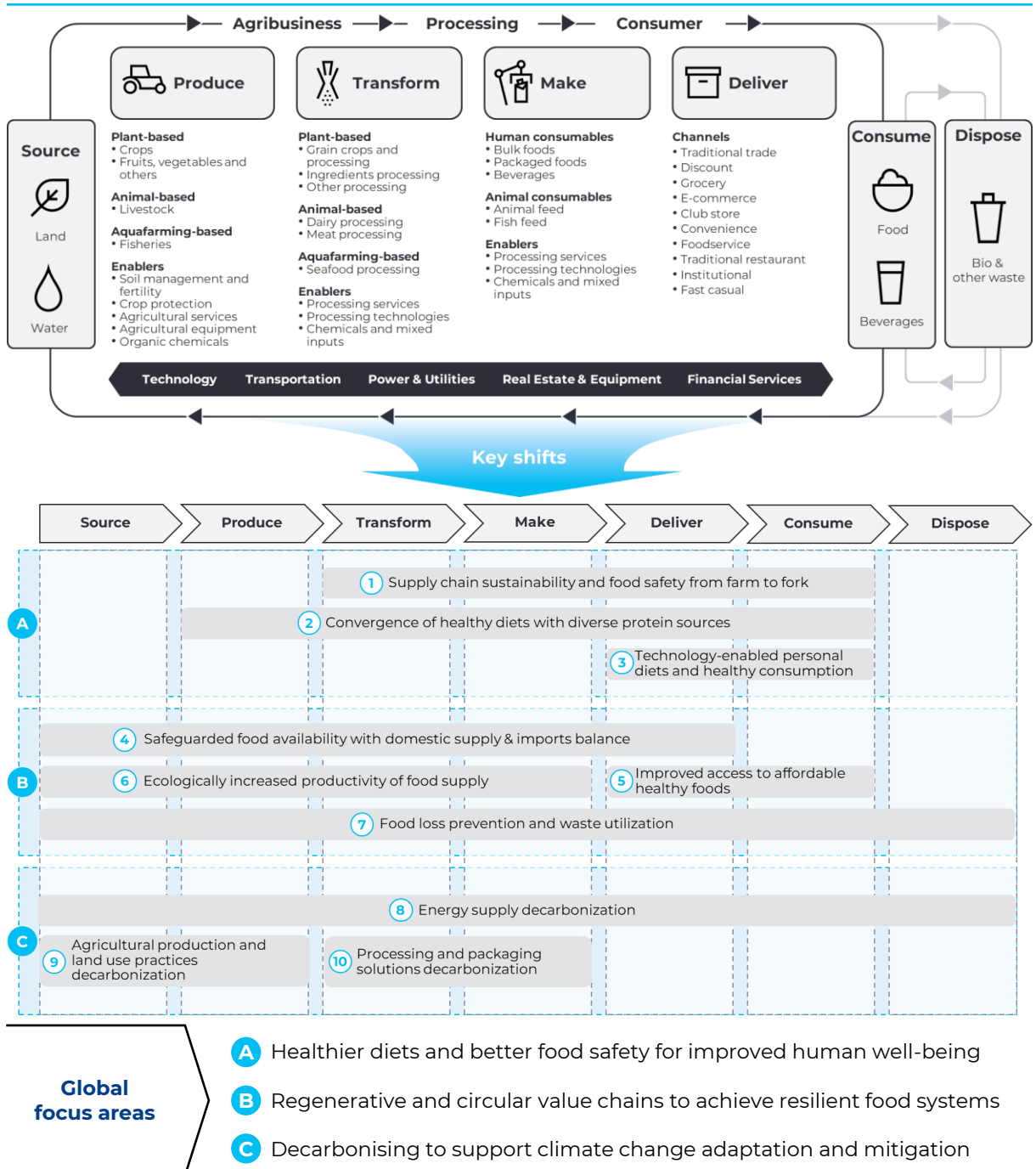
* Emission level range estimate based on interviews and proxies to decarbonise agricultural production and soil use by 2050

4. Safe and just transition to 2040: Three global focus areas

The following three global focus areas aim to provide a perspective for reimagining food systems from: **A) food security and human health**, **B) food supply resilience**, and **C) decarbonisation** perspectives to give tangible descriptions of possible systems-level changes exemplified through ten key shifts, shown in the below value chain illustration to indicate their emphasis on different parts of food systems.

Note that all three global focus areas are complementary by nature, meaning that all of them would ideally coincide as different countries, regions, and organisations plan and execute their transition journeys to ensure that chosen actions and milestones are simultaneously safe and just. The following sub-chapters will describe each of the global focus areas and related key shifts in detail.

Food systems value chain and key shifts illustration under global focus areas



Global focus area A: Healthier diets and better food safety for improved human well-being

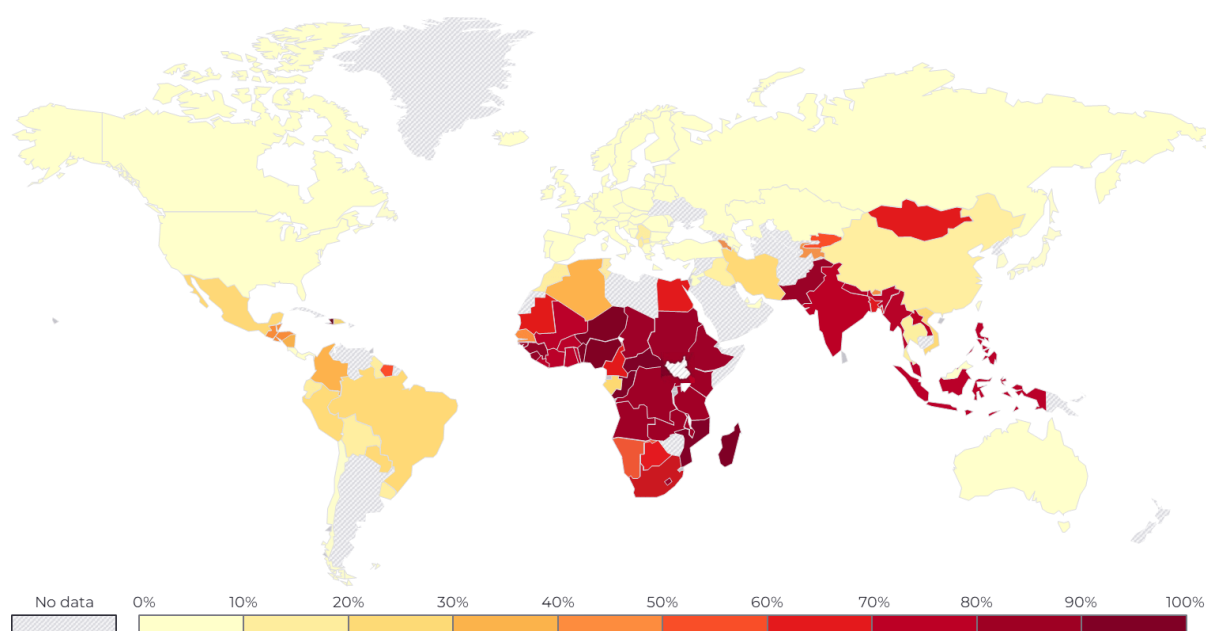
What is this global focus area about?

In the preferred future, consumers across the globe will have remarkably healthier diets (i.e. rich in nutrition, vitamins, and minerals) that improve their health and well-being. As a more regional nuance, people living in less developed or otherwise vulnerable communities would have achieved better food safety, i.e. reduced health risks from e.g. harmful contaminants and cross-contamination, pathogens, and substances. The key prerequisite for this to happen is the affordability of safe and healthy foods, as well as people's willingness to shift their dietary preferences.

The varying geographic challenges can be demonstrated through the share of the world population that cannot afford healthy diets, which is especially high in regions in the southern hemisphere, as illustrated on the heatmap below.

This subchapter highlights the key shifts that would have happened by 2040 to achieve healthier diets and greater food safety by identifying actions across the value chain.

Proxy: Share of population that cannot afford a healthy diet (2021)



Source: World Bank, adapted from Herforth et al. (2022); Our World In Data⁵⁴

Key shifts that would have to be true by 2040

- 1 Supply chain sustainability and food safety from farm to fork
- 2 Convergence of healthy diets with diverse protein sources
- 3 Technology-enabled personal diets and healthy consumption habits

1 Supply chain sustainability and food safety from farm to fork

Surges in governmental action and investments to enhance economic opportunities in vulnerable regions with extended social protections were crucial to ensuring that most excluded communities got access to safe and sufficient nutrition. These achievements were supported by timely interventions, direct foreign aid, and social protection systems that enabled just transition for small holder farmers and development of local food supply chains that broke the cycles of childhood mortality and food-borne diseases.

Food safety practices needed to be ensured throughout the entire value chain, among all food system actors, through the development and implementation of traceability systems supported by available and newly introduced technologies. Hygiene and sanitation practices, which affect exposure to pathogens and contaminants, became widespread practices globally.

Food processing and preparation, which affect the nutritional quality and safety of food as well as the retention and enhancement of nutrients, played a central role in ensuring food was safe for consumption. Advancements in packaging and processing technologies enabled the preservation of perishable foods, and significantly reduced cross contamination, mitigating the spread of disease.

