Food System Economics *Commission*

GLOBAL POLICY REPORT

# The Economics of the Food System Transformation

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# The Food System Economics Commission

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# Executive Summary The Economics of the Food System Transformation

## A transformation of food systems is urgently needed, possible, and offers enormous economic benefits

Our food systems — the way we produce, market, and consume food — are part of the political, social, economic, ecological, and cultural fabric of our communities. They have achieved something of a miracle, keeping pace with decades of population growth while decreasing some forms of malnutrition, reducing poverty and increasing life expectancy. But progress has been uneven around the world. And the recent evolution of food systems has fuelled – and continues to inflame – some of the greatest and gravest challenges facing humanity, notably persistent hunger, undernutrition, the obesity epidemic, loss of biodiversity, environmental damage and climate change. The economic value of this human suffering and planetary harm is well above 10 trillion USD[1] a year, more than food systems contribute to global GDP. In short, our food systems are destroying more value than they create.[2]

Ignoring the consequences of today's food systems locks the world onto a course that escalates their negative effects disastrously. Yet in many policy discussions, such as those around climate change, food systems have long been ignored. Concerns for food affordability and the livelihoods of hundreds of millions who depend on food systems, the power of large-scale players, and divergent views among stakeholders about what sustainable food systems look like have all contributed to make food systems something of an exception. Today there is an opportunity for policymakers to raise the level of ambition. Transforming food systems worldwide provides a uniquely powerful means of addressing the global climate, nature and health emergencies while offering a better life to hundreds of millions of people.

This report identifies the elements of what a transformation from today's food systems to an inclusive, health-enhancing and environmentally sustainable global food system entails. It shows that such a transformation is not only biophysically and technically feasible; it offers immense economic benefits to societies across the world. The net benefits of achieving a food system transformation are worth 5 to 10 trillion USD a year, equivalent to between 4 and 8 percent of global GDP in 2020. Combined with transitions taking place outside the realm of food, notably to low-emission energy, a food system transformation can ensure that global warming stays well below 1.5°C at the end of this century.[3]

The economic and planetary case for transforming our food systems is compelling. But negotiating change across a multitude of diverse stakeholders with unequal power and varying prospects from the transformation is an enormous challenge. The report confronts this challenge head on, highlighting practical ways to dismantle barriers to change and develop achievable transformation strategies. Evidence shows that embracing equity and inclusion is key to making a transformation politically viable and thus essential for success.

The report summarizes the findings of a four-year investigation by the Food System Economics Commission (FSEC), an independent commission expressly created to assess options for comprehensive food system transformation. FSEC findings are based on rigorous economic modeling, in-depth literature reviews, and case studies. All background research is available at foodsystemeconomics.org.

1 Unless otherwise specified all figures are in USD Purchasing Power Parity (PPP) 2020.

2 It is not possible, either conceptually or analytically, to separate the production of non-food agricultural items from food items. In this report "food systems" is used as a short-hand for agri-food systems.

3 The food system transformation addresses both direct emissions of greenhouse gases (such as e.g. methane from ruminant enteric fermentation and nitrous oxide from crop production) and indirect ones (through land-use change).

## The costs of current food systems are far larger than their contribution to global prosperity

Food systems form a nexus linking some of the greatest triumphs and challenges of our times. Thanks to human ingenuity, determination and technical progress, they feed a world population that has doubled since the 1970s. And yet the unaccounted costs of the burdens they place on people and the planet are currently estimated at 15 trillion USD a year, equivalent to 12 percent of GDP in 2020. This finding is in line with other recent estimates in the literature. These unaccounted costs comprise:

→ Health costs, which FSEC estimates to be at least 11 trillion USD. The economic costs of ill health due to food systems are measured through their negative effects on labor productivity. Those are driven by the prevalence of non-communicable diseases, including diabetes, hypertension, and cancer which can be attributed to food. A large share of this burden is born by people living with obesity, currently estimated at 770 million people. FSEC's health costs also include a lower bound figure for the productivity costs of undernutrition, currently affecting 735 million people.

→ Environmental costs are estimated at 3 trillion USD a year and reflect the negative impacts of today's food systems on ecosystems and climate, including the impacts of current agricultural land use and food production practices. These practices are responsible for a third of global greenhouse gas emissions, including emissions arising from deforestation, and result in the net loss of over 6 million hectares of natural forest each year. Environmental costs also reflect the costs of biodiversity loss and environmental damage arising from nitrogen surplus, which leaches into waterways and pollutes the air.

→ Finally, food systems are a source of structural poverty through the costs of food, but also through the low incomes of many who work in food production. The incidence of poverty tends to be higher in agriculture than in the other segments of food systems.

## The global food system is on an unsustainable trajectory and current policy commitments are not strong enough to divert it

Even if countries follow through on all the policy commitments made in their Nationally Determined Contributions (NDCs), they will not succeed in shifting the global food system from its unsustainable trajectory. It will still be responsible for about one third of future global emissions if current trends in the overall economy prevail to 2050. These emissions will contribute to an increase in global mean temperature of 2.7°C by the end of the century,[4] compared to pre-industrial periods. But the negative impacts of the current trajectory go well beyond climate.

The continuation of current trends to 2050, modeled through the Current Trends pathway (CT), has further striking features:

→ Food insecurity and undernutrition continue to plague humanity, still leaving 640 million people, including 121 million children, underweight in 2050, particularly in India, Southeast Asia, and Sub-Saharan Africa.

→ The global adoption of diets high in fats, sugar, salt and ultra-processed foods would increase the number of obese people worldwide by 70 percent to an estimated 1.5 billion in 2050, or 15 percent of the expected global population. Note that the direct medical costs of treating the health consequences of overweight and obesity have been estimated by others to rise from 600 billion USD today to almost 3 trillion by 2030 already.

4 Under current trends warming at the end of the century also coincides with "peak warming".

- Per capita food waste increases by 16 percent compared to today, reaching 76 kg of dry matter per capita in 2050.
- Food production in many countries becomes increasingly vulnerable to climate change and environmental degradation, with the likelihood of extreme events dramatically increasing. Rising food prices due to climate or other shocks heighten poverty and hunger, stretching the budgets of the poor and middle classes. This leads to social tensions and the imposition of measures to limit trade.
- Deforestation will erode a further 71 million hectares of natural forests between 2020 and 2050, an area equivalent to 1.3 times the size of France. This has far-reaching implications for carbon emissions and biodiversity loss.
- Nitrogen surplus from agriculture and natural land also increases from 245 Mt N to about 300 Mt N a year, polluting water, destroying biodiversity and undermining public health.

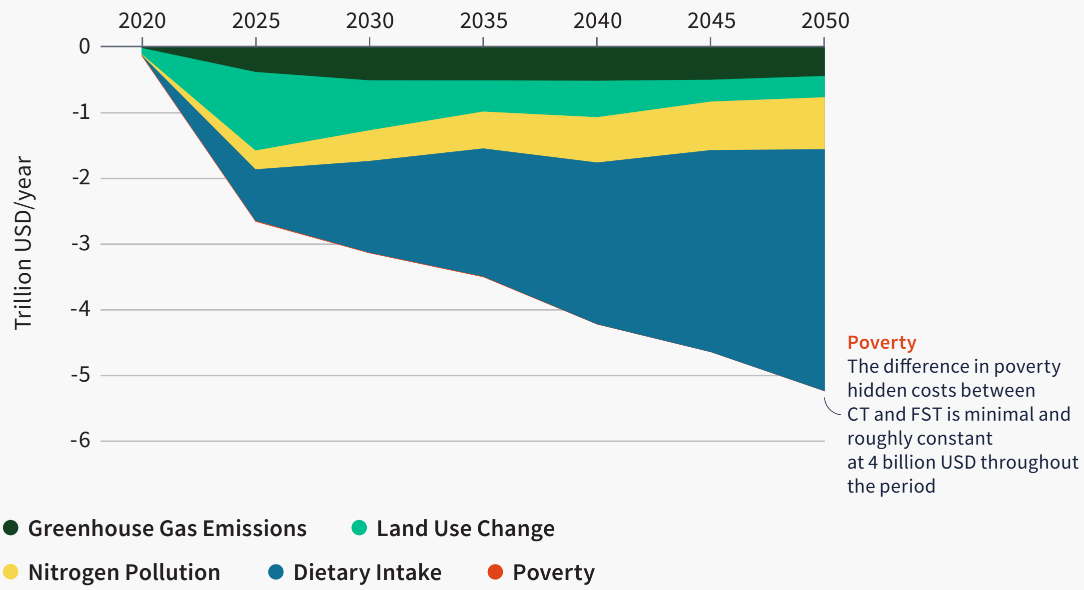
## Transforming food systems would provide economic benefits equivalent to at least 5 trillion USD a year

FSEC has assessed one specific science-based transformation pathway for food system which brings huge benefits for both people and planet. This pathway is called the Food System Transformation (FST). Estimates of those benefits, measured as reductions in the unaccounted costs of food systems outlined above, amount to at least 5 trillion USD per year. When the full effects of a global food system transformation on incomes are factored in, estimates of its benefits rise to 10 trillion USD per year (Box ES.1). The FST offers a future where:

- Undernutrition is eliminated by 2050, and cumulatively 174 million lives are saved from premature death due to diet-related chronic disease, compared to CT. This fall in diet-related chronic disease accounts for 55 percent of the reduction in the food system's hidden costs associated with the FST (see figure ES.1). When accounting for the impacts of changing diets on both consumption and (indirectly) on land use, changing diets accounts for 70 percent of the benefits of transforming food systems.
- Farmers in the global food system — around 400 million people — enjoy a sufficient income from their work thanks to productivity growth and targeted support policies.
- An additional 1.4 billion hectares of land is protected, while a further 200 million hectares are afforested and open to planet-friendly economic uses such as the production of timber for housing.
- A shift to environmentally sustainable production in agriculture reverses biodiversity loss, reduces demand for irrigation water and almost halves nitrogen surplus from agriculture and natural land (i.e. land that has not been altered or developed for human purposes).
- The food system becomes a net carbon sink by 2040. As part of a larger sustainability transformation which includes the energy sector, this helps to ensure that global warming is limited to well below the 1.5°C Paris Climate target by the end of the century, with peak warming barely exceeding 1.5°C.
- Processes of structural transformation are accelerated, meaning that agriculture becomes less labor-intensive than under CT. About 75 million more on-farm jobs are reallocated to other segments of food systems or other sectors than expected under CT.

This alternative future plays out differently in different parts of the world. A shift to healthy diets entails notably higher consumption of fruits, vegetables and nuts in South and South-East Asia and of legumes in China. Meanwhile, consumption of animal-sourced food decreases drastically in high- and middle-income regions.

FIGURE ES.1
**Reduction in hidden costs compared to Current Trends**
Trillion USD PPP 2020




The Northern Hemisphere sees the largest increase in land conservation over CT, while one half of the projected additional afforestation happens in Brazil. And food waste is reduced most in some European countries, the USA, and China.

## At 200–500 billion USD a year, estimated costs of global food system transformation are low compared to its economic benefits

Implementing the FST pathway worldwide will need investments and transfers averaging 500 billion USD each year between now and 2050. Of this amount, about 200 billion USD covers investments in rural infrastructure (including roads, irrigation expansion, access to energy), the protection and restoration of forests, the reduction of food loss and waste, support for the dietary shift and agricultural research and development. All these costs are additional to spending already expected in these areas.

The remainder of the transformation costs cover the safety net support needed to keep food affordable for the poorest, especially in the earlier phases of the food system transformation. Under the FST, agricultural commodity prices increase by roughly 30 percent by 2050, which may significantly increase the prices consumers pay for food. Food price rises will be somewhat offset by rising incomes and changing consumption patterns. However, the risk of food becoming less affordable for the poorest needs to be addressed head on with transfer programs. The initial estimate of FSEC is that this might require up to 300 billion USD a year, based on spending patterns of the poor in low income countries. This estimate needs to be refined depending on local circumstances, including national programs' ambition and how they are scaled up over time, the specific income groups expected to benefit, local household vulnerability to price increases and the availability of resources and capacity needed to operate transfer programs.

Given strained post-COVID budgets and recent geo-political shocks, financing the costs of transforming food systems will be a difficult hurdle for low- and middle-income countries to overcome.

It risks putting the benefits beyond their reach, even though these far outweigh the costs. Yet at a global level, the costs of the food system transformation are equivalent to only 0.2–0.4 percent of global GDP, and clearly affordable compared to the global benefits. New resources, such as those currently under discussion as part of the Multilateral Development Banks reform agenda, could support these efforts.

## Five broad priorities can guide national food system transformation strategies

Global food system change will in reality take place at national and local levels. There is no universal recipe for what each transformation should look like, but five broad priorities can guide national and local strategies everywhere. Bundling policies into coherent strategies to pursue these priorities maximizes the likelihood of impact:

**Shifting consumption patterns towards healthy diets.** A global shift towards healthy diets is the biggest source of benefits in the FSEC FST pathway. Changing what people choose to eat is not easy but policies that have been shown to work include: regulating the marketing of unhealthy foods to children; front-of-pack nutritional guidance; targeting public food procurement on healthy options; taxing sugar-sweetened beverages and unhealthy foods; and reformulating packaged food. These policies can be applied at scale, but more work is needed to find new ways to shift consumption patterns and improve access to healthy food, as well as more research on which policies work best and why.

**Resetting incentives: Repurposing government support for agriculture.** Most agricultural support from governments benefits larger producers and much is linked to harmful environmental, climate, and health effects. Reforming agricultural support to make sure it incentivizes choices in line with the goals of the food system transformation could lower food systems' hidden costs. For example, repurposed subsidies could help to improve access to healthy diets and make them more affordable. However, subsidy repurposing might displace production to less efficient countries thereby increasing environmental impacts. This calls for investments to improve productivity and contain environmental impacts, possibly through international redistribution.

**Resetting incentives: Targeting revenue from new taxes to support the food system transformation.** Transforming food systems into net carbon sinks and reducing nitrogen pollution are two important sources of benefits. Taxing carbon and nitrogen pollution to help achieve these outcomes is in line with recommendations from expert bodies including the IPCC and OECD. But new taxes must be designed to suit the local context. Targeting resulting revenues towards direct and progressive benefits for poorer households that might otherwise struggle to afford food can ensure its outcomes are inclusive and help to win political support for a food system transformation.

**Innovating to increase labor productivity and workers' livelihood opportunities, especially for poorer workers in food systems.** An unprecedented number of new food system technologies is being developed. Currently this comes largely from the private sector. National and international public institutions can do a lot to speed up the development and diffusion of innovations that meet the needs of poorer producers and remove barriers to their adoption. Priority areas for public research and innovation include: improving plant breeding in low- and middle-income countries; supporting environmentally sustainable, biodiversity-friendly, and low-emission farming systems by, for instance, tailoring public procurement and extension services; and developing digital technologies useful to small farmers, such as information systems based on remote-sensing, in-field sensors and market access apps.

**Scaling-up safety nets to keep food affordable for the poorest.** Developing and strengthening safety nets is key to making food system transformations inclusive and politically feasible. Experience with cash transfers during the COVID pandemic has redefined what is possible, in terms of making efficient digital payments and targeting vulnerable populations. Countries should decide to start by targeting limited transfer resources on children, whose nutritional needs are critically linked to their lifetime achievements, while mobilizing more resources and putting in place more comprehensive safety nets.

## Failure to address head on the tensions surrounding food system transformation will hold back change

Transforming food systems brings huge benefits but it also gives rise to unavoidable tensions among potential winners and losers. Managing these tensions calls for new ways of implementing policies. Unless they are addressed, these tensions will stymie change. Issues likely to require management include:

**Fears of food price rises.** Increasing hunger and worsening food insecurity caused by rising food prices can lead to social unrest, especially when politically powerful populations are affected. For good reason, the price of food is considered by governments and opposition parties as an important barometer of their prospects for re-election or election. Concerns about the future affordability of food can paralyse food system reforms, as well as resulting in disruptive policy responses such as export bans. Putting in place effective safety nets, as proposed by FSEC above, is crucial to lifting this barrier to change.