2 Convergence of healthy diets with diverse protein sources

Technological advancements, growing incomes, increased trade, and urbanisation have significantly impacted global food consumption preferences and patterns, especially in developed countries. International collaboration and rapid adoption of digital technologies also brought an increasing variety of foods to consumers.

As many parts of the developed world struggled with obesity, others faced a prevalence of undernourishment. Food systems transitioned to more balanced diets and were optimised to account for planetary boundaries and social justice. Regional differences in diets remained significant, but a wider availability of diverse protein sources, e.g. via precision fermentation, and cellular agriculture, insects and plant-based alternatives helped to offset the local availability of key nutritional ingredients. This supported the progress to end hunger, especially in the Global South.

Businesses played a key role in adjusting their product portfolios and product formulations to promote healthier and more environmentally sustainable options to consumers, while policy intervention through, e.g. national dietary guidelines reflected the latest available scientific standards, considering the negative social and environmental externalities of various food categories recommended for consumption.

3 Technology-enabled personal diets and healthy consumption habits

The consumption patterns of individuals changed through the transformation of food systems. The abundance of information through the internet and the emergence of free-to-use and highly advanced digital services, e.g. generations after the first generative AIs, increased the amount of knowledge consumers had about their choices, including negative externalities for the environment, social aspects along supply chains, and their personal health.

Purchasing decisions became increasingly based on the services and data available, making it possible for individual consumers to adopt highly personalised diets customised to their purchasing power and local offerings. Brands and businesses leveraged personalisation by taking part in consumers' personal health and sustainability journeys.

The digitalisation of healthcare and the emergence of wearables allowed further opportunities to optimise food consumption according to best medical practices, reducing the risk of chronic diseases from overconsumption of unhealthy foods.

What made these shifts possible?

Government policies & regulations

- Governments commissioned and supported research and development initiatives that provided science and evidence-driven understanding on the environmental, economic, and social impacts of food sources to support political decision-making. This led to investments into progressing UN SDGs and a just transition through practices such as the True Cost Accounting that priced economic and social factors into food systems
- Government policies and regulations were developed to reflect healthy and sustainable diets, accounting for negative externalities throughout food system value chains.
- Global policy solutions were implemented to address extreme poverty and undernourishment in developing parts of the world.

Technological development & innovation

- Advanced processing and packaging technologies increased food preservation and shelf life, preventing food-related diseases from spreading from perishable foods.
- Alternative protein breakthroughs became possible through precision fermentation, cellular agriculture, and, for example, insect- and algae-based proteins, achieving price competitiveness with regular foods, which increased healthy nutrition availability globally.

International trade & collaboration

- Barriers for trade of crucial food supplies in vulnerable regions were reduced, and trade and agriculture were subsidised to benefit food security through, for instance, non-tariff policies in the transition stage.
- Open, fair, and transparent trading systems with high traceability of supply chains were ensured together with trade practices, highlighted by WTO, progressing the UN SDGs.

Financial investment & support

- Increased investments enhanced economic opportunities and increased education and awareness in vulnerable communities, providing the means for breaking cycles of malnutrition.
- Public and private backing for the alternative protein sector and solutions addressing food safety and security in the processing and transformation of foods was observed.

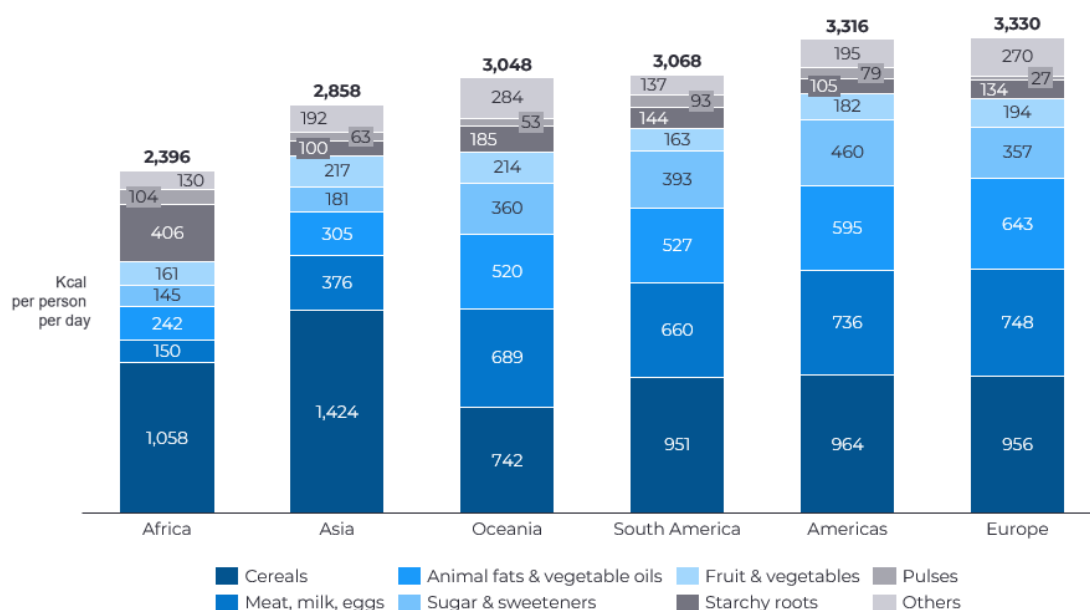
Education & awareness

- Widespread certification schemes were put in place for safe products, linked to product traceability, nutritional values, and labelling (many of which became also legally mandated).
- Populations globally were educated on the benefits of diverse, plant-based diets, leading to increased variety in healthy, nutritious diets globally.
- Increased digitalisation in personal health, through, for example, wearables and dietary applications, has increased demand for highly personalised and healthy diets.

How may the shifts vary in different parts of the planet?

Regionally, the current state of healthy nutrition varies significantly, with countries in the developed parts of the world facing obesity epidemics while less developed areas are in cycles of malnutrition. No silver-bullet solution exists for the challenge, but with timely and collaborative action, food safety and access to healthy diets can be drastically improved. The implications of this can be identified through regions with an 'over', 'under', and 'double burden' of nutrition. The expected implications are that regions with current high daily calorie intake and high purchasing power, e.g. Europe and America, are likely to face challenges with overnutrition, while regions with low intake, e.g. Sub-Saharan Africa, are more likely to face challenges with undernutrition. Countries experiencing strong economic growth or which are emerging economies, e.g. Asia, South America, and North Africa, are seen as 'regions in-between' that may face more challenges with the double burden of malnutrition.

Proxy: Dietary composition by region (2020)



Source: FAO; Our World In Data⁵⁵

Regions facing overnutrition challenges

In this global focus area, governments and regulatory bodies have taken proactive measures to mitigate the negative health and environmental consequences of food production and consumption. Taxing and pricing instruments have been leveraged to account for these externalities, making unhealthy food options less attractive while driving consumers towards healthier alternatives. These policies incentivise the food industry to focus on healthier products by fostering a shift in the market.

Comprehensive nutrition policies have been implemented in schools, ensuring consistent guidelines for the production and serving of healthy and safe foods for consumption as well as nurturing healthy eating habits among the younger generations.

Public awareness campaigns have also played a pivotal role in enlightening individuals about healthier food options and their nutritional impact. With the rise of digital health solutions, consumers are highly aware of their dietary needs as well as the broader environmental and health consequences of the foods they consume. Innovative apps, services, and platforms provide personalised guidance, enabling individuals to make choices aligned with their health, goals, and personal values. Due to the increased ease of healthy choice-making, social pressures towards healthy diets have begun to become common. Additionally, food labelling and nutritional information have become standardised and transparent, empowering informed consumer choices.

Governments and communities have increased efforts to tackle socioeconomic disparities faced by marginalised communities to enable them to access nutritious foods and maintain adequate diets by promoting equitable policies such as enhanced income support programmes, better-targeted food assistance programmes that provide nutritious and healthy options, improved access to healthcare, and additional support for vulnerable groups.

Regions facing undernutrition challenges

A profound shift has occurred as global leaders prioritise the convergence of healthy diets in regions facing malnutrition challenges. International organisations, in collaboration with local governments, implement policies and provide foreign aid that emphasise safety nets. Social protection programmes and integrated healthcare initiatives take centre stage, offering a lifeline to vulnerable populations. This proactive approach not only addresses immediate nutritional needs but also lays the foundation for long-term well-being, reducing the burden of malnutrition and its associated health consequences.

Timely and effective interventions to combat hunger and malnutrition, combined with infrastructure development, serve as catalysts for enhanced stability in the regions. As communities become more food-secure, they are better equipped to engage in international collaboration and capitalise on trade opportunities. Nations collaborate to access a diverse array of safe, nutritious foods, combating nutrient deficiencies and ensuring year-round access to fresh, seasonal produce. Knowledge transfer is further fostered as countries harmonise food safety standards and regulations, raising global food safety standards.

Regions facing the double burden of malnutrition

The double burden of malnutrition has become a growing concern for developing countries as rapid urbanisation leads to a shift in dietary patterns in urban centres while rural areas continue to focus on ensuring their food security.