**Fears of job losses.** Transforming food systems can accelerate the reallocation of jobs away from food production. Localized impacts can be severe when transforming food systems affects the main sources of livelihoods. Developing downstream segments of the food system can help create jobs for farm workers displaced by food system change, particularly in low-income countries. Deploying nature-based agricultural practices such as agroforestry can do the same. The shift towards healthy diets is also likely to create new jobs: the ILO expects some 15 million additional jobs from this source in Latin America alone. But for these new developments to absorb at scale labor shifting from obsolete forms of food production they will need well-targeted investment in productive infrastructure, skills and more equitable access to finance – notably for women farmers.

**Policy siloes.** Numerous government ministries and departments influence food systems. They often pursue disparate, overlapping, and sometimes contradictory policy goals, and their decisions are rarely informed by the views of other stakeholders. While most governments now recognize the urgent need to reform food systems, to ensure success they need to convene more participatory forms of food system governance, develop clear, long-term strategies with transparent accountability, and coordinate their implementation of policies.

**Global inequalities.** While the food system transformation is a clear win at the global level, there are tensions surrounding the distribution of its benefits and costs. The required dietary shift will reconfigure production patterns, likely concentrating many of the costs in some producer countries. Richer producer countries are equipped to contain and mitigate adjustment costs but they are clearly unaffordable for many low-income countries. Food system reforms need to be prioritized for climate finance, in global public health interventions and agreements, and on the agendas of multilateral development banks to be sure of progress at the necessary scale and speed.

**Entrenched vested interests.** Food systems are characterized by marked asymmetries in power, information, and accountability. Powerful corporations often use their influence over policymaking to delay or dilute reforms perceived as a threat to shareholder value. FSEC highlights three ways to assert the public interest in food system reform based on successful examples of generating change. First, emphasize the intended public benefits, such as better child health and lives saved by healthier diets, to build constituencies for reform. Second, form broad-based, multi-stakeholder coalitions to challenge corporate power. Coalitions were instrumental in persuading governments across Latin America to raise taxes on sugary beverages despite corporate lobbying against them. Finally, when using new taxes to change incentives, link the tax revenue directly to interventions which command broad support. For example, Bolivia finances its healthy school meal programs from a tax on hydrocarbons, converting natural capital into human capital.

Daunting as the challenges of transforming food systems may be, there are reasons to be hopeful. Over recent years transforming food systems has risen in visibility as a policy priority. From citizen movements to farmers to businesses, new groups and coalitions are innovating to make food systems more sustainable. New technologies and business models are expanding the scope of what is possible. The COP28 UAE declaration on Sustainable Agriculture, Resilient Food Systems, and Climate Action signed by over 150 countries signals a new ambition to seize the opportunities offered by transforming food systems.

Addressing squarely the concerns that shape policymakers' vision of what is possible offers a pathway to reap large benefits for people and planet.

BOX ES.1
## Modeling the Food System Transformation

To understand the food system transformation in a scientifically rigorous way, FSEC explored food system pathways generated using the modeling framework MAgPIE (Model of Agricultural Production and its Impact on the Environment, Dietrich et al. 2019). MAgPIE projects how the agriculture and food sector may change over time given a consistent set of socio-economic assumptions and biogeophysical constraints. Its modeling capabilities are extended through coupling it with specialized models of public health (Springmann et al. 2018), the energy system (Baumstark et al. 2021), and the climate system (Meinshausen et al. 2020). FSEC uses the resulting pathways to produce economic valuations of the gross and net economic benefits of the food system transformations that they capture.

This report focuses on two such pathways. “Current Trends” (CT), represents a continuation of the trends that characterize food systems today. The “Food System Transformation” (FST), characterizes a global effort to transform current food systems into a global system that produces healthy, nutritious food without sacrificing a livable environment, meets the needs of those working in agriculture and lifts up the world’s poor and hungry. A third pathway, elaborated in Chapter 3, embeds the FST within a more general sustainable transformation that is largely external to the food system. This includes more optimistic assumptions for future GDP and population growth as well as the ongoing energy transition.

**The Current Trends (CT) Pathway**
The Current Trends pathway projects a future extrapolated from past trends and the present. Assuming no deep structural changes in the world economy, global GDP expands by over 100 percent by 2050, yet this prosperity is unevenly distributed. Poverty rates decline, but entrenched structural disparities ensure that a considerable portion of the global population remains impoverished. Food production scales to meet the needs of that global population, expected to reach 9.5 billion by 2050, but 640 million people remain undernourished. At the same time, the increasing prevalence of unhealthy diets in richer countries contributes to a surge in obesity, affecting nearly 1.5 billion people in 2050. Regarding climate change mitigation, nations adhere to their current Nationally Determined Contributions (NDCs), increasing managed forestry by 230 million hectares to reach 560 million hectares globally. Yet, inadequate international cooperation hampers further progress toward the 1.5°C climate goal, and earlier powerful ambitions to meet the Paris climate targets lose momentum. Agricultural expansion and overexploitation of natural resources further degrade natural ecosystems and the biodiversity they foster.

**The Food System Transformation (FST) Pathway**
The Food System Transformation pathway projects an alternative future, defined by worldwide commitment to achieving an inclusive, health-enhancing, and environmentally sustainable food system. Over the next thirty years, all countries gradually transition away from diets dominated by empty calories and animal-sourced proteins, and instead increase their consumption of vegetables, fruits, nuts, legumes, and whole grains. Resolute action eliminates hunger by 2050, sparing 640 million people the pain of going to bed hungry, or not knowing what their children will eat the next morning. Enormous swathes of natural ecosystems are protected from development, and ambitious re-/afforestation programs begin to expand managed forests by 2.5 million hectares each year from today to 2050. These efforts, together with technological progress reducing agricultural pollutants, ensures the land-use sector becomes a net carbon sink by 2040. Campaigns to fight poverty in the agricultural sector are successful, ensuring living wages for the almost 400 million people who work in it. Simultaneously, the transition away from expensive and wasteful diets, coupled with redistribution of carbon taxes, guarantees that food remains affordable.

**The gross and net economic benefits of the food system transformation**
FSEC uses two distinct but complementary methods to assess the economics of transforming food systems: an aggregate top-down approach and a detailed bottom-up approach. The top-down approach (Dietz 2023) calculates the aggregated impacts of the FST in terms of health, environment, and income, expressing changes in social welfare in monetary terms. The bottom-up approach (Lord 2023) quantifies the hidden costs avoided by the FST, including those related to health, environment, and poverty. The bottom-up approach estimates the value that present or future economies may lose from poor health or environmental pollutants like GHG emissions or nitrogen surplus. While both methods are grounded in welfare economics, the top-down method aims for a holistic measure of societal well-being, while the bottom-up approach focuses on tangible, itemized costs. Together, they provide a comprehensive understanding of the economic impacts of food system transformation on a global scale.

*Sources: Baumstark et al. 2021; Bodirsky et al. 2023; Dietrich et al. 2019; Dietz 2023; Lord 2023; Meinshausen et al. 2020; Springmann et al. 2018*

TABLE ES.1
**Packages of measures modelled by FSEC**

| Operational Goal | Food system measures |
|---|---|
| Diets<br>Consumption of healthy diets by all | • Eradication of undernutrition<br>• Stabilization of obesity<br>• Convergence towards healthy diets<br>• Halving food waste |
| Livelihoods<br>Strong livelihoods throughout the food system | • Trade liberalization<br>• Wage increases in agriculture<br>• Capital substitution |
| Biosphere<br>Protection of intact land and restoration of degraded land | • Reducing emissions from deforestation and forest degradation (REDD+)<br>• Land conservation<br>• Peatland rewetting<br>• Water conservation<br>• Biodiversity offset |
| Production<br>Environmentally sustainable production throughout the food system | • Nitrogen efficiency<br>• Longer crop rotations<br>• More landscape habitats<br>• Emission mitigation from rice cultivation<br>• Livestock management<br>• Manure management<br>• Soil carbon management |

External
Sustainable transformations external to the food system

- Slower population growth
- Equitable human development
- Sustainable energy transition
- Increase in bioplastics
- More timber construction

# Introduction
# Transforming food systems to tackle global climate, nature and health emergencies

# Introduction

→ Transforming food systems worldwide provides a uniquely powerful means of addressing the global climate, nature and health polycrisis while offering a better life to hundreds of millions of people.

→ The approach of the Food System Economics Commission to the analysis of the economics of the food system transformation is characterized by five elements: an emphasis on inclusion, putting people at the centre of the transformation; the integration of insights from a variety of economic approaches; the emphasis on generating and sustaining systemic change; the recognition that transforming systems takes time and progress will be uneven; and an emphasis on the interdependencies between food systems and other systems.

## The power of food systems

Our food systems — the way we produce, market, and consume food — are woven into the political, social, economic, ecological, and cultural fabric of our communities. Seen as one global food system, they have performed something of a miracle over recent decades, managing to keep pace with global population growth while decreasing some forms of malnutrition, reducing poverty and increasing life expectancy (Box I.1). But the rapid evolution of food systems has also fuelled and continues to inflame some of our greatest and gravest challenges, from persistent hunger, undernutrition and obesity to declining biodiversity, environmental damage and climate change.

Ignoring the consequences of today's food systems locks the world onto a course that escalates their negative effects disastrously. Yet in many policy discussions, such as in discussions around climate change, food systems have long been ignored – concerns for food affordability and the livelihoods of hundreds of millions who depend on food systems, the power of large-scale players, divergent views among stakeholders about what sustainable food systems look like have all contributed to make food systems something of an exception. Current policy commitments fall short of preventing agriculture from being the source of about one third of global emissions and at the same time a victim of climate change. Efforts to rein in consumption of the foods most harmful for our health are defeated by concerns about food affordability. Incentives to promote more sustainable ways of producing food contend with the challenge of addressing stranded assets at the farm level while offering strong and stable livelihoods. Yet this is an opportunity for policymakers to raise the level of ambition. Transforming food systems worldwide provides a uniquely powerful means of addressing the global climate, nature and health emergencies while offering a better life to hundreds of millions of people.

What would making our food systems inclusive, health-enhancing and environmentally sustainable entail? This report draws on extensive research undertaken by the Food System Economics Commission (FSEC) from 2020 to 2023 to answer this question and three more: is such a global transformation economically viable? What policy levers can make it happen? And what obstacles could block its way?

Chapter 1 examines today's food systems and the opportunities and threats they pose, before setting out five defining characteristics of an inclusive, health-enhancing and environmentally sustainable food system. These characteristics form the goals of potential food system transformation pathways that FSEC has explored using an Integrated Assessment Modelling (IAM) approach, explained in Chapter 2. Overall, the modeling shows that a transformation of the global food system is both possible by 2050

BOX I.1
### Defining food systems

Agri-food systems are defined as “encompassing the entire range of actors and their interlinked value-adding activities involved in the production, aggregation, processing, distribution, consumption and disposal of food products that originate from agriculture, forestry or fisheries, and parts of the broader economic, societal and natural environments in which they are embedded” (FAO 2018).

FSEC’s focus is on the global food system made up of infinite interconnected national and local elements, which in this report are referred to as food systems (plural). It is analytically difficult, often impossible, to separate food and non-food related activities in food systems, as often a single product, for instance maize, has both food and non-food uses. For this report, therefore, FSEC has mostly drawn on analysis of agri-food systems. For simplicity they are referred to throughout as “food systems” except where a special emphasis on the non-food components is needed.

*Source: FAO 2018*

and economically viable. Indeed, food system transformation on a global scale leads to enormous economic benefits that far outweigh its costs, as Chapter 3 shows.

Achieving those global gains depends first and foremost on action to change food systems at the national and local levels. There is no universal recipe of policies for transforming food systems, but transformation strategies everywhere are likely to share the priorities detailed in Chapter 4, namely: shift consumption patterns towards healthy diets; reset incentives to encourage essential changes, especially by repurposing existing government support for agriculture and by taxing carbon and nitrogen pollution; invest to increase productivity in food systems through innovation and improve the livelihoods they offer, particularly for poorer workers; and scale-up safety nets to keep food affordable for the poorest.

Food systems are already changing across the world, as Spotlights on Change throughout the report demonstrate. Citizen movements, farmers, businesses, and others are all innovating to improve food system sustainability (see Spotlight on Change 1). But these uncoordinated improvements are scaling too slowly to achieve a global transformation in time. Much faster, large-scale change needs to be negotiated among the multitude of diverse stakeholders in food systems who have unequal power and very different interests in the major changes ahead. Chapter 5 identifies potential barriers to change and highlights practical ways to dismantle them, to help food system stakeholders negotiate system transformations that are politically achievable.

## FSEC’s approach to understanding food systems and their transformation

Several recent reports have explored different aspects of the food system transformation (Willett et al. 2019; FOLU 2019; Mbow et al. 2019; FAO et al. 2022). Building on those insights and others, FSEC’s analytical focus is defined by five elements:

→ First, the **emphasis on inclusion.** This means the report puts people at the centre of food system transformation. For FSEC, protecting and enhancing the livelihoods of those who depend on food systems and ensuring that healthy, diverse and safe diets are accessible and affordable to all are essential aims of any transformation strategy. They entail addressing inequalities across gender and race, and those experienced by particular socioeconomic groups (see Spotlight on Change 2). This emphasis on inclusion requires understanding how different groups might be affected by food transformation strategies and to incorporate distributional impacts in strategy design. Understanding of distributional impacts includes not only direct income and price effects but also broader effects, such as the shifting profile of opportunities and jobs that a transformation will bring.

- Second, the **integration of insights from a variety of economic approaches.** The research informing the report integrates long-term global pathway analysis and modeling with political economy analysis to identify relevant policy tools and insights into how feasible transformation strategies can be shaped (Gaupp et al. 2021).

- Third, the **emphasis on generating and sustaining system change.** This emphasis explains why the report covers not only changes in the production and consumption of food, but also the need for new institutions and new ideas to shape preferences and shift interests, fostering sustained systemic support for new practices and behaviours. Taking this systemic approach to the design of transformation strategies means considering all the relevant interactions and feedback loops between different elements of food systems as well as the synergies and trade-offs

SPOTLIGHT ON CHANGE 1

## Different actors, similar goals

### Transforming deserts into fertile farmland

Part of the rich dynamism of food systems is that change can be initiated at all levels, from the global to the very local. And while government action and funding can often play a central role, there is much that can be achieved by individual actors and communities. The two very different examples of land restoration interventions in the Loess Plateau in western China and in Tigray, in northern Ethiopia, help illustrate the variety of ways that transformative change can happen in food systems.

The once rich soils of the Loess Plateau in western China, a region about the size of France, used to feed one quarter of the Chinese population. Intense pressure on the land eroded the soil leaving the population in poverty by the 20th century. Funds from the World Bank and the Chinese government restored 4 million hectares of land on the Loess Plateau in the 2000s. Local farmers' incomes have more than doubled, sediment erosion has been reduced by 100 million tons annually, the risk of flooding has been reduced and grain production has increased dramatically. The changes were brought about by designating ecological and economic areas of land, terracing, sediment traps, dams, and other methods of capturing rainwater.

In contrast with this largely central government project, large-scale restoration of arid areas in Ethiopia started as a bottom-up initiative led by local farmers: The inherently barren Tigray region in Northern Ethiopia is frequently hit by severe and ever more frequent droughts. These contributed to several hundred thousand people starving to death in the 1980s. As a result, local smallholders and communities came up with innovate approaches and techniques for capturing water. As well as the building of wells, they tended upper mountain slopes to capture water and prevent soil erosion. Farmers in the region created a collective knowledge repository with more than 50 methods to prevent soil erosion and capture water. The World Food Programme provides technical assistance, while the Ethiopian government has granted microloans to smallholders, and provides subsidized artificial fertilizers and improved plant seeds. Most farmers have paid off their loans expeditiously thanks to significantly increased and diversified yields, including a wide range of cereals, vegetables, and fruits. The continued expansion of fertile lands in Ethiopia is endangered by the terrible domestic conflict, as well as disputes with neighbouring Sudan and foreign land-grabbers over fertile soils, which are threatening to reverse progress.

*Sources: Buckingham 2016; Hagazi et al. 2020*

SPOTLIGHT ON CHANGE 2

## Tackling the constraints that limit women's access to land

### Regularizing land tenure in Rwanda

Gaining security of tenure generally makes landholders more willing to invest in improving the productivity of their land and its natural capital. It may also empower women, as Rwanda's experience demonstrates.

Historically, competition for land in Rwanda has fuelled pervasive land disputes, "land grabbing" and illegal land sales, in turn exacerbating inequality, landlessness and social tensions. To reduce such land-related conflicts, Rwanda has taken far-reaching legal measures aimed at clarifying land rights and ending discrimination that impedes women from becoming landowners. Between 2007 and 2013, Rwanda tested and rolled out a land tenure regularization (LTR) program which identified and registered more than 10.3 million land parcels (DAI 2023). The program included sensitizing stakeholders, demarcating the boundaries of land parcels with both landowners and neighbours present, documenting the parcels on an index map and registering everyone with a claim to each parcel, including women and minors. The tenure maps and registers were digitized and made publicly available.

A scientific evaluation of the effects of the pilot program (2007/08) found a subsequent increase in secure land tenure among married women, who are more likely to be regarded as joint landowners than before. Women were more likely to inherit land too. Although Rwandan inheritance law requires gender equality, informal inheritance of land by men often bypassed women's rights. By requiring landowners to specify their planned inheritors, the LTR virtually eliminated gender bias in inheritance. In addition, households almost doubled their investment in soil conservation and female-headed households almost tripled their investment (Ali et al. 2014). Since completion of the program, 92 percent of land certificates include the name of a woman (DAI, 2023).

*Sources: Ali et al. 2014; DAI 2023*

between different food system objectives. (FAO 2018).

→ Fourth, the **recognition that transforming systems takes time and progress will be uneven.** Changes to a food system's supply side are especially likely to be uneven where altering established production patterns depends on large, "lumpy" investments. External shocks can also interrupt the pace of change. And some effects of a transformation may themselves produce unintended volatility.

→ Finally, our **focus on the interdependencies between food systems and other systems.** Transforming food systems will not be enough by itself to keep the world within 1.5°C of global warming, significantly reduce obesity and the incidence of diet-related, non-communicable diseases, and strengthen the livelihoods of people working in food systems. FSEC's analysis seeks therefore to distinguish progress that can be achieved by changes within food systems and advances that depend on accompanying broader socio-economic developments.

The diversity of the world's food systems makes it hard to pin down specific recipes for transforming them. But the dynamism, adaptability, and innovative abilities of all the actors that shape food systems grounds the hope that transformations to an inclusive, health-enhancing and environmentally sustainable food system will be achieved by 2050.

# Chapter 1
# Shared Goals for Food Systems

# Chapter 1

→ Food systems are incredibly diverse and transforming them towards more inclusive, health-enhancing and environmentally sustainable outcomes will require solutions tailored to their different contexts.

→ Despite local specificities, the future of food systems is likely to be shaped by heightened concerns for resilience to climate and conflict shocks, an ongoing shift away from traditional diets, high levels of innovation along the whole food value chain, and continued reallocation of labor out of agriculture.

→ Transforming food systems towards inclusive, health-enhancing and environmentally sustainable outcomes can be translated as the pursuit of five operational goals: (1) consumption of healthy diets by all; (2) strong livelihoods throughout the food system; (3) protection of intact lands and restoration of degraded lands; (4) environmentally sustainable food production and (5) resilient food systems that maintain food and nutrition security in the short and the long run.

## Introduction

This chapter looks at the challenges of transforming food systems given their diversity and the variety of trends that shape them. It describes the major trends affecting food systems today and the opportunities and threats ahead. It then identifies five defining characteristics of inclusive, health-enhancing and environmentally sustainable food systems. FSEC's modeling of transformation pathways, detailed in Chapter 2, adopts these five characteristics as operational goals and considers courses of actions or pathways to reach them. In practical terms, these five operational goals can also guide the actual transformation of any food system, whatever its scale and geographic location, into one that is inclusive, health-enhancing and environmentally sustainable.

## Food systems around the globe are highly diverse and dynamic

A first step towards transforming food systems is to recognize their differences, similarities and interconnections, and the variety of country-level and global trends shaping their future.

### Country-level trends

Food systems are highly diverse. Ambikapathi et al. (2022) group them in five categories ranging from traditional systems using ancient practices to highly automated, industrial systems. This categorisation helps to identify several trends that have shaped food systems in all countries, to varying degrees, as they have experienced both the modernization of agriculture and its declining contribution to national economies. These trends include:

→ Increasing affordability of healthy diets, driven by the increasing supply and falling prices of a number of healthy foods. However, healthy diets remain unaffordable for 3.1 billion people (FAO et al. 2022), and obesity and other non-communicable diseases associated with unhealthy diets have been rising worldwide over the past few decades (Willett et al. 2019; Branca et al. 2019).

→ A large shift away from distinctively local diets high in traditional, minimally-processed staples and cereals towards more globally homogenized diets higher in sugar, salt and fat. This trend has been driven by urbanization and rising incomes as well as the growing role of multinational corporations in shaping food systems (Vaidyanathan 2021).

→ A growing burden on the environment arising from over-consumption of certain foods and excessive food loss and waste. In particular, the over-consumption of ruminant meat in industrialized food systems is expanding their carbon footprint.
→ The movement of labor out of agriculture as urban and rural activities and employment in manufacturing and services have expanded. These developments have transformed the structure of most economies. Corollaries of this structural transformation are an ageing farmer population and increasing land consolidation (Giller et al. 2021).

While agricultural productivity growth related to these trends has helped to reduce poverty and increase food security in many countries, some in Sub-Saharan Africa (SSA) and South Asia have been exceptions (IFAD 2016).

## Global trends

In addition to these country-level trends, at least three major global trends shaping food systems have intensified since the turn of the millennium: Market concentration in the agri-food industry; trade and interdependence; and the frequency of shocks producing food crises across the globe. These trends are having varying effects on inclusion, food security, nutrition and the environment.

### GROWING MARKET CONCENTRATION IN THE AGRI-FOOD INDUSTRY

Market concentration in the agri-food industry has increased across most segments and geographies due to mergers and acquisitions combined with the spread of modern food retailing – the "supermarket revolution" (Reardon et al. 2010). While concentration does not necessarily enable a few large companies to manipulate prices at the expense of consumers, big market players are seen to use their financial power to exert significant influence on food systems and on policy decisions affecting them (Hernández et al. 2023; see also Chapter 5). For example, big players can push back against government regulation and advocate self-regulation instead (Béné 2022). As a result, agri-food industry regulators have increasing difficulty in setting and enforcing industry standards to protect consumers, workers and the environment. In other sectors, such as tobacco, the lack of effective regulatory standards has been associated with failure to contain excessive influence from big players (Sharma et al. 2010). This weakness in the regulation of the tobacco industry was addressed successfully by the WHO Framework Convention on Tobacco Control (FCTC) (Puska & Daube 2019).

### GROWING INTERNATIONAL TRADE AND INTERDEPENDENCE

Although on average only 17 percent of all food by weight is currently internationally traded, the value of trade in food and agricultural commodities has grown eight-fold over the past five decades, a period in which agricultural production tripled (Global Panel 2020). Staple grains, mostly for animal feed, dominate this trade although growth in other food categories, including fruits, vegetables, meat and eggs, is enabling the diversification of diets worldwide.

There is much debate on the implications of the growing interdependence of food systems through trade over the past few decades, since trade has multiple and often contrasting effects:

→ The distributional effects of trade on inclusion vary according to the impact of trade on sources of incomes, on the consumption and prices of traded and non-traded goods and on the assets owned by different groups of people. In general, however, the income opportunities offered by more trade integration can be difficult for smaller producers to grasp (Onono-Okelo & Omondi 2023). Women in particular face disproportionate barriers to accessing the resources they need to benefit from these opportunities (Njuki et al. 2023).

→ The effects of trade on food security may be countervailing to some extent. Trade helps to smooth volatility in domestic consumption of heavily traded staples (Bradford et al. 2022). However, interdependence between food systems can amplify the impact of local or regional supply shocks, such as those caused by Russia's invasion of Ukraine or export restrictions in producer countries to protect domestic consumption.

→ From a nutritional point of view, "food trade plays an important role in the global distribution of nutrients" (Global Panel 2020). However, its impact has been mixed depending on what type of food is traded and in which region. For example, fruit imports have risen globally since the mid-1990s, but fruit imports per capita have stalled in Sub-Saharan Africa and South Asia. At the same time, nutritionally less helpful sugar imports have risen in high income countries and also in some low and lower-middle income countries. The establishment by multinationals of new production facilities in Latin America to take advantage of growing trade in ultra-processed food has been linked to the growth in local consumption of those foods (Global Panel 2020).

→ The environmental aspects of trade are much debated and may also be countervailing to some extent. In principle, trade can be crucial for adaptation to climate change. Producers can adapt to regional biophysical and climatic conditions by specializing in export products suited to their local conditions, avoiding the negative impacts on biodiversity and the environment of trying to meet all their needs locally (WRI 2022). However, empirical estimates of success are mixed. The evidence suggests that trade overall leads to more efficient water use (Dalin & Rodríguez-Iturbe 2016) but its effects on greenhouse gas emissions and pollution are less clear. Trade may also indirectly

SPOTLIGHT ON CHANGE 3

## The potential of urban agriculture to feed cities

Urban agriculture can nourish up to one billion city dwellers while supporting progress towards several other sustainable development goals. These range from strengthening livelihoods, extending environmentally sustainable production and creating new local food supply chains to enhancing ecosystem services such as climate change adaptation and countering the urban heat island effect. Urban agriculture can also play a major role in strengthening the resilience of cities and communities.

In low-income countries urban agriculture already provides significant shares of household income in urban areas, notably in Nigeria (71 percent), Madagascar (63 percent), and Ethiopia (40 percent) (Poulsen et al. 2015). Urban agriculture has the advantage of offering women additional income earning opportunities. In higher income countries too, there is growing awareness of the potential for urban agriculture. The city of Berlin estimates that urban agricultures could supply up to 80 percent of the city's fresh vegetable demand. In China, cities could meet 30 percent of their vegetable demand from indoor and rooftop urban agriculture on average, with its potential ranging from supplying 10 to more than 200 percent of individual cities' total vegetable needs.

The success of urban farming depends on a range of factors. Available space, local population density, vegetable yields and resource management all make a difference. To encourage successful urban agriculture over the long term, cities need to offer both incentives and the right supporting physical and organizational infrastructure, including commercial frameworks.

*Sources: Pradhan et al. 2023; Poulsen et al. 2015* amplify pressure to convert natural habitats to agricultural uses by enabling output from newly cultivated areas to meet international demand (Global Panel 2020). Growth in trade also directly affects the environment through the demand for storage, packaging and transport that it stimulates (Nemecek et al. 2016).

#### GROWING FREQUENCY OF SHOCKS LEADING TO FOOD CRISES ON A GLOBAL SCALE

Extreme weather events and geopolitical and economic shocks have been the main triggers of increasingly frequent food crises (Cottrell et al. 2019). Financial markets often amplify any resulting volatility in food prices (Headey et al. 2010). Repeated food crises over the past two decades have highlighted the fragility of today's highly interdependent, concentrated global food systems (FAO 2022).

Paradoxically, this fragility arises from the pursuit of efficiency. Short-term optimization of resources has tended to concentrate a large proportion of global production of many traded food commodities in locations with the most favorable cost/output ratios. This makes global supply of those commodities much more vulnerable to shocks in those locations than would be the case if there were less specialization and more redundancy in food systems, that is, if traded commodities were grown in more locations more widely dispersed around the globe (Janetos et al. 2017). Pilditch et al (2023) discuss the trade-off between optimizing for too narrow a set of variables and diminishing resilience

SPOTLIGHT ON CHANGE 4

## Developing new production opportunities downstream

**Processing cashew by-products in Benin**

Benin relies on exports of shelled, raw cashew nuts, which grow on cashew apples. At present, the cashew apples and nutshells are generally discarded as waste. However, cashew apples are rich in nutrients and especially beneficial for diabetes patients. They can be processed into various products such as cashew apple juice. And both cashew apples and nutshells can be re-used to produce bioenergy.

Cashew apple processing at scale has not yet developed in Benin partly because the apples are highly perishable and must be processed the day they are picked. The lack of available technical know-how and equipment plus unstable electricity supplies pose further challenges to processors, as does the currently low domestic demand for cashew apple juice due to low awareness of its availability, taste and health benefits among consumers.

Scenario analysis shows that overcoming these challenges to develop a cashew processing sector would bring a host of benefits to Benin: the economic benefits of additional growth; higher income for cashew farmers; alternative employment for agricultural workers including new jobs in processing, transport, marketing, and sales; the social benefits of increasing incomes for women, who form a large part of the cashew harvesting and processing workforce; the population health benefits of substituting cashew juice for sugar-sweetened beverages; and the environmental benefits of processing waste into healthy food and green energy.

Targeted policies that would speed development of Benin's cashew processing sector include promoting cashew apple juice to consumers, improving rural infrastructure, and providing support for a processing value chain. Helping farmers to execute the first stage in that chain on-farm would solve the perishability problem and reduce transport volumes. Converting cashew apples and nutshells into bioenergy would give processing factories both a new source of electricity and additional income.

*Source: Kinkpe & Grethe 2023*

as a common feature of complex systems.

Structural inequalities common in food systems underlie uneven distributions of losses when a food crisis strikes. Women and other marginalized groups are particularly vulnerable. Women tend to be less able to guard against the risks of shocks or recover from their effects because of social norms including restrictions on their mobility and access to information and other resources (Njuki et al. 2023). Moreover, the governing bodies of today's food systems have limited mechanisms for coordinating crisis management. As a result, food price spikes following supply shocks increase hunger, poverty and inequality, especially in the poorest countries (Ocampo et al. 2022).

## Looking ahead: opportunities and threats shaping the future of food systems

The food system trends summarized above shape several future opportunities and threats:

- **Food system resilience will remain a central concern** because climate and conflict shocks pose real risks to food systems at all levels, from local to global. Population growth will also add to pressures on food systems: the global population is expected to reach about 9.5 billion by the middle of this century. According to the latest IPCC report, "Climate-related extremes have affected the productivity of all agricultural and fishery sectors, with negative consequences for food security and livelihoods […]. Climate change will make some current food production areas unsuitable […]. Climate change will increase the number of people at risk of hunger in mid-century, concentrated in Sub-Saharan Africa, South Asia and Central America" (Bezner Kerr et al. 2022, p.717). Furthermore, lower nutrient levels are expected in some crops due to warming and increases in $CO_2$ concentrations (Ziska 2022; Smith et al. 2018; Ebi et al. 2021).
- **Food consumption patterns will probably continue to shift away from traditional norms,** driven by complex responses to factors such as urbanization, income growth, the loss of culinary knowledge and traditions (HLPE 2017), and the marketing of non-traditional foods and beverages (Kearney 2010). Some aspects of this shift will give currently undernourished populations access to healthier diets. Others are likely to fuel the growing consumption of ultra-processed food, resulting in more instances of diet-related non-communicable disease and their associated economic threats, such as rising healthcare costs. In addition, sustained global increases in the supply of animal-sourced products are likely to increase pressures on the environment unless there are significant innovations in production methods and improvements in their productivity.
- **Innovation will continue apace, possibly leading to entire new models of production.** Supply chains are already being redesigned. For example, labor shortages are promoting the use of robots in highly labor-intensive sectors such as fruit and vegetable production. Plant breeding and precision farming will remain important for adapting production systems to more volatile conditions and assuring product quality. Other developments include more locally-produced food and circular production models, more food grown in cities (see Spotlight on Change 3), and more diversification of suppliers (Hertel et al. 2023). Artificial intelligence applications are likely to transform many parts of the economy and will affect food systems. Synthetic foodstuffs may become increasingly important as they can be sourced locally, making supply chains more resilient. They could also replace animal-sourced proteins, although their effects on inclusion, health and the environment when deployed at scale are as yet unknown and untested.
- **The modernization and structural transformation of agriculture will continue to reshape opportunities and livelihoods.** Both trends may offer many people now working in agriculture the chance to diversify and strengthen their sources of income or to get new jobs, either in other parts of food systems or elsewhere in the economy. New investments, for example in rural infrastructure, may be needed to create new opportunities (See Spotlight on Change 4). However, while the movement of workers out of agriculture clearly helped to reduce poverty during the second half

of the 20th century, there is current evidence that some people leaving agriculture in countries experiencing a late structural transformation are moving into low productivity services rather than more productive manufacturing jobs (Ambikapathi et al. 2022; Gollin et al. 2016).