Governments and policymakers achieve a delicate balance between addressing undernutrition and combating overnutrition. Policies and interventions are thoughtfully designed to provide targeted support to vulnerable populations while also promoting healthier dietary choices for all. Ensuring that children receive adequate nutrition to thrive becomes a paramount goal, while simultaneously encouraging adults to adopt more balanced diets and active lifestyles.

Education emerges as a powerful catalyst for change with comprehensive nutrition education programmes integrated into school curricula, fostering a lifelong understanding of the importance of balanced diets and healthy eating habits.

Technology takes centre stage in the future of food systems, where advances in agriculture, food production, processing, and distribution enable countries to produce diverse, nutritious crops more efficiently and with reduced environmental impact. Innovative food processing and packaging technologies further enhance food safety and extend the shelf life of nutritious products, reducing food waste.

Indications of shifts in progress

Increasing policy focus on tackling malnutrition and food safety. Numerous countries across the globe have embarked on the path of taxing fats and sugars to promote healthier dietary choices. Currently, over 85 nations have implemented some form of taxation on sugar-sweetened beverages, with noteworthy successes witnessed in places like Mexico, South Africa, and the United Kingdom.⁵⁶ Furthermore, various nations, including Japan, Denmark, Hungary, France, India, and the United States, have also ventured into the taxation of high-fat content products.⁵⁷

In tandem, national policies like Jamaica's Food and Nutrition Security Policy⁵⁸ and Kenya's Health Policy⁵⁹ stand as robust frameworks crafted by governments to attain lasting food and nutrition security while combating malnutrition within their borders. These efforts reflect a growing global commitment to combating the dual challenges of undernutrition and overnutrition.

Countries are also increasingly addressing food safety concerns, such as the FDA's renewed Food Safety Modernization Act (FSMA) in the United States, which aims to transform the food safety system from reactive to preventive, with various rules finalised in 2023 covering areas such as produce safety, agricultural water safety, food traceability, third-party certification, food traceability, and sanitary food transportation.⁶⁰

Shaping dietary guidelines. National food-based dietary guidelines, as outlined by the FAO, serve as invaluable tools, offering context-specific advice and principles to promote healthy diets. These guidelines play a pivotal role as policy instruments that align with national health and nutrition priorities, reflect production and consumption patterns, and enhance accessibility to nutritious foods. In July 2023, the WHO released updated guidelines on fats and carbohydrates, with a clear focus on mitigating the risk of unhealthy weight gain and diet-related noncommunicable diseases such as type 2 diabetes, cardiovascular disease, and specific cancer types.⁶¹ Additionally, FAO's June 2023 publication addressing inequalities in food security and nutrition provides a roadmap of recommended policies to tackle these disparities, marking significant strides towards a healthier and more equitable global food landscape.⁶²

Incorporating sustainability into dietary guidelines is a complex task with economic, environmental, and socio-cultural dimensions. The Nordic Nutrition Recommendations 2023 take a position on incorporating environmental externalities into national dietary guidelines, showcasing the role governments can play in climate action in food systems.⁶³

Enhancing multifaceted investments to combat malnutrition. In 2023, UNESCO, in collaboration with UNICEF, WFP, FAO, GPE, and WHO, released a comprehensive paper on improving global school health and nutrition, revealing that 9 out of 10 countries worldwide are already investing in such programmes, with one in two primary school children benefiting from school meals.⁶⁴

The African Development Bank intensifies efforts to combat child malnutrition in Sub-Saharan Africa through its Multisectoral Nutrition Action Plan, aiming to reduce child stunting on the continent by 40% by 2025. To date, the bank has dedicated nearly \$2.8 billion of its portfolio to smart nutrition.⁶⁵

Global focus area B: Regenerative and circular value chains to achieve resilient food systems

What is this global focus area about?

In the preferred future, food supply will become more resilient, meaning adequate capacity to withstand and recover from shocks, stresses, and disruptions while maintaining the essential functions of producing, distributing, and providing access to safe and nutritious food for all members of society. Such resilience encompasses the ability to adapt to changing conditions, absorb disturbances, and continue functioning effectively, even in the face of challenges such as natural disasters, economic fluctuations, supply chain disruptions, and other unexpected events.

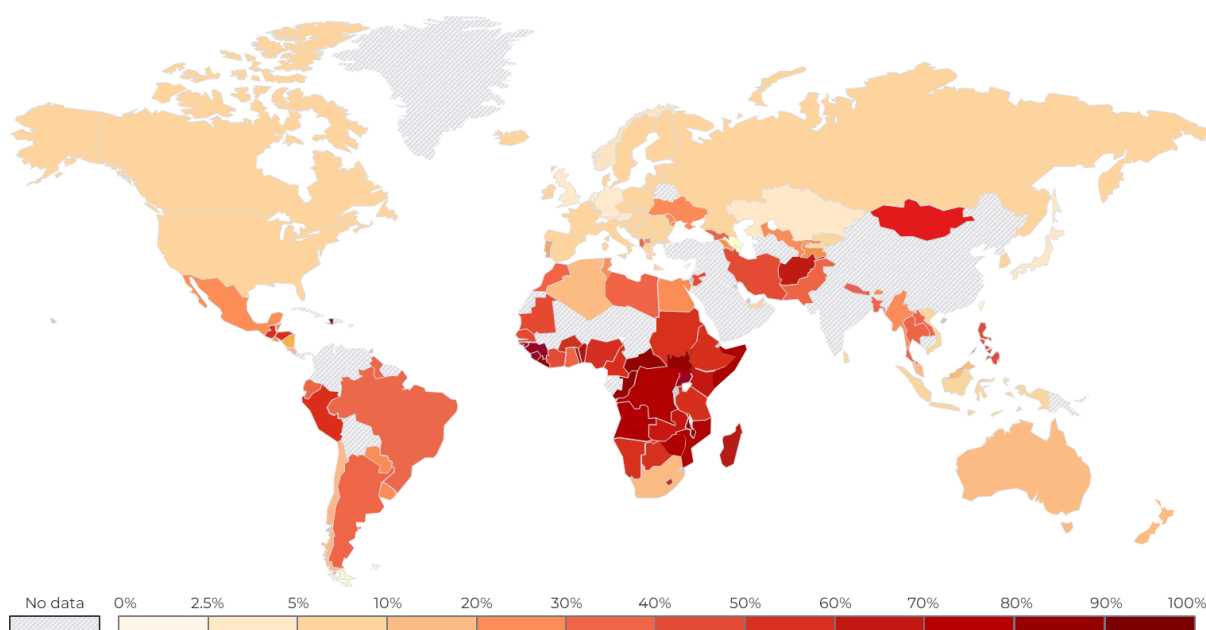
Regenerative value chains bolster food systems resilience by prioritising sustainable and diverse agricultural practices. They promote biodiversity, water stewardship, enhance soil health, and sequester carbon, reducing the vulnerability of food production to environmental changes. By supporting local and diverse food sources and involving communities in decision-making, these value chains also enhance adaptability and social resilience.

Circular value chains contribute significantly to the resilience of food systems by emphasising sustainable practices and minimising waste. They prioritise resource efficiency, reducing the environmental footprint of food production by adopting principles of reducing, reusing, and recycling that minimise the depletion of natural resources, which enhances the long-term viability of food systems. They also promote local and decentralised food production, reducing dependence on centralised supply chains and increasing resilience to disruptions.

The achieved resilience can be demonstrated by the significant reduction in food insecurity that billions of people suffer from today, especially in regions on the southern hemisphere, as illustrated in the heatmap below.

This subchapter highlights the key shifts that would have happened by 2040 to reach better food supply resilience by pointing out actions across the value chain.

Proxy: Share of population with moderate or severe food insecurity (2020)



Source: Food and Agriculture Organisation of the United Nations; OurWorldInData⁶⁶

Key shifts that would have to be true by 2040

4 Safeguarded food availability with domestic supply & imports balance

5 Improved access to affordable healthy foods

6 Ecologically increased productivity of food supply

7 Food loss prevention and waste utilisation

4 Safeguarded food availability with domestic supply & imports balance

Food availability was better safeguarded by maintaining a balance between domestic supply and imports to meet the population's demand, irrespective of external challenges like climate change, population growth, urbanisation, and dietary shifts. This was enabled by promoting an adequate diversity of food sources and crops that could adapt to different agroecological conditions and provide balanced nutrition for humans. Additionally, a just transition, strategic imports, and supply chain sustainability served as a buffer during times of local scarcity, mitigating potential production shortfalls or disruptions in domestic supply.

Key enablers included the establishment of robust and efficient infrastructure for 1) food storage, 2) processing, 3) distribution, and 4) trade, which effectively reduced food loss and waste and ensured food safety and quality. International trade agreements and regulations further contributed to the success of this endeavour by securing local farmers livelihoods.

5 Improved access to affordable healthy foods

Achieving fair and stable access to nutritious foods to end hunger and food poverty, especially among the poor and vulnerable, who were most affected by food price shocks and food insecurity.

(1) The physical availability of food in the local markets, shops, or farms, as well as the transportation and infrastructure that facilitated the movement of food from production to consumption, were ensured.

(2) The economic affordability of food, influenced by the income and purchasing power of consumers, as well as the prices and subsidies of food products, was addressed.

(3) The social acceptability of foods reflecting the cultural norms, values, beliefs, and traditions that shaped the food choices and preferences of people was taken into consideration.

(4) Nutritional adequacy of food, which refers to the quality and diversity of food that could meet the dietary and health needs of people, was prioritised.

6 Ecologically increased productivity of food supply

Ecologically increased productivity of the food supply was achieved through two key steps:

(1) Improving the efficiency and circularity of food systems. This involved the reduction of food losses and waste along the entire value chain, from production to consumption, including small holder farmers. Efforts were made to optimise the use of natural resources, such as land, water, energy, and nutrients, while minimising environmental impacts of food systems, such as soil degradation, water pollution, and deforestation.

(2) Enhancing the adaptability and innovation of food systems. This required fostering the capacity of food system participants to cope with and respond to changing conditions, such as climate change, market dynamics, consumer preferences, and policy interventions. Investments were made in research and development, knowledge sharing, digital technologies, and social innovations that improved the productivity, quality, safety, social justice, and accessibility of food.

7 Food loss prevention and waste utilisation

Food loss prevention and waste utilisation played a pivotal role in reducing resources used to produce food, yielding three significant benefits: (1) it saved food for human and animal consumption, (2) it generated economic savings for businesses and consumers, and (3) it lowered the environmental and climate impact of food production and consumption.

These accomplishments were achieved through significant reduction in food loss and waste and by promoting circularity along the entire food value chain. Major purchasers (e.g. retailers) found ways to use products which did not fit the ideal attributes (e.g. shape, colour etc.) to get this produce also available for consumers. Innovative technologies and practices were adopted from production to consumption to stabilise and increase the shelf-life of highly perishable foods. Circular economy principles became ingrained, with food waste and side streams being repurposed into valuable resources. Consumer education and awareness campaigns reduced food loss and waste at the household level. Advanced traceability systems and labelling strategies ensured better monitoring and communication of food quality throughout the supply chain.

What made these shifts possible?

Government policies & regulations

- Government policies took an evidence-based, people-centred approach to reflect humanitarian concerns globally with a focus on just transition. Regulation was used as a policy instrument to promote a circular bioeconomy and motivate reductions in inefficiencies and food loss with incentives and targets. Additionally, policies to measure the true cost of food, while disincentivising unsustainable foods through e.g. taxes and tariffs became widely used.

Technological development & innovation

- Technological innovations that boosted productivity significantly increased yield and resource efficiency; more efficient fertilisers, better genetics, automation, and precision agriculture increased food availability significantly.
- Advanced processing and packaging technology increased food preservation and shelf life, significantly mitigating food loss.

International trade & collaboration

- An open, fair, and predictable multilateral trading system enabled increased business confidence in food-stressed areas to ensure global food balance.
- International trade systems were developed to see perishable goods released through international borders in a timely manner, reducing food loss.

Financial investment & support

- Producer support programmes globally led to significant gains in productivity; incentives and subsidies for regenerative livestock management improved resilience in water-stressed areas.
- Stability in international collaboration saw capital allocation increase in developing regions, increasing food security and availability.

Education & awareness

- Promoting and fostering awareness about the importance of sustainable food production led to cultural shifts that prioritised well-being and sustainability in consumer choices.
- Technology and information sharing in the global community fostered a culture of innovation, inviting collaboration between industry, policymakers, and academia to address injustice and environmental challenges.

How may the key shifts vary in different parts of the planet?

Improvements in food supply resilience will differ across geographic regions due to the differences in food systems existing infrastructure, productivity improvement potential, and financial means to invest in improvements. In this global focus area, two clearly distinctive cohorts have been identified as plausible, mainly driven by the likelihood of food insecurity risk in countries and among their citizens, as illustrated by the heatmap on the global focus area B introduction page.

Countries with low risk to moderate or severe food insecurity. Urbanisation keeps accelerating at predicted rates, presenting the challenges of sufficient access to meet the daily requirements of healthy diets for everyone and the exclusion of small farmers from renewed food value chains. The global response to urbanisation has, however, been well organised with timely, collaborative interventions, transforming food value chains from their conventional structures.

In high-income regions, such as the United States and the European Union, urbanisation has led to more complex value chains that create economic prosperity throughout surrounding communities, expanding the social benefits of concentrated on-farm activities to wider regions.

Efficient and circular supply chains have given farmers and food producers better access to agricultural inputs and services as gaps between rural and urban communities recede. The better connectivity between parts of the food systems increase access to affordable and healthy diets, reducing the risk of chronic disease and obesity.

Technological development and the emergence of sustainable energy sources have made urban agricultural production economically viable in a controlled environment agriculture that is prevalent in major cities and improves access to year-round vegetables in urban communities. Multi-story vertical farms alleviate pressure on land use, allowing for conservation, restoration, and preservation of natural carbon sinks where traditionally intensive agriculture would have taken place.

Small-scale food producers play an important part in achieving food system resilience, especially in rural regions. Most of the developed world has significantly higher agricultural output compared to more vulnerable regions. Development guided by SDG indicator 2.3.1, which aims to double the productivity and incomes of small-scale food producers, has led to significant improvements in food availability, affordability, and resilience to climate change.

Countries with significant risk to moderate or severe food insecurity. With the emergence of more efficient ways to produce and deliver food, connecting rural and urban areas, food has become more affordable and accessible. Low-income countries, where the share of food expenditure has historically been high, are now able to increase access to healthy diets.

Substantial improvements in agricultural productivity and increased awareness on the ecological impacts of agriculture have led to the adoption of more advanced agricultural techniques and a cultural shift in how natural resources are preserved. With significantly increased yields, farmers can achieve higher outputs with less land used, leading to restoration efforts across once-degraded agricultural lands, while improving farmers livelihoods.

Areas highly dependent on fish-based diets have gained access to modern, safe fish farming infrastructure, allowing for wild fish stocks to be restored, as sufficient nutrition can be produced in a controlled environment. The livelihood of small fishers is improved through healthier and more abundant wild fish stocks.

Coordinated investments and governance mechanisms beyond sectoral and national boundaries have resulted in sufficient infrastructure and stability in the most vulnerable communities to develop efficiency in food production and value chains in an equitable manner free from human rights abuses. Just transition towards 'greening' the economy in a fair and inclusive manner was also on top of the transition agenda. Extensive awareness campaigns invoked a cultural shift, promoting healthier diets and food hygiene and cutting down on the prevalence of food-borne diseases.

Indications of shifts in progress

Global community addressing sustainable food production and resilient agricultural practices.

- Global initiatives like the World Food Programme and the Global Food Security Initiative, among others, aim to foster collaboration among governments, businesses, and NGOs to address crucial system-level challenges the food systems are facing.
- Organisations such as the International Institute for Environment and Development (IIED)¹¹¹ and ILO¹¹⁰ have set-up studies and programs focused on just transition for farmers and agribusinesses
- The UN SDGs, particularly Goal 2 focuses on achieving food security, improving nutrition, and promoting sustainable agriculture. Indicator 2.4.1 is the “proportion of agricultural area under productive and sustainable agriculture” – improvements in crop yields have brought significant improvements in how humanity uses the natural land resources available.
- FAO has addressed the challenge of land conversion and soil degradation as it estimates that over 1.75 billion ha of cropland has been spared since 1961 due to increases in agricultural productivity.⁶⁷ Productivity growth, has however, its limitations; over fertilisation often attributed to rapid increases in productivity, resulting in potential degradation and excess nitrogen and phosphorous loading.
- The WTO Agreement on Fisheries Subsidies, which was adopted in June 2022, is a recent example of a ground-breaking multilateral agreement that addresses ocean sustainability by banning harmful fisheries subsidies, making it the first SDG target met through a multilateral agreement and a significant milestone for the WTO with it being the first WTO agreement to focus on conservation of the environment.⁶⁸
- The Sustainable food system framework, a legislative proposal by the European Commission expected to be brought forward by the end of 2023, aims to create a socially responsible food value chain within the EU that minimises environmental and climate impacts, ultimately turning the EU food system into a positive force for the well-being of individuals, economies, and the planet, enhancing resilience and ensuring food security amidst climate change and biodiversity challenges. It will also include a framework on labelling with the objective of empowering consumers to make informed, healthy, and sustainable food choices.⁶⁹
- The Team Europe Initiative (TEI), comprising the European Commission, France, Spain, Germany, Finland, and other supporting partners, have committed close to half a billion euros to support the transformation of value chains in Sub-Saharan Africa, the Middle East, Asia, the Pacific, and Southern America by promoting investments, research, innovation, and support to increase sustainability and resiliency in those regions through food security, job creation, and environmental preservation, with a strong focus on smallholder farmers and their ecosystems. There are currently 168 TEIs ongoing.⁷⁰
- FAO has emphasised the importance of aligning the existing water management policies and practices through institutional and legal frameworks that would support water rights, provide incentives for water use, and improve supply enhancement and demand management.¹⁰⁶

Emerging circular agri-food value chains

The European Environmental Agency refers to the metabolic definition of circularity in food systems by looking at circularity in terms of layers: Layer 1, the most limited definition of the circular economy focuses on improving material flows, such as biomass, packaging materials, and food waste reductions. Layer 2 introduces a circular economy in a limited system where limits to natural resource consumption are considered part of food systems actions to bring balance to soil and water use and agricultural outputs. The final layer describes “molecular circularity in production systems”, where circularity of carbon, nitrogen, and phosphorous is achieved through regenerative agricultural practices such as agroforestry and silvopastoralism.⁷¹

In recent years, the European Union as well as individual member states have made strides in promoting circular economy in environmental action, highlighted by the Circular Economy Action Plan, and the European Green Deal.