Assessments of how these opportunities and threats will play out vary wildly. For example, some expect further urbanization and land consolidation to foster the more productive, intensive use of land for food production, which they see as key to protecting uncultivated land from the encroachment of agriculture if matched with policies and support to halt land expansion (Folberth et al. 2020). Others emphasize the potential of new and more geographically diffuse, smaller-scale production models focused, for example, on urban or peri-urban agriculture (Pradhan et al. 2023) or alternative proteins (Humpenoeder et al. 2022) to offset future threats to food supply and nature. The homogeneity of these trends across geographies is also in question. Some see a global increase in the consumption of animal-sourced food as inevitable as incomes rise around the globe despite evidence that such a trend would be detrimental to both human and environmental health. The global increase in meat consumption is incompatible with both the 1.5°C climate target and the land targets agreed upon in the 2023 Kunming-Montreal Convention on Biodiversity. Others point to signs of a shift away from eating meat products in high-income countries (Willoughby & Muzi 2023).

The food systems of the future are likely to be characterized by all these contrasting forces, though differently in different parts of the world. Global trade, for example, will continue to mitigate the impact of local shocks, while new, more diffuse food production models may create some of the redundancy in food systems needed to lessen the impact of global shocks.

## Five goals for the food systems of the future

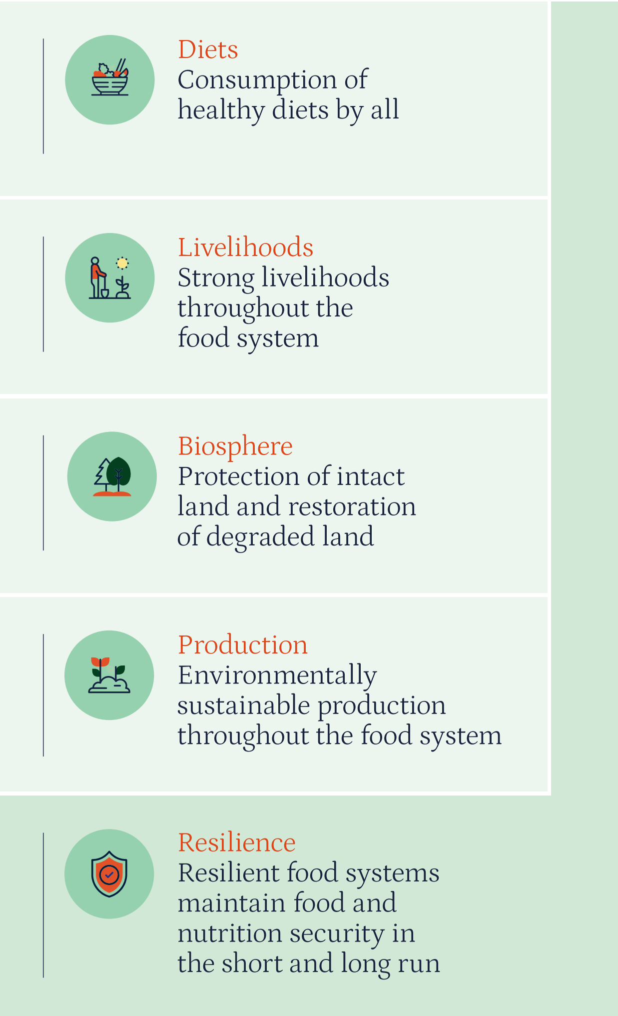
Given the diversity of food systems today and the complexity of the trends shaping them described above, are there any characteristics common to inclusive, health-enhancing and environmentally sustainable food systems?

FSEC has identified five of such defining characteristics. Those can be taken as operational goals that can be quantified to guide specific transformative actions. The operational goals include: (1) consumption of healthy diets by all; (2) strong food system livelihoods; (3) protection of intact lands and restoration of degraded lands; (4) environmentally sustainable food production and (5) resilient food systems that maintain food and nutrition security in the short and the long run (Figure 1.1). While the five goals can be adopted in every context, the actions needed to reach these goals are context-specific and will differ by location.

**Consumption of healthy diets by all.** This goal addresses all forms of malnutrition, including overweight and obesity. It encompasses both food security for all, to address the current undernourishment of almost 1 in 10 people on the planet, and affordable diets for all, to address the lack of affordable healthy food currently experienced by more than 3.1 billion people worldwide (FAO et al. 2022).

General alignment on what a healthy diet comprises is needed for this goal to guide coherent action at the global level. The healthy diet's composition needs to be sufficiently flexible to accommodate local variations in food culture, ecological context and each individual's age and gender. Scientific debate about the recommended ranges of healthy consumption levels for some foods continues. However, there is broad scientific consensus on the need for diets to be diverse, including foods across major food groups, and to allow significant flexibility of choice of foods from those groups within overall healthy levels of consumption (Neufeld et al. 2023). The EAT-Lancet Planetary Health reference diet (Willett et al. 2019; Springmann et al. 2018), FAO and WHO recommendations for Sustainable Healthy Diets (FAO & WHO 2019), and National Food-Based Dietary Guidelines (FAO 2023) all provide dietary recommendations that are aligned at this general level. Although there are some variations in their general dietary recommendations, they differ from each

FIGURE 1.1
**Five operational goals for transforming food systems**




other much less than actual consumption patterns differ from what they recommend. In other words, there is strong consensus on the recommended direction of change in diets. Following this direction while retaining regional differences in diet would on average require:

→ a nearly universal increase in the consumption of whole grains, fruits, vegetables and nuts;
→ less consumption of ultra-processed foods; and
→ regional changes in the consumption of animal-sourced food, with consumption significantly reducing in high-income countries and rising in low-income countries to ensure the adequate consumption of essential nutrients (Afshin et al. 2019) in all regions.

There are no constraints on the diversity of foods that can be consumed in a healthy diet beyond the requirements that it provides a healthy balance of foods from the major food groups and safeguards cultural differences and values.

**Strong livelihoods throughout the whole food system,** meaning higher incomes and better jobs for food system workers. An estimated 1.2 billion people work in agri-food systems and 3.8 billion live in families whose livelihoods depend on food systems (Davis et al. 2023). Those livelihoods are supported by a variety of jobs, from daily manual labor on farms to managerial employment in large supermarket chains. Often, food system livelihoods involve work in multiple roles within food systems, or across food and non-food related activities. Importantly, many food system livelihoods entail working to varying degrees in the informal sector. This complicates the task of understanding, monitoring and managing food systems, as informal work is often unrecorded. The need to identify local solutions to food systems challenges, and particularly the challenge of strengthening of livelihoods, largely stems from the differences in the extent and nature of informality across food systems (see Box 1.1 on informality and the challenges of strengthening informal workers' livelihoods).

The persistent concentration of extreme poverty in agriculture is an indirect indication that many farming systems limit the productive potential and well-being of people whose livelihoods depend on them. Such systems restrict workers' access to resources including security of tenure, capital, and inputs that they need to improve productivity. In addition, activities in many local food systems are assigned to particular groups, often by gender or caste. This can further limit the opportunities available to the poorest, most vulnerable groups to improve their livelihoods. Many food systems also offer little social protection for workers. Examples of oppressive work conditions and modern slavery from food systems all over the world are well documented (McGregor et al. 2018).

**Protection of intact land and restoration of degraded land.** Ensuring the ecological sustainability of food systems requires halting or limiting the expansion of agriculture into remaining intact ecosystems and wilderness areas. These lands currently occupy approximately 50 percent of the globe's land surface, but much of this area is taken up by desert and boreal/tundra ecosystems unsuitable for agriculture. In each ecoregion[1], intact lands need to be protected from encroachment to halt the loss of biodiversity and of unique "ecological communities" - i.e., groups of native species that are interacting in the same unique habitat – and help maintain nature's contributions to people, including the regulation of climate and water cycles (Rockström et al. 2023; Richardson et al. 2023). Restoration of degraded lands can help these essential environmental services recover and flourish. Retention of upwards of 75 percent of forest lands is required to retain their contribution to climate mitigation targets (Richardson et al. 2023).

**Environmentally sustainable production throughout the food system.** Food systems contribute significantly to total GHG emissions, biodiversity loss and environmental pollution. They account for about a third of global GHG emissions, with conversion of land to agriculture and agricultural production itself responsible for much of that amount, notably in the form of methane emissions from ruminant livestock and rice production. Emission intensities also vary significantly within product categories, depending on production practices and contexts. For example, environmental impacts of maize, wheat, and rice production from the 10 percent most emission-intensive forms of production are more than three times as large as those from the 10 percent least emission-intensive forms (Deconinck & Toyama 2022). Emissions from areas of food systems other than agricultural production remain under-researched, although new approaches to monitoring and reporting emissions from supply chains are helping to make them more transparent (Deconinck & Hobeika 2022).

Sustainable intensification of production is necessary in order to spare remaining intact land for its contributions to climate and environmental stability (Folberth et al. 2020). Sustainable and ecological intensification aim to close yield gaps where they persist, while recognizing and amplifying the ecological performance of production systems, including retaining sufficient embedded habitats within agriculture to secure pollination, pest regulation, and other ecosystem services necessary in agricultural lands – at least 20 percent habitat per square kilometre has been proposed as a minimum value necessary to maintain such services (Willett et al. 2019; Rockström et al. 2023; Garibaldi et al. 2020). A diversity of practices qualifies as sustainable intensification including conservation agriculture, agroforestry, precision agriculture, organic agriculture to name but a few (FOLU 2023). There are concerns that some of these practices reduce yields with active debates on how to sustainably manage production landscapes with topics including regenerative agriculture, sustainable intensification, and ecological intensification. To aid navigation of this debate, the FAO has adopted 10 principles of agroecology that emphasize inclusion and diversity (FAO 2018).

**Resilient food systems that maintain food and nutrition security in the short and long run.** Resilience is closely entwined with the other four operational goals. Consuming healthy diets, providing higher incomes and better jobs, protecting and restoring land, and producing food in an environmentally sustainable fashion all help to give food systems the capacity to cope with sudden shocks. Their resulting resilience is particularly important for protecting the most vulnerable. Strengthening food systems' ability to withstand shocks through measures that create more redundancy in food systems and reduce the impact of shocks is therefore an essential component of a food system transformation strategy, partic-

1 A large area of land or water containing a characteristic set of natural communities that share a large majority of their species, ecological dynamics and environmental conditions (Fath 2018)

ularly as climate change increases the risk of shock.

To illustrate, environmental shocks threaten food security, especially for the poorest, by restricting supply and causing price spikes. They can also derail efforts to make food systems sustainable over the long term by pushing policymakers into crisis management. The urgent need to address short-term food supplies, particularly for lower-income groups, may divert their attention from longer-term transformation goals. During food crises, for instance, policymakers often relax environmental regulations as a means of quickly increasing food production, which undermines long-term goals. (Laaninen 2022; Cerier 2023). In contrast, protecting valuable ecosystems, and restoring the productivity of degraded lands delivers myriad environmental services that both lessen the likelihood of environmental shocks and help to ensure food security over time.

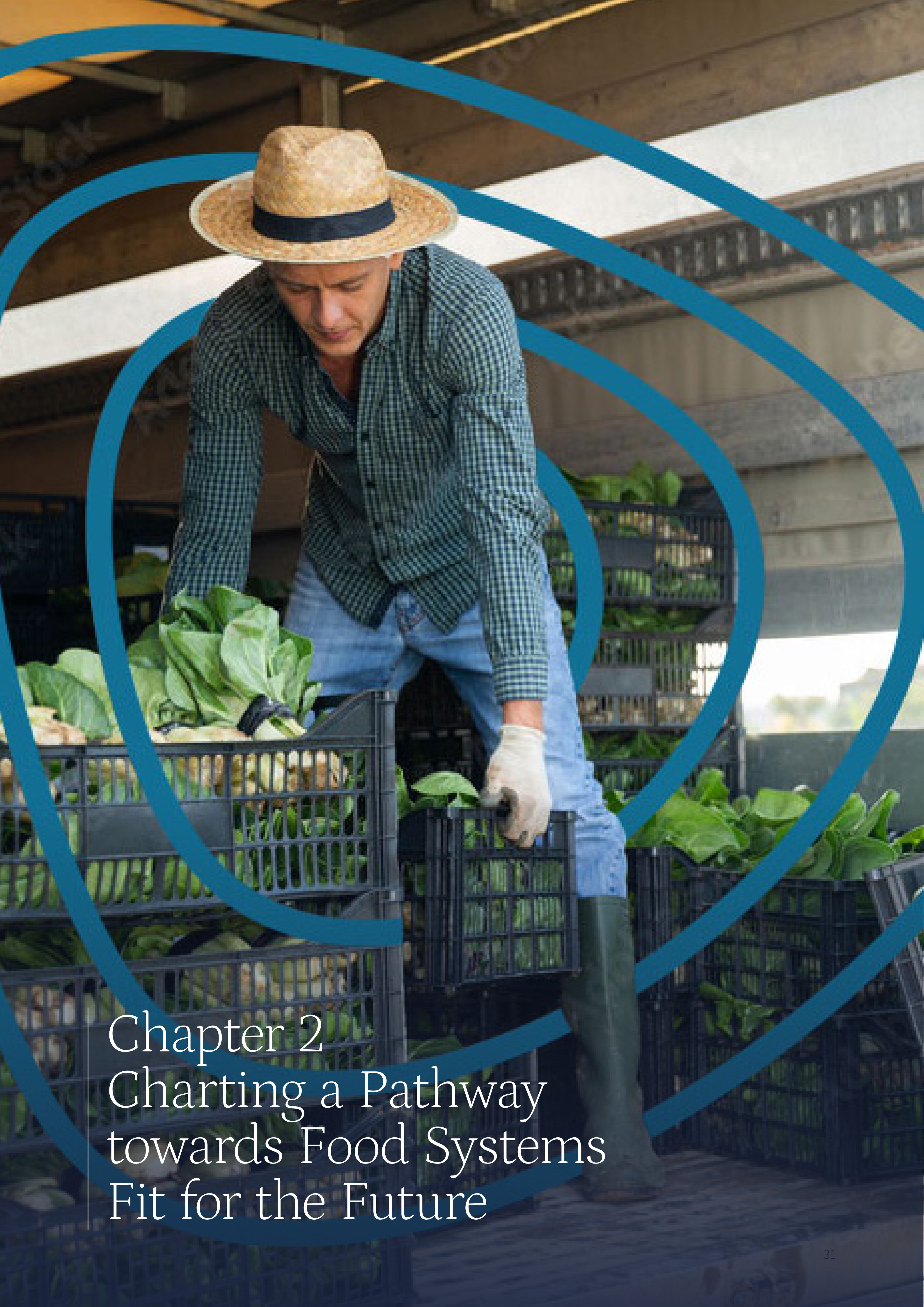
BOX 1.1
### Informality and the challenges of strengthening informal workers' livelihoods

The livelihoods of many people working in food systems are at least partly informal, meaning they are beyond the reach of formal regulations. Globally, agriculture is the sector with the highest level of informal employment. Today 98 percent of agricultural workers in Africa are employed informally, as are 99 percent in South Asia, and India is the country with the largest number of informal food system workers by far (ILO 2018). In Sub-Saharan Africa, food traders are mostly unregistered, and 70 percent of the urban population in 11 African cities get all their food from such informal street vendors or other informal retailers (Resnick 2017).

Informality is generally prevalent where many enterprises lie outside the scope of regulations. For example, in India the employment threshold that triggers regulatory scrutiny of an enterprise is five workers and an estimated 95 percent of all firms in the economy have fewer than five (MOSPI 2016). Alternatively, workers may be contracted by formal organizations in arrangements not governed by labor laws. And where informal entities and workers do come under the scope of policies, these may have limited impact for various reasons. For instance, policies to regulate the terms of pervasive informal financing might be circumvented by creditors requiring repayment from indebted producers outside regulated sites. Or informal workers may be eligible for state income transfers but cannot receive them because they are not registered with the state welfare system.

The boundaries between formal and informal work are often blurred. The combination of corruption, working arrangements that are exploitative without being illegal, poor compliance with policies and weak policy enforcement all make it especially difficult for regulators to influence activity in the informal sector. Moreover, high levels of informality can amplify policies' unintended effects. For instance, when street food vendors are closed down for breaking food safety regulations, this not only damages their livelihoods but also removes a supply of food from their poor customers.

*Sources: Resnick 2017; ILO 2018; MOSPI 2016.*



# Chapter 2
# Charting a Pathway towards Food Systems Fit for the Future

## Chapter 2

- → It is biophysically and technologically feasible to transform the current global food system into one that is inclusive, health-enhancing and environmentally sustainable. The Food System Economics Commission has explored this transformation by contrasting two science-based, quantitative pathways up to 2050: Current Trends (CT) and the Food System Transformation (FST).
- → All measures aimed at transforming food systems need to be implemented in a deliberately integrated fashion to leverage synergies and manage trade-offs between different food system goals.
- → The FST pathway achieves health targets by eradicating food insecurity, improving diet-related health outcomes, and achieving a strong reduction in nutrition-related mortality.
- → In the FST pathway, greenhouse gas emission reductions keep global warming below 2°C by 2050, biodiversity loss is reversed, and nitrogen surpluses are reduced by half.
- → This pathway enhances processes of structural transformation and reallocation of labor outside of agriculture.
- → Broader societal goals, such as stabilizing climate and eradicating poverty, require complementary actions outside of food systems, particularly in the energy system.

## Introduction

Chapter 1 showed how the world's food systems are together on an unsustainable pathway. It then set out five goals for the food systems of the future. Achieving those goals worldwide would in effect produce a global food system that is inclusive, health-enhancing and environmentally sustainable. But is it biophysically and technologically possible for food system reforms across the globe to pursue and achieve these multiple goals at the same time?

To answer this question, FSEC has developed a science-based Food System Transformation (FST) pathway targeting the five operational goals set out in Chapter 1. Using integrated modeling, FSEC has tested the feasibility of pursuing this FST pathway to achieve the goals at the global level by 2050. Developing science-based pathways to reach defined operational goals and modeling to test them is a well-established means of exploring strategic options and revealing synergies and trade-offs across multiple goals.

FSEC's main finding is that it is indeed biophysically and technologically feasible for the global food system to become inclusive, health-enhancing and environmentally sustainable. The FST pathway modeling quantifies gradual progress towards the operational goals set out in Chapter 1 by 2050, as societies respond to packages of measures aimed at changing dietary patterns, improving rural livelihoods, conserving ecosystems and improving agricultural management.

Throughout this chapter, the outcomes of the FST pathway are contrasted with those emanating from following Current Trends (CT). A crucial insight

FIGURE 2.1
**Detailed description of packages of measures modelled by FSEC in the FST and External pathways**

| Operational Goal | Food system measures |
|---|---|
| **Diets**<br>Consumption of healthy diets by all | **Eradication of undernutrition**<br>Caloric intake is increased to eliminate undernutrition by 2050.<br>**Stabilization of obesity**<br>Excess caloric intake is reduced to stabilize the rate of obesity at 50 percent of Current Trends.<br>**Convergence towards healthy diets**<br>Countries are in line with minimum levels of legumes, nuts and seeds, fruits and vegetables, and fish, and maximum levels of staples, sugar, and animal-sourced foods.<br>**Halving food waste**<br>Household and retail food waste is reduced to a maximum of 20 percent of per-capita caloric intake. |
| **Livelihoods**<br>Strong livelihoods throughout the food system | **Trade liberalization**<br>Trade barriers are reduced for crops, livestock, and secondary products.<br>**Wage increases in agriculture**<br>A minimum wage in primary production increases incomes in low-income countries, but also higher production costs and some labor substitution by capital.<br>**Capital substitution**<br>Capital is substituted by labor in countries with high capital intensity, leading to increased employment and production costs. |
| **Biosphere**<br>Protection of intact land and restoration of degraded land | **Reducing emissions from deforestation and forest degradation (REDD+)**<br>A GHG price on AFOLU emissions curtails deforestation and degradation, promoting the regrowth of natural vegetation on non-agricultural land.<br>**Land conservation**<br>Protected areas expand from 15 to 30 percent of global land, including threatened biodiversity hotspots and intact – though currently unprotected – forests.<br>**Peatland rewetting**<br>A GHG price on AFOLU emissions disincentivizes draining intact peatlands and encourages the rewetting of drained ones.<br>**Water conservation**<br>Local minimum environmental water flow requirements cannot be overdrawn.<br>**Biodiversity offset**<br>The Biodiversity Intactness Index (BII) does not decline post-2020. Local biodiversity loss must be offset by increases in the same biome and region. |
| **Production**<br>Environmentally sustainable production throughout the food system | **Nitrogen efficiency**<br>Nitrogen uptake efficiency is increased through technical measures including optimized manure application, nitrification inhibitors, designated fertilizer-free zones, etc.<br>**Longer crop rotations**<br>Payments incentivize longer crop rotations to offset the external costs associated with less diverse farming practices.<br>**More landscape habitats**<br>20 percent of land in agricultural landscapes is reserved for semi-natural habitats to support biodiversity and ecosystem services.<br>**Emission mitigation from rice cultivation**<br>Reduced emissions through direct seeding, improved residue management, flooding and drainage, and improved fertilization.<br>**Livestock management**<br>Livestock intensification, especially in low-income countries, enhances feed-to-product conversion efficiency.<br>**Manure management**<br>About 50 percent of confined manure is anaerobically digested with a 90 percent recycling rate; reducing storage losses and emissions compared to conventional methods.<br>**Soil carbon management**<br>A GHG price on AFOLU emissions discourages the degradation of soil carbon (e.g. through land conversion) and encourages sequestration. |

**External**
Sustainable transformations external to the food system

**Slower population growth**
Population growth slows more quickly than expected, particularly in low-income countries.

**Equitable human development**
Societal development is more equitable, with stronger institutions, education, and social justice.

**Sustainable energy transition**
Sustainable development strongly curtails GHG emissions in the energy and transport sectors.

**Increase in bioplastics**
30 percent of the projected total plastic demand is replaced by bioplastics.

**More timber construction**
Wood is used as construction material for 50 percent of future urban buildings.

gained from this modeling is that measures aimed at transforming food systems need to be implemented in a deliberately integrated fashion to leverage synergies and manage trade-offs between different food system goals. For instance, shifting diets towards more plant-based consumption patterns is essential to moderate the emerging food price pressures generated by protecting ecosystems and shifting to environmentally sustainable production throughout food systems. Spotlight on Change 5 provides an example of how synergies between food system goals can advance systemic transformation.

The chapter also considers a third pathway that combines actions taken on the FST pathway and additional changes external to the food system, for example, creating low-emission energy systems. This is called the Food System and External Transformations pathway (FXT). The packages of food system measures assumed to be implemented in the FST and FXT pathways and their connection to the five goals are shown in Figure 2.1 (see also Chapter 2 Annex).

Comparing the FST and FXT outcomes brings to light a critical finding from this modeling exercise: achieving the FST without pervasive sustainable progress beyond food systems will not be enough to secure society's broader goals, particularly for stabilizing the climate and reducing poverty.

## The value of identifying and modeling quantitative, science-based pathways

The United Nations Food Systems Summit in 2021 highlighted the need for comprehensive and sustainable pathways, rooted in scientific evidence, research, and principles, to guide a sustainable transformation of food systems (UNFSS 2021). Science-based pathways aid in identifying and designing policy instruments that incentivize transformative changes. They also help to guide the invest-

SPOTLIGHT ON CHANGE 5

## How synergies between food system goals can propel transformation

**The rewilding of California's rice production**

The Central Valley of California, once home to grizzly bears, is now one of the most productive agricultural regions in the world and a major contributor to the state's total agriculture, valued at 48 billion USD. In the middle of the valley, the San Joaquin, American, and Sacramento Rivers form the Sacramento Delta, which is California's rice growing region. Until the early 1990s, farmers burned rice straw to clear their fields for spring planting. But the negative effects on air quality and human respiratory health in the Sacramento region led to a ban on burning rice straw in 1991.

Instead of burning, farmers switched to winter flooding, which slowly decomposes the rice straw. Migratory waterfowl began to choose the flooded fields as their winter habitat, and accelerated decomposition of the rice straw in the process. Banning rice straw burning for health reasons doubled California's wetland habitat and turned the state's rice farmers into its most successful restoration agents without reducing the rice-growing area or compromising yields: at 10 tons per hectare, these remain among the highest in the world. The economic value of this habitat has been assessed at 1.5 billion USD, plus the additional economic value of duck hunting. The same land also serves as the first line of defence against flooding for the city of Sacramento, valued at 121 million USD (40-400 USD per hectare). Much of the area lies in the Yolo Bypass, which is jointly managed by farmers, the Army Corp of Engineers, and the California Department of Fish and Game. Together these groups coordinate land and water management in the delta to reap multiple benefits: Human health, wildlife conservation, rice production, recreation, and flood protection.

*Source: Bogdanski et al. 2017*

ments from both public and private sectors needed to finance them (Hainzelin et al. 2023; Béné et al. 2019; FOLU 2019; Hendriks et al. 2023; von Braun et al. 2023).

Integrated assessment models, of the kind that FSEC has used here, are valuable tools for generating these science-based pathways because they can present plausible futures based on consistent assumptions about key drivers of change and their interactions (van Vuuren et al. 2012; Hainzelin et al. 2023; Bai et al. 2016). These models allow for the simulation of long-term, large-scale food system transformations by integrating key processes that drive the economics of land use alongside the biogeophysical dynamics that constrain it. These models additionally incorporate broader societal shifts in population and GDP, and thus facilitate synthetic investigation of the consequences of long-term structural changes in the food system. This kind of integrative modeling enables, for example, rigorous estimation of synergies and trade-offs in pursuing different objectives of the food system transformation at national level, as illustrated by the country level analysis FSEC conducted for India (see Box 2.1).

## Modeling the FSEC pathways

The FSEC science-based pathways are designed and modelled to estimate a set of outcome variables wider than any previous food system pathways. These outcomes reflect not only the economics of the foods people eat, but also food consumption's consequences on the environment (GHG emissions,

BOX 2.1

### Synergies and trade-offs on the pathway to a sustainable food system in India

India's food system faces several interconnected challenges: Undernutrition and diet-related diseases persist; conventional agricultural practices deplete groundwater, cause high GHG emissions and pollute the environment; and many farmers are indebted. FSEC's modeling shows that by following a pathway to a sustainable food system, India could improve nutrition, reduce environmental damage and enhance livelihoods. Moreover, there are synergies between these multiple goals. But there are also trade-offs, which must be negotiated and navigated, calling for careful policy design.

On the one hand, including more fruits, legumes, and nuts in Indian diets would significantly improve public health by reducing both underweight and obesity. It would also diversify crops grown in the country, reduce GHG emissions from farming and boost agricultural employment. On the other hand, growing more fruits, vegetables and nuts would require more irrigation, while water is already scarce in many regions. Similarly, liberalizing trade and raising wages to improve food system livelihoods will not only raise farmers' incomes but bring multiple environmental benefits as well. However, these measures will add to already significant pressures to reallocate jobs from agriculture, which will need to be absorbed by new jobs in other food system segments or other sectors. Measures to conserve and restore land likewise offer multiple benefits by improving biodiversity and lowering GHG emissions. Adopting more sustainable agricultural practices will do much to protect the environment and bring India's GHG emissions down further. However, along with action to make diets more nutritious and improve livelihoods, as noted above, these measures will raise food prices and the costs of agricultural production. Food may become less affordable, and poverty may increase without countervailing policies, such as social protection and compensation measures.

This example helps underscore the trade-offs and synergies that transforming food systems entail in practice. As discussed in Chapter 4 and Chapter 5 emerging national food system strategies that are focused on incentives and regulation, innovation, and investment and fine-tuned to address the political economy constraints can help policymakers navigate these challenges.

*Source: Das et al. 2023*

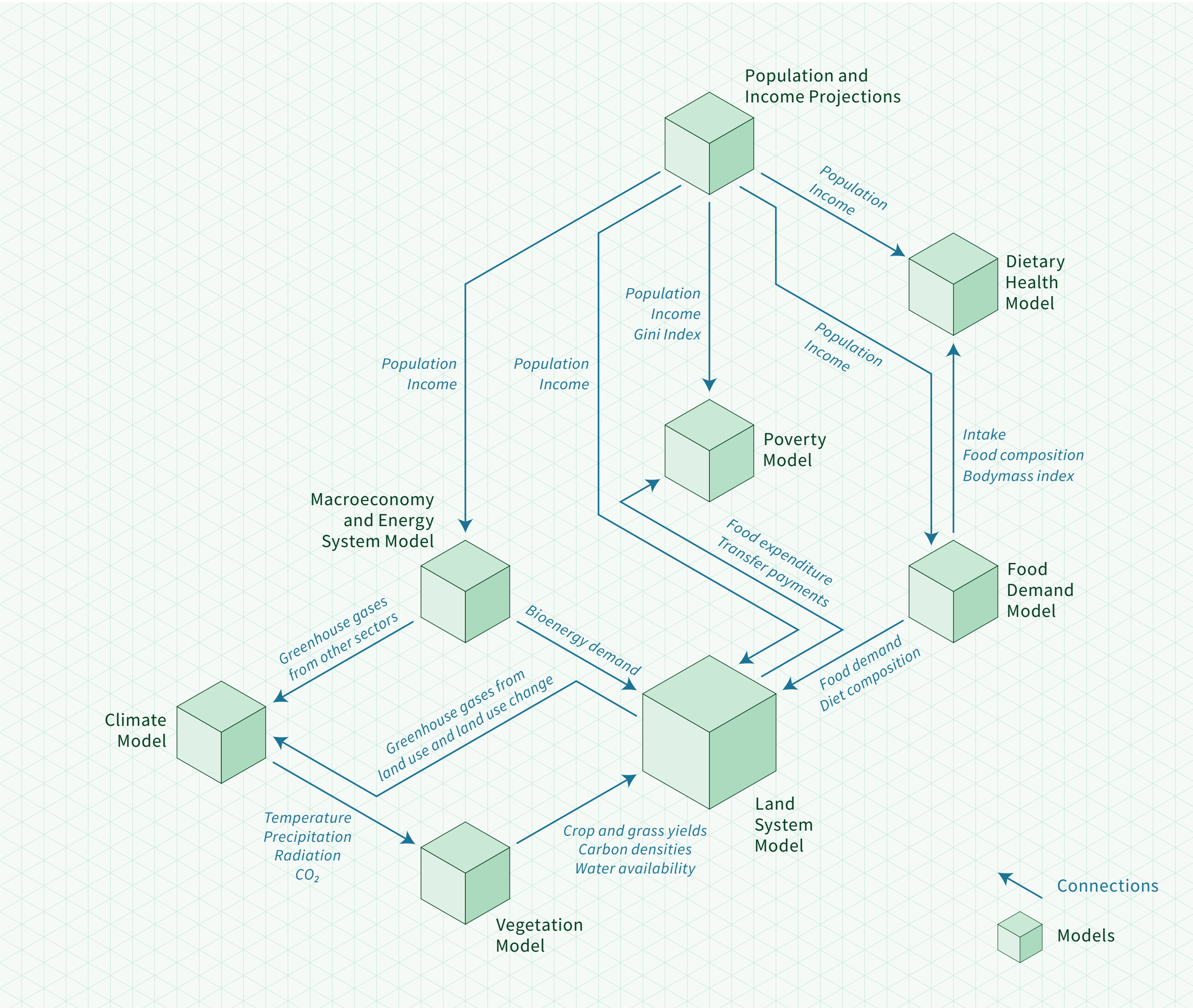
nutrient surpluses, biodiversity), people's health (premature mortality, obesity and undernourishment), and their livelihoods (agricultural wages, poverty). FSEC has been able to assess this wide range of variables by constructing a comprehensive framework that integrates a variety of specialized models describing land systems, macroeconomies, human health and poverty, and the climate system and their mutual interactions (see Figure 2.2). These constituent models are each well-established, with robust records of scientific publication, and are themselves often included in the ongoing modeling exercises contributing to the IPCC reports. However, FSEC's pathways are the first of their kind to combine these state-of-the-art models into a single comprehensive framework.