Reaching circularity in food systems is still emerging, but strong tailwinds through concentrated policy efforts are already driving the sector to take action in transitioning to a circular food economy.

Local examples of emerging regenerative agriculture

- Argentinian farmers are switching from growing cereal to improved and natural pasture for grazing livestock to combat desertification and adapt to climate change.⁷²
- The Regional Sahel Pastoralism Support Project supports the countries of Burkina Faso, Chad, Mali, Mauritania, Niger, and Senegal. In extremely dry areas, pastoralists move their herds according to the availability of pasture and water, helping protect natural ecosystems by improving resource management.⁷³
- Government support in Uruguay to help farmers adopt climate-smart livestock practices, improve carbon sequestration in grasslands, and improve energy efficiency in supply chains.⁷⁴
- SMART Punjab project empowers small-scale Pakistani farmers to buy improved seeds and fertilisers at reduced prices to address fertiliser imbalances and improve yields.⁷⁵

Examples of advancements in food loss prevention and streamlining of value chains

- The emerging circular bioeconomy in the EU through integrated biomass logistics centres allows for the integration of non-food value chains into the pre-existing food chains.⁷⁶
- EU-Funded SKIN project created a large European knowledge-sharing network, bringing together 160 good practice case studies focusing on short supply chains to mitigate food waste.⁷⁷
- In the Philippines, where destructive weather effects threaten low-income communities and farmers' livelihoods, the Philippines Rural Development Project brings investments along value chains to improve storage and processing facilities, reducing food waste.⁷⁸

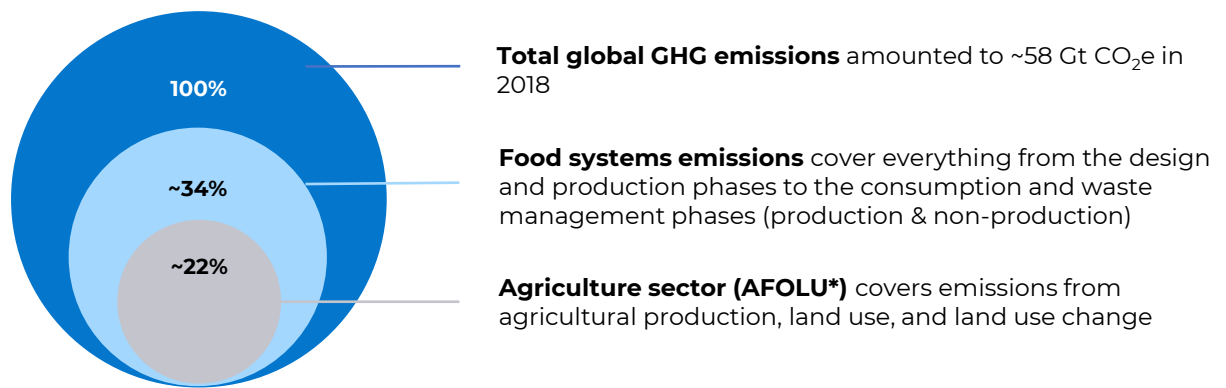
Global focus area C: Decarbonising to support climate change adaptation and mitigation

What is this global focus area about?

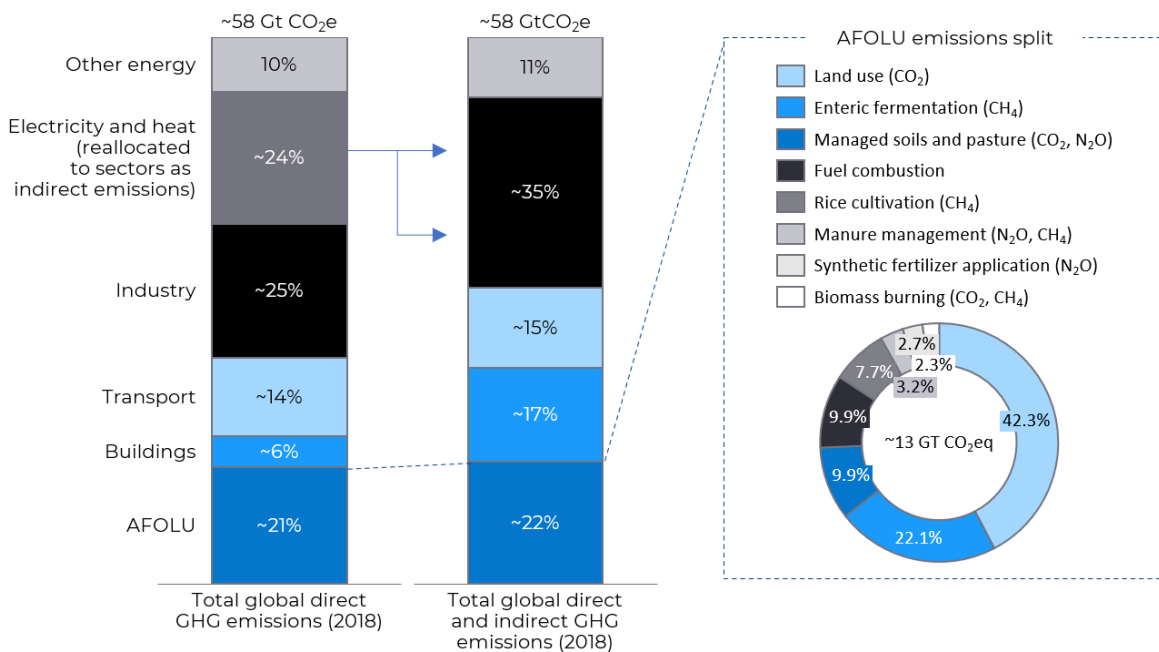
In the preferred future, food systems have more than halved the current 18 Gt CO₂e² emissions, while still being able to grow food production in an already warming climate. This would have required decarbonisation across the globe, as major regions (except Oceania) each account for 7-39% of food systems emissions today. Value chain-wide decarbonisation efforts were also needed, although most significant efforts would have been put into decarbonising agricultural production and land use activities (currently accounting for 22% of all global emissions), as illustrated in the below chart.¹⁰⁷

This subchapter highlights the key shifts that would have happened by 2040 to reach the halving of GHG emissions by pointing out actions across the value chain.

Context regarding agriculture sector and food system emissions



Proxy: Direct and indirect emissions by sector and agricultural production activity (2018), Gt CO₂e



Source: Lamb et al. (2021)¹⁰⁷

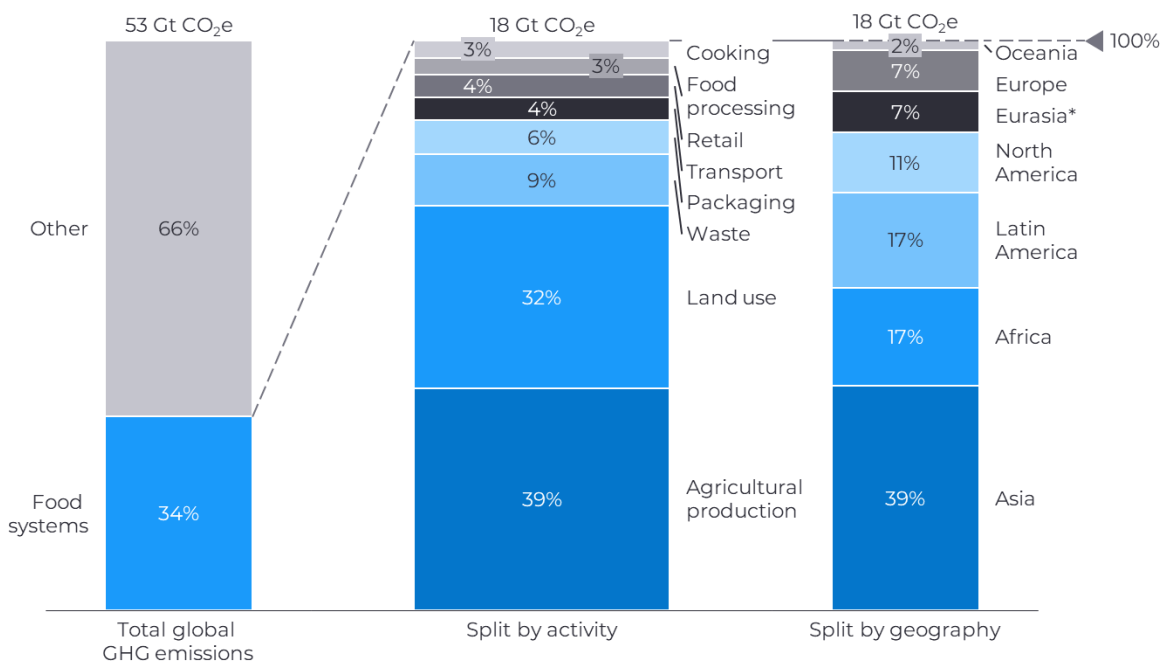
* AFOLU refers to 'Agriculture, Forestry, and Other Land Use'

What activities have had an impact?