The findings in the following section draw on comparison of FSEC's pathway modeling showing potential global food system development towards 2050.

One pathway reflects the continuation of current trends (CT) and a second represents a comprehensive food system transformation (FST) pathway (see Bodirsky et al. 2023, for more details). A third pathway extends the FST to account for potential sustainable transformations occurring external to the food system (FXT). This includes, for example, the decarbonization of energy systems.

The results are summarized in terms of 16 outcome indicators, each connected to one of the

FIGURE 2.2
**Modeling Framework**



five FSEC operational goals (Figure 2.1). Health indicators include underweight, premature mortality and obesity. Environmental indicators include a biodiversity intactness index, Shannon index, nitrogen surplus, environmental water flow violations, AFOLU GHG emissions, and global surface warming. Inclusion and economy indicators consist of expenditure on agricultural products, number of people in poverty, agricultural employment, agricultural wages, bio-economy supply, and agricultural production costs.

FSEC has explored what happens if the FST pathway is realized within the larger socio-economic context modelled in the Shared Socio-economic Pathway 2 (SSP2) or "Middle of the Road" (O'Neill et al. 2014). SSPs are a set of standardized assumptions used by climate researchers to account for potential future change in key variables such as population and GDP growth. By integrating prevalent socio-economic trends, the analysis isolates the effects of the food system transformation from these confounding variables, which shape the wider outcomes but fall beyond the realm of the transformation itself. Importantly, as modelled here, SSP2 assumes that countries successfully implement their current policy commitments (Nationally Determined Contributions, NDCs) to reduce greenhouse gas emissions.

To model the FXT pathway, FSEC incorporated into the FST pathway several more general sustainable transformations external to the food system, as well as more optimistic assumptions of population and GDP change aligned with the trends of Shared Socio-economic Pathway 1 (SSP1) or "Taking the Green Road" (O'Neill et al. 2014). The FXT pathway also considers the effects of a renewable energy transformation and an increase in timber demand for construction (Figure 2.1).

This analysis focuses on the broadly-scoped measures taken to achieve food system goals, as detailed in the following section. It does not model the underlying policies necessary to incentivize and ensure implementation of the measures. To illustrate, the FST modeling assumes that the changes needed to ensure healthy diets are introduced in different parts of the world without prescribing how they come about. Details about different policy levers and their effectiveness are discussed in Chapter 4. Disaggregating global modeling outcomes demonstrates that the FST pathway often generates diverse outcomes in different regions particularly concerning the affordability of food. Notable differences in regional outcomes are highlighted throughout this chapter. Chapter 4 explores potential responses for policymakers. Further decomposition and details of regional outcomes of the pathway modeling is in Chapter 2 Annex.

## The Food System Transformation Pathway

The FST pathway (Figure 2.1) provides a comprehensive understanding of how changes to different aspects of the global food system, ranging from production to consumption, interact to achieve outcomes that are inclusive, health-enhancing, and environmentally sustainable. Comparison with the CT pathway underscores the urgency of achieving FST ambition.

The FST is designed to:

- → Immediately reduce greenhouse gas emissions and ensure the land system becomes a net carbon sink by 2040;
- → Eradicate undernutrition by 2050 and halve obesity compared to CT (that is equivalent to stabilizing obesity at current levels);
- → Reverse the decline of biodiversity, and protect and expand forests;
- → Increase the wages of agricultural workers and contain poverty.

The FST has been designed to ensure a rapid fall in GHG emissions, as accumulating emissions increase the challenge of future mitigation. It also reflects the need for rapid action to stem the irreversible loss of biodiversity and address hunger and malnutrition. The modelled shift towards healthy diets, while also ambitious in pace, is relatively slower than the other elements of the transformation.

Translating these shifts in the model to achieve the five operational goals set out in Chapter 1 has required implementing 19 selected measures, (Figure 2.1). They have been identified based on the findings of existing literature and previous assessments of sustainable development pathways (Soergel et al. 2021). The measures include eradicating undernutrition, halving food waste, stemming the loss of biodiversity, improving nitrogen-use efficiency, and reversing deforestation among others. The measures are grouped in packages aligned with the FSEC operational goals, to enable the modeling to identify interlinkages between them. To operationalize the shift to healthy diets, the FST reflects all countries gradually adopting by 2050 a healthy reference diet as defined by the EAT-Lancet Commission (Willett et al. 2019, Springmann et al. 2018). This diet includes healthy minimum food intake levels for fruits, vegetables, soybeans and other legumes, and nuts. It also includes healthy maximum food intake levels for sugar and vegetable oils, as well as red meat, poultry, eggs, and milk products (Bodirsky et al. 2023). Within these limits, as detailed in Figure 2.1, country-specific dietary patterns can be quite diverse. Together, these measures constitute the full FST pathway (Figure 2.1). In addition to the complete FST, the impacts of all 19 measures have been modelled individually and in combination[1] to explore their interactions and interdependencies.

Readers should note that while food system resilience is best measured by its ability to adapt to short-term disruptions, integrated assessment models are designed to analyse long-term dynamics and trends. This makes them unsuitable for assessing resilience to short-term shocks and extreme events. For that reason, no food system measures in the FST are explicitly linked to achieving the operational goal of resilience; however, as discussed in Chapter 1, reorienting food systems to achieve the other operational goals will also strengthen their resilience.

## The Current Trends pathway underscores that a food system transformation is urgently needed to avoid systemic failures

The transformative impact of the FST is fully brought out by comparisons with the Current Trend pathway. Current Trends shows that without effective food system measures the world will undergo a deepening ecological and health crisis. While the relatively optimistic assumptions embedded in SSP2 on global economic development improves poverty levels and wages in the Current Trends pathway, these inclusive gains come at the cost of increasing environment degradation. This trade-off threatens to severely undermine Earth system stability and long-term living standards. Food production in many countries would become increasingly vulnerable to climate change and environmental degradation, with the likelihood of extreme events dramatically increasing. Rising food prices due to climate or other shocks heighten poverty and hunger, stretch the budgets of the poor and the middle classes and lead to social tension. Some of the more specific 2050 outcomes of Current Trends include:

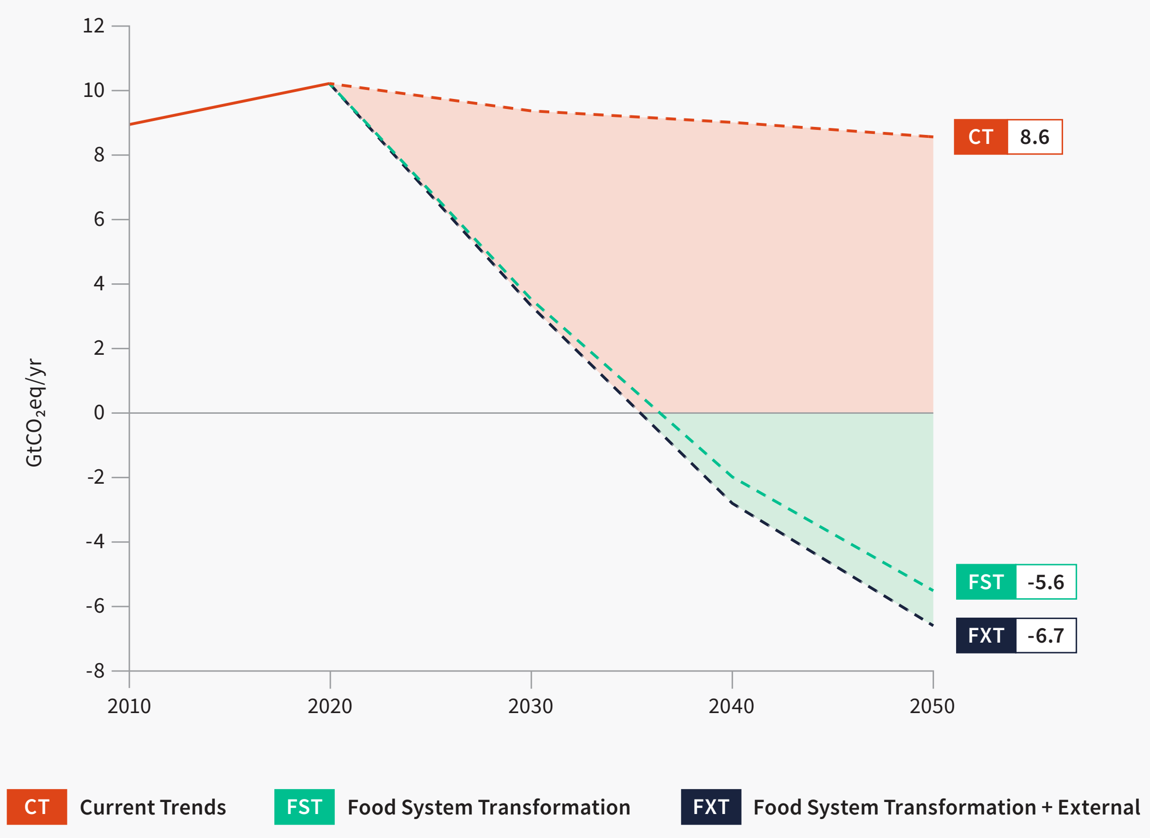
→ Food insecurity and undernutrition would continue plaguing humanity, leaving 640 million people (and 121 million children) underweight in 2050, particularly in India, Southeast Asia, and Sub-Saharan Africa.
→ The global adoption of diets high in fats, sugar, salt, and ultra-processed foods would increase the number of obese people worldwide by 70 percent, reaching 1.5 billion in 2050, or 15 percent of the expected global population.[2]
→ Per capita food waste would increase by 16 percent compared to today, reaching 76 kg of dry matter per capita in 2050.
→ While Latin American countries may successfully fulfil their NDCs on deforestation, Sub-Saharan Africa and Southeast Asia are likely to continue losing their primary forests and associated

1 Using the open-source, integrated land system model MAgPIE (Dietrich et al. 2019). Model-based outcome indicators are provided at the aggregate global level, at the level of 14 world regions and three country income groups, and at a spatial grid of about 50x50km for showing spatial heterogeneity.

2 Note that other sources estimate the direct medical costs of treating the health consequences of overweight and obesity are already estimated to rise to almost 3 trillion USD by 2030, from 600 billion USD today (Okunogbe et al. 2022).

FIGURE 2.3
**Pathways for select outcome indicators of the food system until 2050**

FIGURE 2.3A
**Global AFOLU GHG Emissions**
Gigatonnes $CO_2$ equivalent per year



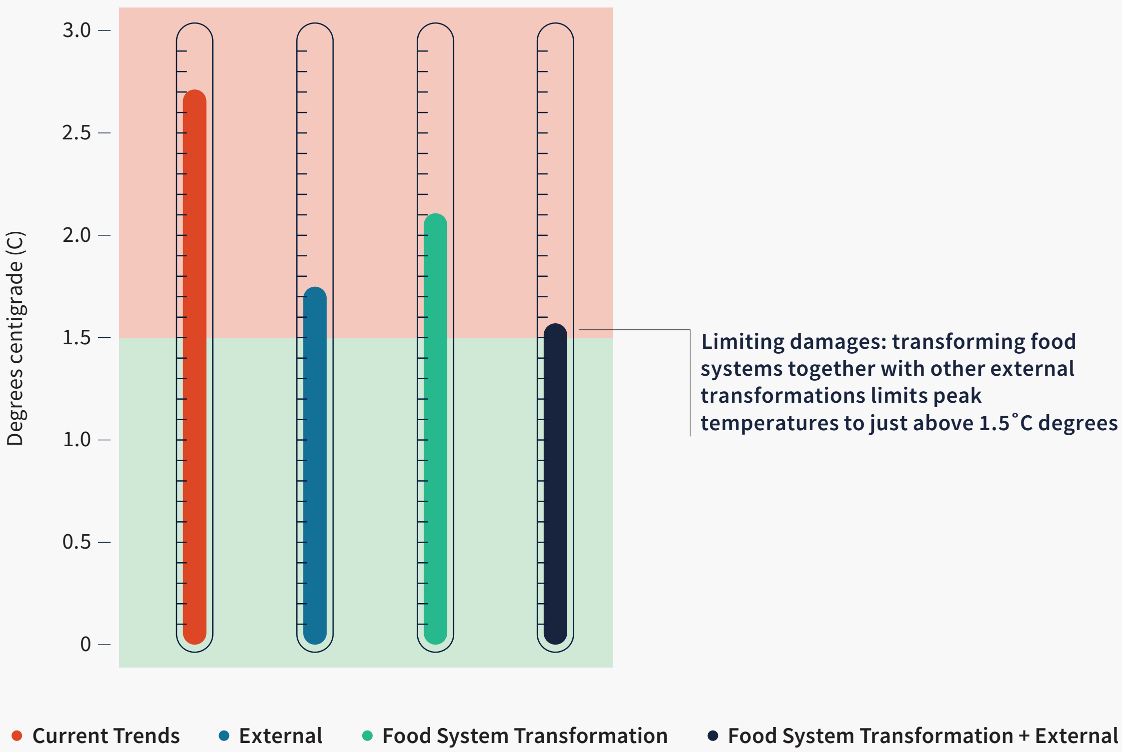

biodiversity. Deforestation will erode a further 71 million hectares of natural forests between 2020 and 2050, an area equivalent to 1.3 times the size of France, with far-reaching implications for carbon emissions and biodiversity loss.

- Nitrogen surpluses will increase from 245 Mt N a year to about 300 Mt N in 2050. As more nitrogen continues to leach into waterways and natural areas, it will undermine public health and exacerbate biodiversity loss.
- The median estimate of global surface temperature under CT rises to 2.7°C by the end of the century, with a 30 percent likelihood of exceeding 3°C. Under Current Trends, global GHG emissions from agriculture, forestry, and other land use (AFOLU) will drop by 16 percent from 2020 to 2050. Implicit in this reduction is that countries implement the mitigation measures necessary to meet their current NDCs within the UNFCCC framework. However, the scale of expected non-food related GHG emissions means this progress in reducing AFOLU emissions does not prevent an overall failure to address the climate crisis.

## An inclusive, health-enhancing, and environmentally sustainable food system is possible

Overall, the findings show that prioritizing rapid implementation of all FST measures can achieve

FIGURE 2.3B
**Global Surface Warming**
Degree C, peak global warming level between 2020-2100, relative to 1850-1900




the transformative change described by the five goals and effectively tackle the systemic failures and sustainability challenges that characterize Current Trends by 2050. However, turning sharply away from the Current Trends pathway, with its immediate and long-term threats to human health, climate, biodiversity, and inclusion, remains a huge challenge.

Major achievements include:
**The FST alone will transform the land sector into a net carbon sink by 2040 and limit peak global mean temperature to just above 2.0°C.** (Figure 2.3B) Heavy investment in carbon sinks, such as forests and peatlands, and substantial reductions in non-$CO_2$ emissions from agriculture are the critical FST measures. An additional 1.4 billion hectares of land is protected, while a further 200 million hectares are afforested and open to economic uses such as the production of timber for housing. The shift away from diets rich in animal-sourced protein is important too as these diets generate extreme pressure on land. As a result of these changes, emissions under FST become net negative as early as 2040, with Brazil and the rest of Latin America becoming the most effective carbon sink per hectare due to extensive reforestation. These positive developments will gradually help to reduce the occurrence of extreme weather events (IPCC 2021) and thus safeguard future agricultural production.

**Coupling the FST with external transformations (FXT) could further reduce peak global mean temperature (that is the maximum temperature reached over the period) to slightly above 1.5°C and lead to global mean temperatures well below 1.5°C by the end of the century.** An ambitious transformation of the food system will be a critical and necessary component of an economy-wide transformation to sustainability. Far-reaching changes in factors external to food systems, including a successful phase-out of fossil fuels, lower-than-expected population growth, and a thriving, equitable global economy, could limit peak warming to slightly above 1.7°C. But only by pursuing the FST as well does it become possible to limit peak global mean temperature to just above 1.5°C.

**A shift to environmentally sustainable production in agriculture reverses biodiversity loss, reduces demand for irrigation water and almost halves nitrogen surplus from agriculture and natural land.** Protecting ecosystems significantly reduces biodiversity loss, while adherence to regional water withdrawal limits curtails the overuse of freshwater resources without compromising agricultural yields. These measures, combined with diversified cropping systems, contribute to a more resilient food system, capable of sustaining a growing population even in the context of global change (Isbell et al. 2015; Rosa et al. 2020; Egli et al. 2021). The adoption of technical mitigation measures together with the widespread shift towards more plant-rich diets dramatically reduces nitrogen pollution. (Figure 2.3C).

**Greater trade integration, along with diversification of trade routes, improves connections between regions with food surpluses and deficits.** This interconnection strengthens food system resilience to shocks, helping to prevent loss of lives during extreme weather events and crop failures (Janssens et al. 2020).

**FST eradicates food insecurity, improves diet-related health, and sharply reduces nutrition-related mortality in all regions.** By ensuring that all people have access to sufficient calories, the FST eradicates undernutrition. In contrast, under Current Trends prevailing food insecurity and undernutrition would leave 640 million people

FIGURE 2.3C
**Global Nitrogen Surplus**
Million tonnes N per year

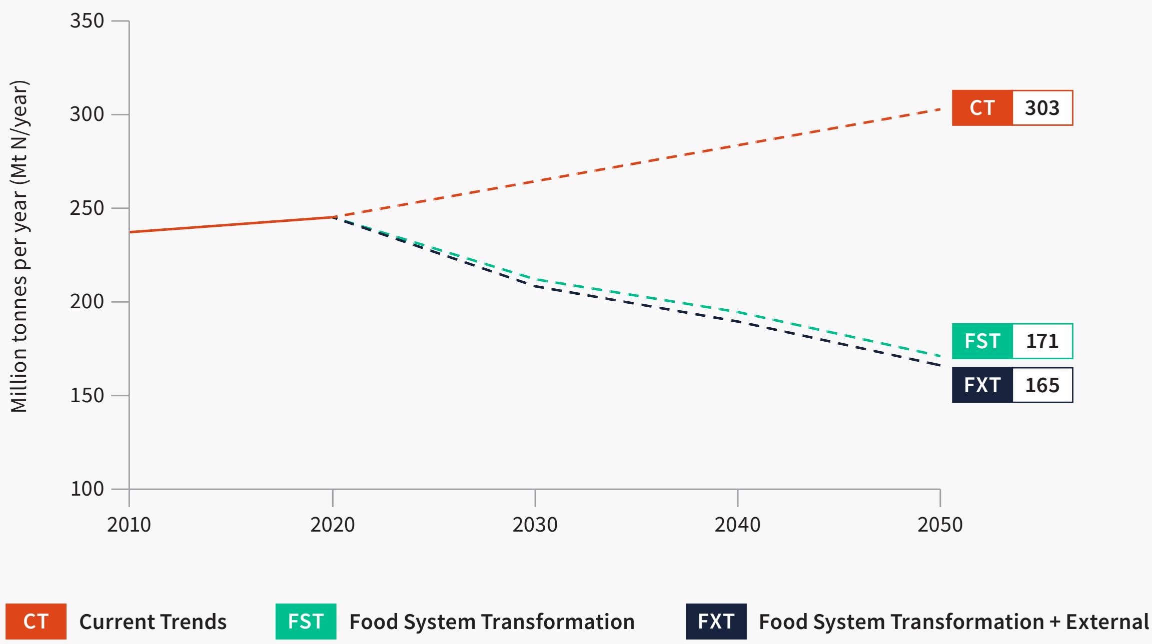


FIGURE 2.3D
**Global Premature Mortality**
Millions of attributable deaths

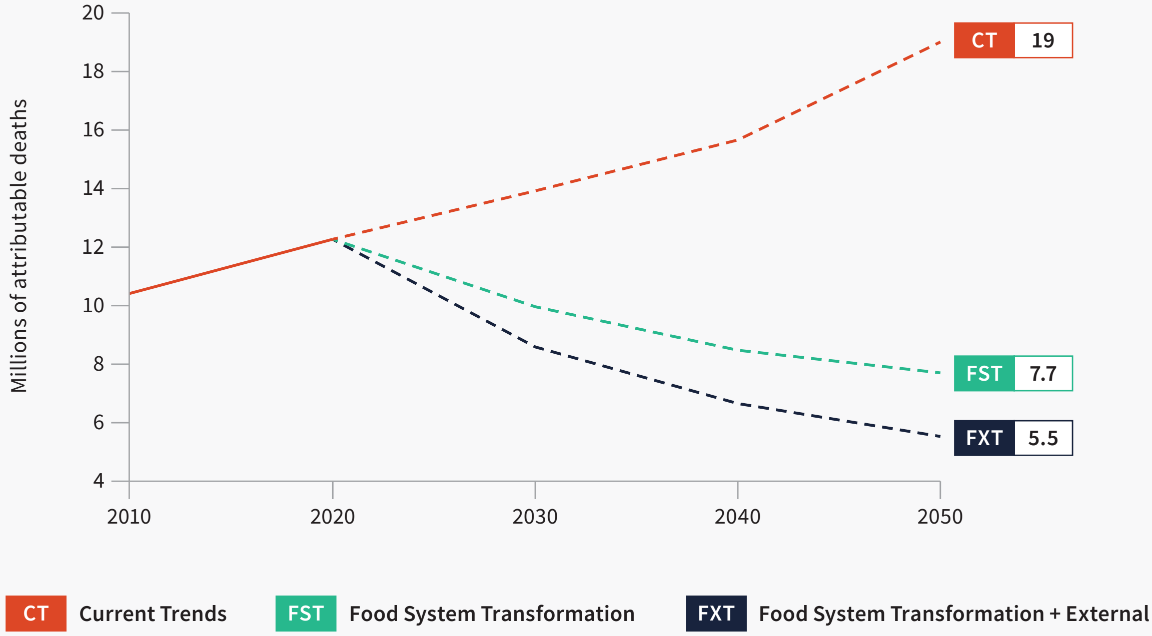
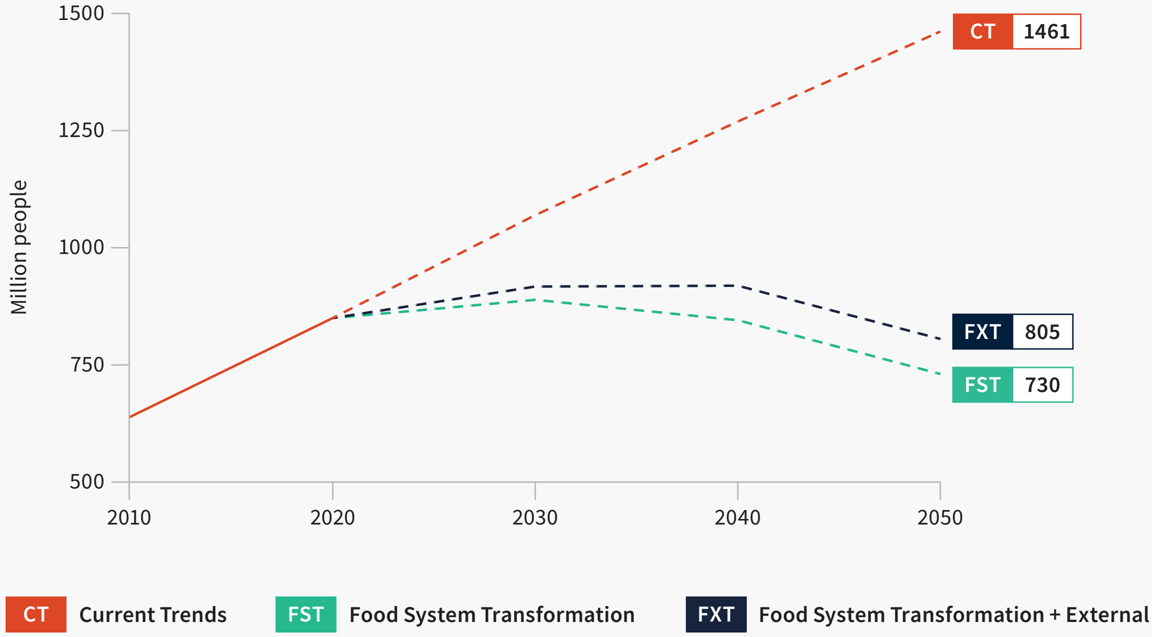



FIGURE 2.3E
**Global Obesity Prevalence**
Million people



(and 121 million children) underweight in 2050. The FST reduces diet-related mortality from 12 million deaths per year attributable to poor diets in 2020 to 7.7 million in 2050 by decreasing rates of diet-related diseases such as of cardiovascular conditions and cancers (Figure 2.3D). Compared to CT, 174 million lives are saved by the reduction in diet-related chronic diseases under FST. At the same time, obesity as a result of diets high in fats, sugar, salt, and ultra-processed foods would increase by 70 percent under CT and affect 1.5 billion people, that is 15 percent of the expected global population in 2050 (Figure 2.3E).

**The necessary shifts in diet vary by region.** (Figure 2.4) While over- and under-consumption now occur across high-, medium- and low-income regions, on average, high- and middle-income regions need to reduce their per capita intake of animal-sourced food by 68 percent and 62 percent respectively from 2020 to 2050, and increase their intake of fruits, nuts, vegetables, and legumes. In low-income regions, such as Sub-Saharan Africa and India, overall intake – in particular intake of healthy foods – must increase to combat undernutrition. The outlook for their intake of meat varies. For instance, in order to meet healthy intake levels, some countries in Sub-Saharan Africa need to increase their intake of animal-sourced food to ensure adequate healthy protein intake, but some middle-income countries in the region need to reduce it. Similarly, high intake of particular animal-sourced foods, such as dairy products in India, needs to fall. In total, low-income regions see a 33 percent aggregate decline in the intake of animal-sourced foods under FST even though their intake by currently undernourished groups in those regions should increase to improve health.

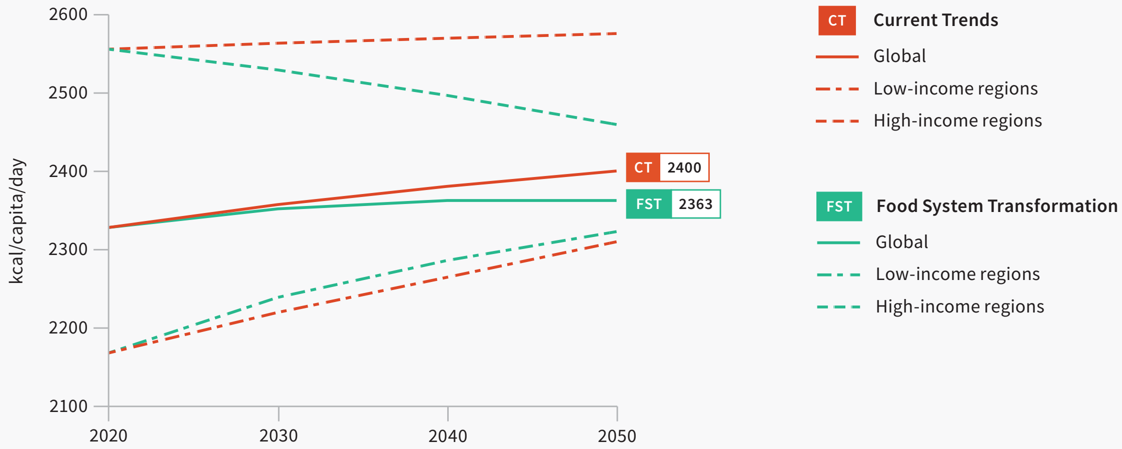
**Dietary change under FST eases the need to increase crop yields further and distributes legume production more equally around the world, with environmental benefits.** Under the FST, conserving biodiversity hotspots and wetlands together with more afforestation and reforestation restrict the area of land available for agriculture. However, the FST also reduces global demand for cropland and pasture compared to CT, as land-intensive livestock products are replaced by plant-based proteins in healthy diets from less land-intensive legumes such as soybeans, groundnuts and other pulses. Production of legumes increases most strongly in Sub-Saharan Africa, China and India, while there are moderate reductions in Brazil and the US. This represents a significant shift from legumes for feed production to legumes for food production. The higher share of legumes in healthy diets diversifies crop production systems and reduces the need for nitrogen fertilizers.

**The FST leads to a fall in global per capita food waste of 24 percent between 2020 and 2050.** This contrasts with an expected increase under CT of 16 percent, which would bring it to 76 kg of food waste per capita (dry matter) per capita by 2050. FST suggests that high- and middle-income regions, where food waste is currently highest, will contribute most to waste reduction, lowering it by 39 percent and 29 percent compared to 2020 respectively. Per capita food waste in low-income regions is expected to increase by 5 percent from today's currently low levels. Food losses in the supply chain, although not covered by the modeling, will also need to be reduced.