Decarbonising the global food systems goes beyond just focusing on agricultural production and land use. The entire value chain from farm to consumption is responsible for 34% of global GHG emissions, as illustrated in the below figure.³ Hence, in this paper, we focus on the wider food systems, to address challenges and opportunities for all value chain participants.

Addressing all parts of the food value chain will have required technological breakthroughs, and comprehensive, collective actions through timely and robust policy interventions. A shift towards renewable energy for food processing and transportation, targeted reduction of food waste, and sustainable packaging solutions are some of the measures that can have helped reduce emissions from the food value chain outside of agricultural production.

Proxy: Share of food systems GHG emissions by activity and geography (2015), Gt CO₂e



* Including Russia, Ukraine, Central Asia, Middle East, and Turkey

Source: Crippa et al. (2021)³

Key shifts that would have to be true by 2040

- 8 Energy supply decarbonisation
- 9 Agricultural production and land use practices decarbonisation
- 10 Processing and packaging solutions decarbonisation

8 Energy supply decarbonisation

Affordable and widely available low-to-no carbon energy supply played a crucial role in drastically cutting emissions across the food value chain. This transformation was heavily reliant on the progress made in the global energy transition towards decarbonisation, which encompassed the increased adoption of renewable energy sources, e.g. solar and wind, nuclear power, low-carbon fuels, e.g., biofuels and green hydrogen, and electrification, facilitated by the development of robust energy storage technologies. Especially within transportation, energy supply decarbonisation enabled the widespread adoption of low-carbon and electrified transportation solutions, thus further contributing to the overall decarbonisation efforts in the food supply chain.

While several key barriers were encountered, including 1) the considerable cost associated with the required investments, 2) the limited availability of suppliers and technological expertise necessary for implementing these changes, and 3) challenges related to maintaining low to no carbon energy utilisation, there were certain key enablers that led to these transformative changes. These included: 1) the implementation of policies and programmes driving shifts within the energy industry; 2) technological advancements leading to higher efficiency and reduced costs as technologies scaled; and 3) substantial financial investments and support measures that were aimed at incentivising the transformation of energy supply.

9 Agricultural production and land use practices decarbonisation

Economically viable emission-reducing agricultural practices that were tailored to local conditions played a crucial role in reducing emissions from agricultural production and land use practices. A decisive part of this transition was the focus on utilising "fit-for-local-purpose" methods that were most suitable to local decarbonisation efforts and were developed for economically viable scale, such as soil carbon sequestration through practices like agroforestry and reforestation, livestock decarbonisation through improved manure management, and the adoption of lower carbon inputs and methods, which included reduced synthetic fertiliser use and precision agriculture.

Various key challenges were faced, such as the lack of easily accessible and area-specific knowledge on the best-fit methods to support decision-making, the costs of necessary investments, and a lack of suppliers and technological knowhow to implement changes. However, certain pivotal factors enabled these transformative changes, which included having identified and understood 'method-location fit' of available alternatives for the best cost-impact ratio, along with the implementation of policies and programmes that supported transition plans, financing options, education for producers, and ensured long-term economic viability.

10 Processing and packaging solutions decarbonisation

Low-emission technologies and operations enabled through processing and packaging activities played a vital role in supporting the aforementioned decarbonisation efforts both upstream and downstream. A few selected activities that occurred included:

- 1) Upstream: Initiatives focused on shortening supply chains and transportation requirements through the implementation of smaller near-farm processing and packaging facilities. Additionally, technologies were leveraged to gather data, for example to monitor emission impacts of farming.
- 2) Processing and packaging sites: Energy-efficient technologies and equipment were developed and employed, enabling data-driven emissions tracking and optimised production planning. These efforts included the utilisation of side streams for heat, their reuse, and upcycling, and the adoption of low-carbon inputs for packaging materials or non-fossil chemicals in processing.
- 3) Downstream: Circular end products such as packaging, as well as the necessary data assets for traceability of 'climate-friendly' consumables, were actively pursued. These efforts were facilitated by the development of technologies and digital solutions that addressed data needs within food systems and were supported by policies and programmes aimed at fostering closed-loop systems.

What made these shifts possible?

Government policies & regulations

- Governments across the globe took strong legislative actions to force decarbonisation while also 'levelling the competitive playing field' for businesses by mitigating adaptation and transition costs and by making lucrative markets for 'carbon handprint' driven businesses that accelerated food system shifts

Technological development & innovation

- The supply of affordable and renewable energy became widespread through the success of the policy-driven global energy transition.
- Businesses across value chains adopted digital innovations and constantly improved low-carbon production technologies to scale climate-friendly food products which eventually became significant selection criteria for consumers.

International trade & collaboration

- Businesses, public and the 3rd sector, including research institutions, created systematic and global collaboration approaches to identify best land use and agricultural production improvements specific to local economic and ecological conditions, enabling best practice sharing, adequate international trade, and engaging with local communities.

Financial investment & support

- Financiers set borrowers' climate transition and mitigation measures and capabilities at the forefront of factors determining access to capital and interest rate levels when applying for business loans.
- Financial support mechanisms, e.g. through international development banks, ensured that lower-income countries were also able to develop their food systems without increasing their emissions significantly.

Education & awareness

- Consumers increased awareness and ease of assessing their consumption choices impact on emissions shifted consumption patterns and preferences, resulting in increasing social pressures to consume responsibly.

How may the key shifts vary in different parts of the planet?

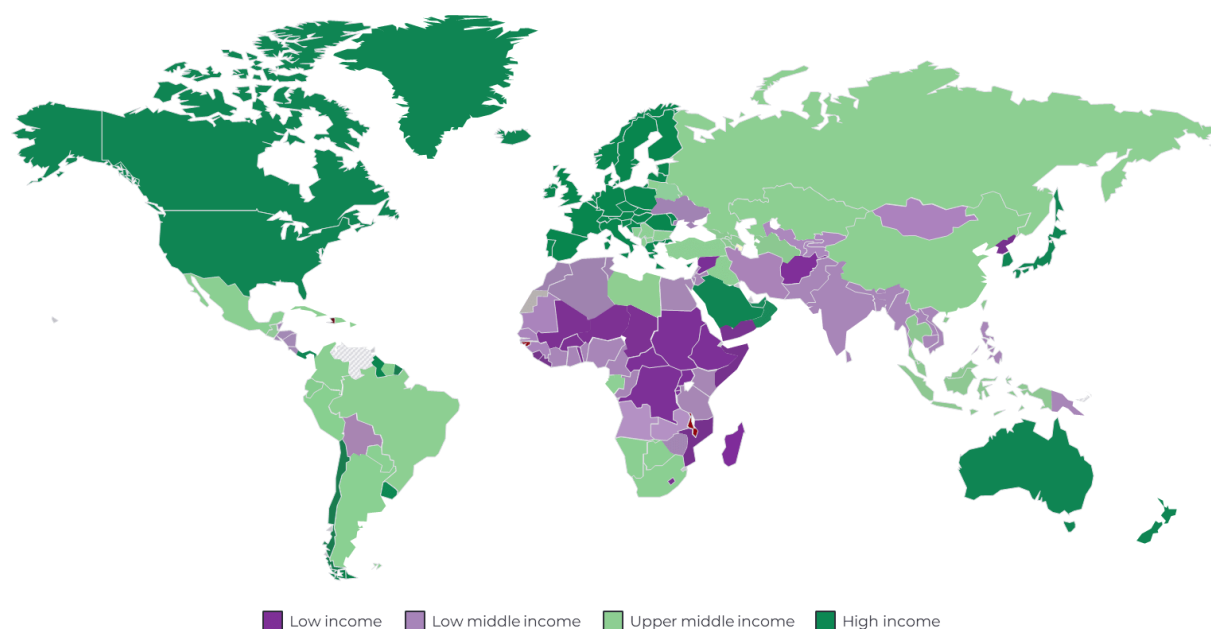
Decarbonisation of food systems will have significant differences between geographical regions due to differences in factors such as political willingness, economic capabilities, and technological advancements. In this global focus area, two clearly distinctive cohorts have been identified as plausible, mainly driven by the economic strength of countries and their citizens.

Countries capable of making all four shifts. In connection with the large-scale energy transition, the major economic regions with high incomes (incl. North America, Europe, China, Japan, and Australia) have gained a remarkable supply of low-to-no carbon energy (incl. renewables and nuclear), which has become available to food systems across their value chains.

Practices in land use, agricultural production, processing, and packaging have leaped forward through the wide use of data and technology, which has enabled consumers to access affordable, low to no carbon proteins and nutrients.

Countries with more focused and fragmented shifts. Many developing countries that do not have the economic means for widescale decarbonisation (exemplified by those having low to lower middle incomes today) and which often have a high share of agricultural activities relative to their GDP have focused on narrower shifts such as improvements in land use and agricultural practices as consumer purchasing power and most advanced (hence costly) technologies have not gained large-scale footholds in the countries.

Proxy: Countries by income level (2022)



Source: The World Bank⁷⁹

Indications of shifts in progress

150 countries representing 88% of global GHG emissions have communicated a net-zero target³¹ – ambitions and targets in relation to food systems remain vague.

There is clearly a shared international intent and ambition towards large-scale decarbonisation based on countries commitments and policies towards net-zero targets. As food systems produce a third of global GHG emissions, there is no possibility for countries to ignore it; however, until today, most have not set specific targets or plans for food systems.³³ Nevertheless, there are many ongoing initiatives around the world looking to speed up the decarbonisation of food systems:

- In 2023, the EU revised the LULUCF Regulation for the period up to 2030, aiming to increase the EU's net removals of carbon dioxide by approximately 15% compared to current levels, thereby reversing the recent decline in net removals, with a focus on managing various land use sectors, including cropland, grassland, wetlands, forests, settlements, and land use changes, as agricultural and forest lands covering a significant portion of the EU's territory offer substantial potential for carbon sequestration and climate change mitigation.⁸⁰
- The EU's new Joint Work initiative, released in 2023, underscores the significance of agriculture, food systems, and food security in addressing climate change while promoting sustainability. Its goal by 2026 is to provide an overview of ambitious climate actions and establish a common framework for facilitating and evaluating support, with a specific focus on integrating and scaling up mitigation and adaptation measures related to agriculture, food systems, food security, and nutrition within the national climate plans (NDCs and NAPs) of member states.⁸¹

- The SCALA programme, Scaling up Climate Ambition on Land Use and Agriculture, led by FAO and UNDP, supports twelve countries in Africa, Asia, and Latin America in translating their NDCs and NAPs into effective climate solutions for land use and agriculture, emphasising private sector engagement as well as adopting gender-responsive and inclusive approaches to benefit the most vulnerable natural resource-dependent communities. The programme was extended in 2023 to include small Island developing states and middle-income countries with the goal of providing comprehensive support for NDC implementation in 120 countries by 2026.⁸²

A critical element for collective endeavours to reduce carbon emissions in food systems is the establishment of a standardised measurement framework for assessing the true cost of food systems. UNEP, FAO, and UNDEP have identified that a key first step for a collaborative framework for food systems transformation is to redefine the value of food through True Cost Accounting (TCA) to reveal both the benefits of affordable and healthy food and the environmental and health-related costs associated with food.⁸³ UNEP and the global alliance for the future of food have developed the TEEBAgriFood Framework with over 150 scientists from 33 countries to assess the holistic economics of agriculture and food systems, with ongoing efforts to implement this framework in 10 countries worldwide, involving government agencies, research institutions, and private sector stakeholders.⁸⁴

Climate change awareness is increasing among consumers – especially in higher-income countries, which have emerging cohorts who indicate a willingness to pay more for ‘sustainable’ (incl. climate-friendly) products. Gen Z prefers to buy sustainable brands and is willing to spend on average 10% more on sustainable products.⁸⁵ Gen Z’s economic influence will only increase as the younger members of this cohort grow into adulthood, and it is expected to be the largest generational cohort by 2040. Further recent surveys conducted by IBM and the National Retail Federation⁸⁶ as well as the Baker Retailing Center at the University of Pennsylvania⁸⁷ found that between half and two-thirds of consumers said they would pay more for sustainable products rising to 80% for consumers aged 18-34.

Investments, commitments, and innovations on the rise as regenerative and potential of nature-based solutions in alternative proteins and ground-breaking genome-editing research target cattle emissions. Several prominent multinational companies have made significant commitments to promote regenerative agriculture practices. Companies such as General Mills, Whole Foods, PepsiCo, Walmart, and many others have pledged to implement regenerative agriculture methods on millions of acres of farmland by 2030.⁸⁸ Additionally, EIT Food, in partnership with Microsoft and Danone, is accelerating agrifood start-ups specialising in artificial intelligence, with the aim of advancing regenerative agriculture through digitalisation.⁸⁹ As of 2022, approximately 15% of global farmland is estimated to already be managed using regenerative practices.⁹⁰

Nature-based solutions, as highlighted by the World Bank, offer the potential to contribute significantly to climate change mitigation, with the capacity to potentially deliver 37% of the necessary reductions as per the Paris Agreement. As an example, in Colombia, a successful initiative saw the planting of 3.1 million trees and the adoption of polyculture techniques by farmers, enhancing carbon sequestration, diversifying food sources, and bolstering productivity.⁹¹

Investments in alternative proteins, including fermented products and cell-based meat, have jumped from \$1 billion in 2019 to \$5 billion in 2021. Alternatives make up 2% of meat, egg, and dairy products sold, but will rise to 11% in 2035 based on current growth trends.⁹² For instance, Remilk recently unveiled plans to construct the world’s largest precision fermentation facility, located in Denmark, on over 750,000 square feet of land after securing \$120 million in Series B funding.⁹³

4. Collective actions to advance the transition

This chapter provides an overview of the collective actions that are needed to develop global food systems towards the preferred future.

Collective actions needed from key decision-makers



Policymakers

Policymakers need to provide predictable legislative ambitions and actions to drive ecological improvements while also 'levelling the competitive playing field' for businesses by mitigating transition costs and by promoting economic opportunities for 'sustainable business models' to accelerate businesses transition journeys. Key steps required by policymakers include:

1. Policies need to be people-centred by making healthy diets accessible to everyone and acknowledging food systems' role in livelihoods, especially for marginalised communities.
2. Policymakers need to build on existing global development targets (such as the SDGs and the Paris Agreement on Climate Change) to embody the goal of sustainable, healthy diets for everyone as a shared objective.
3. Policy targets need to address both planetary and dietary challenges simultaneously, recognising their interconnected nature rather than tackling them separately in silos.
4. Governments at all development stages must resolve policy distortions, such as taxation, subsidies, and research and development, that could fundamentally impede change.
5. Relevant ministries, including agriculture, fisheries, health, transport infrastructure, and the environment should collaborate to implement policies that realign production systems to support sustainable, healthy diets, moving beyond narrow productivity targets.⁹⁴

True Cost Accounting (TCA) – Next steps in identifying the true cost of food

UNEP, FAO and UNDEP have identified that a critical element for collective endeavours to reduce carbon emissions in food systems is the establishment of a standardised measurement framework for assessing the true cost of food systems. Redefining the value of food through TCA can reveal both the benefits of affordable and healthy food as well as the associated environmental and health-related costs.⁸³

SOFI is currently leading a study including over 150 countries to understand the complexities of TCA. The key goal is to address methodological and data challenges while offering preliminary estimates of hidden costs, and providing concrete case studies that link these hidden costs to actionable measures. FAO aims to integrate TCA into agri-food system assessments and policy recommendations.

Case example: Switzerland's federal government has started to work on measuring TCA for the Swiss food system. This approach is supported by the Swiss parliament which formally requested a draft of suggested legislation by 2027 to put TCA into practice. Initial results will be presented in collaboration with FAO in 2024.⁹⁵

In pursuit of sustainable and equitable food systems, policymakers must establish clear legislative objectives that promote ecological improvements and economic opportunities. Some example focus areas include:

- Ensuring the supply of affordable low-to-no carbon energy;
- Having financing mechanisms in place that promote attractive access to and cost of capital for transition-supporting investments;
- Increasing public investment, creating incentives for private investment, and promoting a more efficient use of the funding;
- Realigning economic and regulatory incentives to ensure that negative environmental externalities are internalised to a large extent;
- Securing multilateral trade systems to balance food supply shortages in areas unable to secure food supply domestically;
- Educating and building awareness among consumers of healthy food consumption;
- Catalysing food loss and waste reduction along the entire value chain from sourcing and production to consumption and disposal;
- Developing ambitious strategies to create a data-driven sector that can assess and monitor its economic and environmental performance;
- Ensuring prior and informed consent is reflected in local law to enable renewable energy projects to move ahead with support from, and to the benefit of, indigenous peoples;
- Researching the effects of climate change on people and communities in key sectors to enable companies to support just adaptation and resilience measures.

A policy framework to catalyse food loss and waste reduction

According to the United Nations, policy has the potential to support the reduction of emissions by 4.5 gigatons of equivalent carbon dioxide per year by integrating food loss and waste in national climate action plans, or nationally determined contributions (NDCs).⁹⁶ A set of concrete actions is necessary to achieve progress:

1. Measure food loss and waste across the food supply chain to enable prevention: As effective action requires data; food loss and waste measurement would provide better insight into where food loss and waste is occurring and enable target setting.
2. Legally binding national food loss and waste prevention targets in NDCs to pave the way for concrete action and make the critical link between food loss and waste and climate objectives.
3. Support innovative solutions through appropriate policy and financial frameworks, such as encouraging and incentivising the development and adoption of new technologies that help combat food loss and waste as well as supporting R&D efforts.
4. Foster education and awareness-raising initiatives on food loss and waste prevention for all actors in the food supply chain, including consumers.



Businesses

Businesses need to have a better understanding of their direct and indirect economic, environmental, and societal impacts to establish their baselines, which allows for better opportunity identification and ambition-setting for transition actions. To match transition-driven economic opportunities with positive environmental and societal impacts, businesses need to rethink their business models. As the current Secretary-General of the United Nations, António Guterres, urged during the 2023 New York Climate Week, businesses should see that aligning with Sustainable Development Goals (SDGs) is good for businesses to thrive.⁹⁷

Addressing this monumental challenge requires more than individual efforts. A sustained and collaborative approach must be at the heart of all pledges, initiatives, and agreements to make this transformation happen. Hence, businesses must identify regulatory barriers and use their influence to remove them, if they prevent them from doing the right thing.

Aligning business goals with Sustainable Development Goals

The 17 Sustainable Development Goals (SDGs) were developed by the UN to provide a shared blueprint for peace and prosperity for people and the planet, now and into the future.⁹⁹ According to the UN, SDGs must become the DNA of business strategy and management and should be integrated into relevant business sector metrics, indices, benchmarks, and remuneration frameworks. To help achieve this, the Global Investors for Sustainable Development (GISD) Alliance was initiated by the UN Secretary-General, which brings together a group of leaders of major financial institutions with the aim of mobilising private financing for the SDGs by providing standardised definitions and sector-specific metrics to align investments.¹⁰⁰

Case example: Sustainability is an integral part of Tetra Pak's Strategy 2030, as one of the four pillars.⁹⁸ Tetra Pak continues to support the UN SDGs and build on its 18-year commitment to the UN Global Compact and its ten principles.

Aligning business goals with Science Based Targets

Science Based Targets initiative (SBTi) is a partnership between CDP, the United Nations Global Compact, World Resources Institute (WRI) and the Worldwide Fund for Nature (WWF) with the goal of driving ambitious climate action in the private sector by enabling organisations to set science-based emissions reduction targets. The SBTi introduced a standardised approach to emissions reduction, offering a blueprint for science-based net-zero targets to combat greenwashing. Targets are considered 'science-based' if they are in line with the latest climate science and the Paris Agreement goals, limiting global warming to 1.5°C above pre-industrial levels.¹⁰¹

Case example: As of August 2022, Tetra Pak was one of the first 59 companies to have its short- and long-term net-zero targets approved by SBTi to reach net-zero greenhouse gas emissions (GHG) across the value chain by 2050, with an absolute* reduction (i.e. covering scope 1-3) of 46% by 2030 and 90% by 2050 from a 2019 base year. According to Tetra Pak, the four key requirements of the net-zero standard are: 1) focus on deep cuts to value-chain emissions, 2) setting near- and long-term targets, 3) no net-zero claims until long-term targets are met, and 4) going beyond the value chain by making investments outside the company's science-based targets.

* Absolute emissions covers scopes 1, 2 and 3: scope 1 covers direct emissions from owned or controlled sources; scope 2 covers indirect emissions from the generation of purchased electricity, steam, heating, and cooling consumed by the reporting company; scope 3 includes all other indirect emissions that occur in a company's value chain.



Non-governmental organisations (NGOs) & civil society

Non-governmental organisations (NGOs) have a pivotal role to play in driving positive change within food systems. NGOs need to continue challenging businesses by primarily serving as a critical voice grounded in scientific evidence. By holding businesses accountable, NGOs can ensure that sustainability efforts are more than just superficial narratives and instead are firmly rooted in measurable and impactful actions.

Moreover, public-private partnerships are instrumental in steering food systems towards more sustainable and responsible practices. To achieve this, local NGOs should take on a more prominent role in actively participating in projects initiated by businesses. By doing so, they can collaborate with various stakeholders and actively contribute to the implementation of necessary transitions within businesses.

In addition, NGOs should work closely with both policymakers and businesses to identify and address widening and emerging white spaces, i.e. issues not adequately addressed by either the public or private sector individually. These challenges could encompass providing aid to vulnerable communities that lack the means to adapt to essential shifts in food systems as well as facilitating best practices and knowledge sharing among key decision-makers to foster improved cross-border collaboration and further the development of food systems.

Aquaculture Stewardship Council for more sustainable fish farming

Aquaculture Stewardship Council (ASC), was established by World Wildlife Fund (WWF) and the Dutch Sustainable Trade Initiative (IDH) to develop environmental and socially responsible standards for fish farming. The standards are based on scientific evidence and are designed to address the environmental and social impacts of fish farming, such as habitat destruction, pollution, and social welfare, including fair labour conditions and human rights. Certification by the ASC provides companies with a means of demonstrating that they are using sustainable and equitable practices.

Case example: The ASC's certification process has led to over 1,400 environmental and 700 social improvements on farms. These improvements have included measures to reduce the environmental impact of fish farming, such as better management of waste and feed, and social improvements, such as fair working conditions for employees. More than 1,193 brands utilise its certification logos towards appealing consumers with products originating from more than 2,000 certified farm sites.¹⁰⁵



Consumers

Consumers play a vital role in shaping the future of our food systems, especially when they have adequate purchasing power, which often enables healthier food consumption choices. The adoption of healthy and diverse diets does not only promote individual well-being but also tends to have a smaller ecological footprint on the environment.

Consumers are also citizens with the power to initiate change at a broader level. Engaging in a citizens' movement can amplify the impact of individual actions. This movement involves collective efforts by concerned citizens who are passionate about transforming food systems for the better. It encourages individuals to come together, advocate for healthier and more sustainable food practices, and drive awareness and change within their communities. These actions can include, for example, supporting local and sustainable food producers, consciously reducing food waste, and advocating for policies that promote healthy and eco-friendly food options.

Ultimately, the transformation of food systems requires active engagement from both informed consumers and responsible citizens, to not only empower individuals to make healthier choices but also drive broader systemic changes in our food systems to achieve a more sustainable and equitable future.

Food Citizenship

The Food Ethics Council in the UK advocating for fair and resilient food systems established the Food Citizenship movement in 2016 which is a diverse collective of people, charities, farmers, producers, retailers, government bodies and more committed to empowering people as citizens rather than mere consumers. It is rooted in the belief that people inherently care about others, animals, and the environment, and the movement seeks to harness this inherent compassion by providing meaningful and joyful avenues for individuals to make a positive impact in the safe and just transition of food systems.¹⁰²

Case study example: An ongoing food citizenship project led by Nourish Scotland is centred around agroecology (i.e. farming with nature) which is a way of farming that can strengthen the livelihoods of food producers and increase the resilience of food systems. The project included the development of a peer-to-peer knowledge exchange programme that brings food producers together to share insights and experiences, discussing topics such as transitioning to agroforestry, implementing herbal leys, managing common grazing, and enhancing biodiversity while maintaining profitability.¹⁰³



5. Appendix: Glossary

Circular Economy / Circularity	Systems that design out waste and pollution, keep products and materials in use and regenerate natural systems (WEF).
Decarbonisation	The process of eliminating or reducing greenhouse gases, especially carbon dioxide (CO ₂) emissions (UNFCCC).
Food insecurity	Economic and social conditions that limit adequate access to safe and nutritious food (WHO).
Food safety	Practices implemented at all stages of food production chain to ensure that food does not cause harm to a person's health. Food safety aims to have food that is safe to eat (WHO).
Food system	Full range of actors and activities involved in the production, processing, distribution, preparation, and consumption of food, as well as the outputs of these activities, including socio-economic and environmental outcomes. Refer to the figure on page 12 for more details (WHO).
Healthy diet	Diet that provides adequate amount of nutrients and health-promoting substances from nutritious foods and avoids the consumption of health-harming substances. It is health-promoting and disease-preventing, however, varying between individuals and social contexts (WHO).
Malnutrition	Deficiencies, excesses or imbalances in a person's intake of energy and/or nutrients (WHO).
New food sources	Term broadly referring to any food ingredient that lacks an established history of human consumption, or ingredients made from innovative new processes. Also referred to as 'novel foods'. Precise legal definitions vary from region to region.
Overnutrition	Excessive intake of energy and nutrients (WHO).
Regenerative value chain	A part of circular value chain that seeks to restore and renew natural resources and ecosystems (World resources forum).
Just transition	A just transition means greening the economy in a way that is as fair and inclusive as possible to everyone concerned, creating decent work opportunities and leaving no one behind (ILO).
Sustainable dairy	Sustainable dairy is defined as a dairy industry that emits less greenhouse emissions by introducing technologies, equipment and best practices in production and processing to safeguard nutrition security and sustain a billion livelihoods for tomorrow, while helping secure a future for us all.
Sustainable food systems	Growing, producing, processing, packaging, distributing and consuming food without negatively impacting the planet (OECD).
Sustainable packaging	Packaging that achieves its functional requirements with minimal environmental impact, that is made from responsibly sourced renewable or recycled materials, is recyclable, and has low carbon footprint in regards to manufacturing, shipping, and recycling
Undernutrition	Insufficient intake of energy and nutrients (WHO).
Water stewardship	Water usage in a way that is socially equitable, environmentally sustainable and economically beneficial (UN).

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