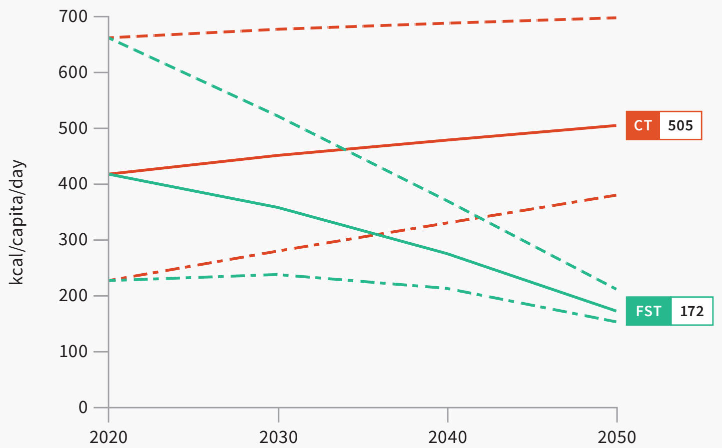
**Global convergence towards healthy diets limits the rise in agricultural commodity prices and stabilizes expenditures on agricultural products.** Upward pressure on agricultural commodity prices is observed under the FST for two main reasons: first, FST improves livelihoods by ensuring minimum wages for workers in the agricultural sector, but in turn increases production costs that ultimately lead to higher prices. Second, many of the benefits of FST depend on changes in land use that make cultivable land more scarce. One such change is reforestation to safeguard biodiversity and mitigate climate change. The resulting increase in agricultural commodity prices is largely mitigated by the dietary shift away from unhealthy and unsustainable diets. As a result, under the FST agricultural commodity prices rise to 28 percent above 2020 levels by 2050, which represents a much slower rate of increase than has

FIGURE 2.4
**Intake of select food groups globally, and in low and high income regions until 2050**

2.4A **Total caloric intake**




2.4B **Livestock product intake**




2.4C **Legume, fruit, nut, vegetable intake**

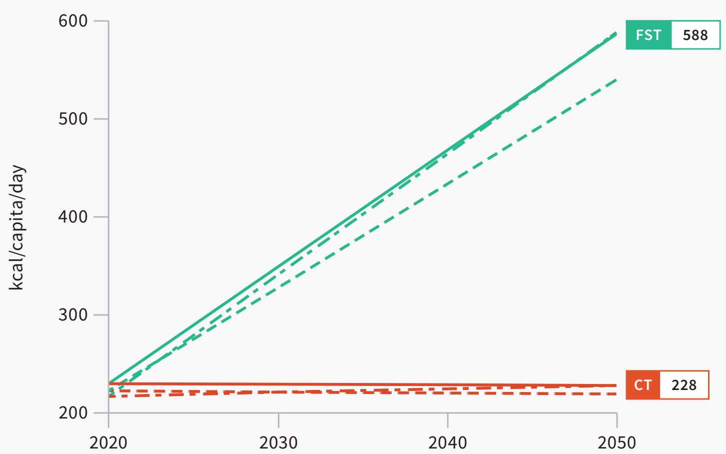
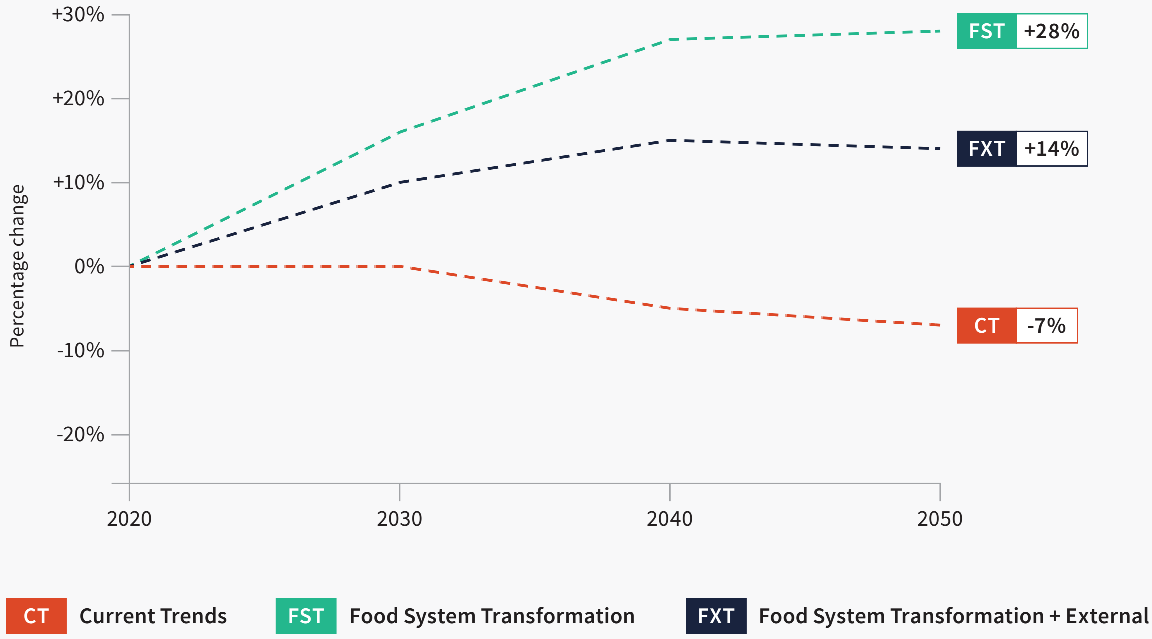


FIGURE 2.3F
**Global Agricultural Price Index**
Percentage change




occurred over past decades.

At a global level, the shift away from overconsumption of food (especially overconsumption of animal-sourced foods) coupled with less food waste will lead expenditure on agricultural products to stabilize by 2050 under the FST. However, in Sub-Saharan Africa and India expenditures on food will increase. This is due to differences in the composition of their respective dietary shifts, as healthier diets require an increase in the intake of legumes, fruits, and nuts, and a decrease in the staple foods of those regions, which are relatively less costly (Figure 2.4). Rising food expenditures in these regions will have a negligible impact on their poverty levels as they are compensated for by other elements of the FST (Figure 2.3H).

**FST does not affect the pace of poverty reduction.** Under FST, the reduction in poverty is only marginally larger than under Current Trends. Under FST the incomes of the poor increase in aggregate, thanks to an exogenous increase in agricultural wages and universal transfers financed by the recycling of environmental taxes. However, the increase in production costs puts pressures on prices which largely neutralizes the real income impacts of those measures. More people would be lifted out of poverty if transformative action is taken beyond the food system. Measures external to the food system that result in more equitable GDP growth and faster human development in line with SSP1, as shown by the FXT, would help to raise another 610 million people above the poverty line by 2050 and bring the number of people in poverty worldwide down to 225 million. However, further measures would be needed to completely eradicate poverty and ensure food is affordable in all regions, especially for those working outside the agricultural sector.

**FST amplifies the reallocation of labor from agriculture, but other parts of food systems are likely to absorb more jobs, particularly in lower income countries.** Under CT, mechanization and increases in labor productivity will reallocate 309 million people from agriculture towards other sectors. FST would add 75 million more people formerly employed in primary food production to that flow – 37

FIGURE 2.3G
**Global Expenditure on Agricultural Products**
USD per capita per year (MER 2005)

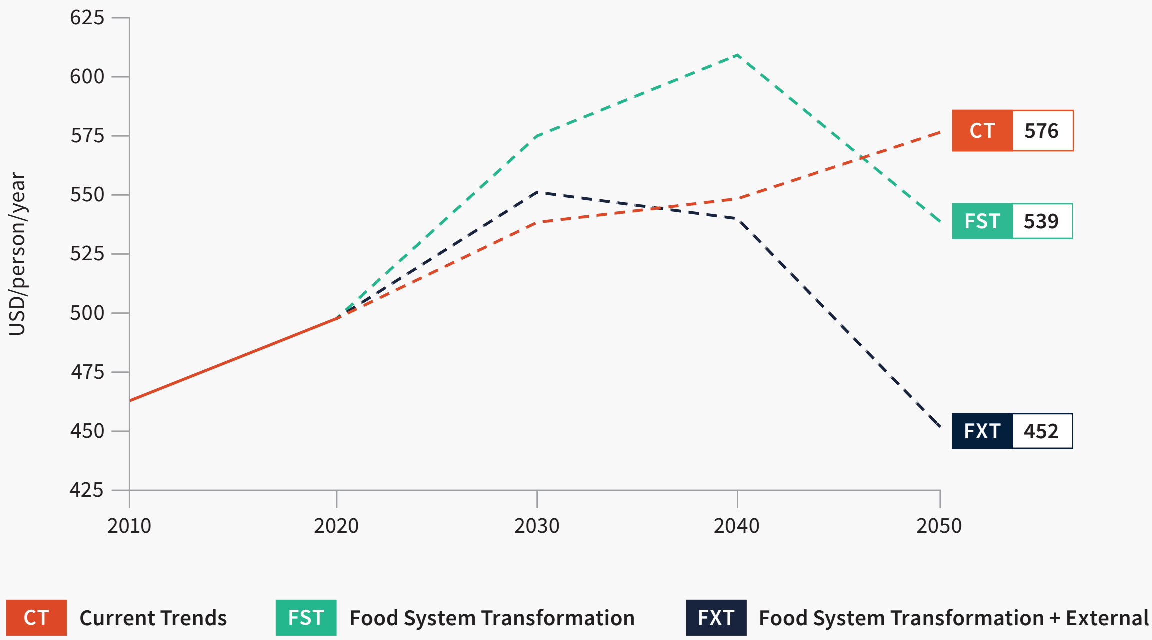
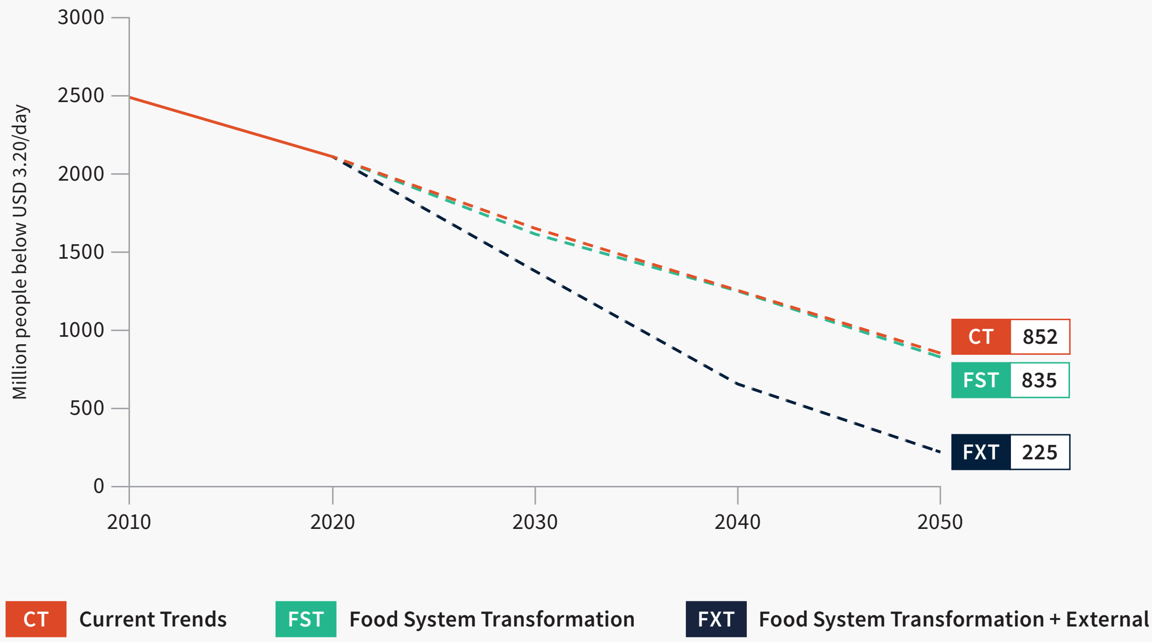



FIGURE 2.3H
**Global Poverty Headcount**
Million people below USD 3.20 per day (PPP 2011)



million in Sub-Saharan Africa, the region that overall would see the largest drop in the share of working age population employed in agriculture; 13 million in China; 12 million in India.

One reason for the further reallocation of labor under FST is that the shift away from animal-sourced foods generates a 50 percent drop in global livestock production, reducing employment in that sector. Other factors decreasing employment in production are additional waste reduction and improved efficiency through increased trade. In contrast, the spread of certain labor-intensive agricultural practices under FST – such as more efficient use of nitrogen and the production of fruits, vegetables, nuts, and seeds – will increase demand for agricultural labor. However, such impacts are not enough to compensate fully for the fall in employment arising from lower livestock production.

Other parts of food systems can be expected to generate more labor demand under FST even if these additional employment effects cannot be modelled. For example, investments in nature-based solutions and providing plant-rich diets are likely to create new employment opportunities. The ILO estimates that the dietary shift in Latin America alone could create an additional 15 million jobs (Saget et al. 2020). Nature restoration and protection interventions can provide significant job opportunities, particularly when large in scale. The "Great Green Wall" initiative by the African Union for the Sahel and Sahara region has the potential to create 10 million jobs (GCA 2021). The scope for creating additional jobs in the downstream food economy (e.g., trade, processing, and storage and its finance and infrastructure) is largest in regions where current food system employment is still overwhelmingly in production, such as Sub-Saharan Africa (Christiaensen et al. 2021; Allen et al. 2018). Non-farm food system jobs in this region currently account for 22 percent of all food system jobs, compared to a global average of over 40 percent (Davis et al. 2023; FSEC Africa Brief).

# Chapter 2
# Annex

## Main regional aggregates

Regionally specific modeling can help identify challenges and opportunities for each region, allowing for targeted measures and policies. In modeling FSEC pathways, regional decomposition allows for a more nuanced understanding of food systems transformation by identifying which regions deviate from global trends. In this modeling assessment, 14 world regions were allocated geographically (Figure A.1). Based on current per-capita income, these 14 regions can be classified as low-income (LIR), middle-income (MIR), and high-income regions (HIR) (Table A.2). In this Appendix, regional outcomes of the food system transformation (FST) are analysed for four regions: Sub-Saharan Africa (SSA), Brazil and the rest of Latin America (BRA + LAM), China (CHA), and South and Southeast Asia, excluding India (OAS). The choice of these regions reflects their classification as low- and middle-income regions.

FIGURE A.1
**Map with world regions used for the modelling of FSEC pathways. Regional abbreviations are in Table A.2.**

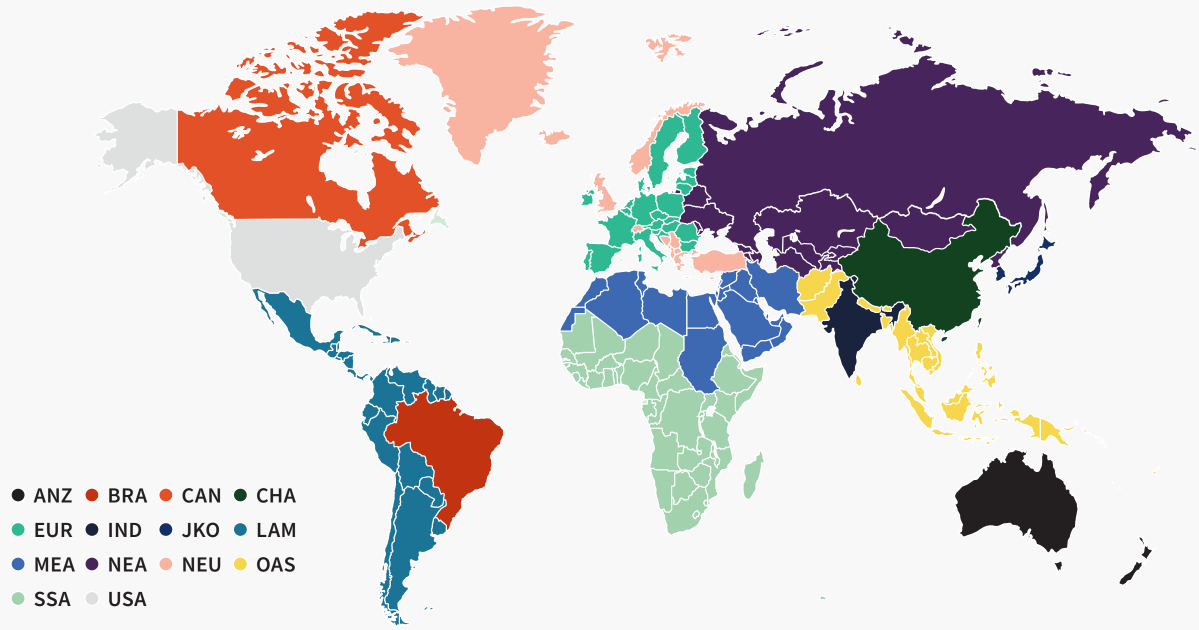



TABLE A.2
**World regions used for FSEC pathways and their classification into low-income, middle-income, and high-income.**

| | | |
|---|---|---|
| ANZ | Australia & New Zealand | High-income region (HIR) |
| BRA | Brazil | Middle-income region (MIR) |
| CAN | Canada | High-income region (HIR) |
| CHA | China | Middle-income region (MIR) |
| EUR | European Union | High-income region (HIR) |
| IND | India | Low-income region (LIR) |
| JKO | Japan & South Korea | High-income region (HIR) |
| LAM | Latin America (excl. Brazil) | Middle-income region (MIR) |
| MEA | Middle East & North Africa | Middle-income region (MIR) |
| NEA | Northern Eurasia | Middle-income region (MIR) |
| NEU | Europe (Non-EU) | High-income region (HIR) |
| OAS | Other Asia | Middle-income region (MIR) |
| SSA | Sub-Saharan Africa | Low-income region (LIR) |
| USA | United States of America | High-income region (HIR) |

## Regional outcomes

The FST and CT pathways can be compared at the sub-global level using the aggregated regions in Table A.2. The regional decomposition provides a comprehensive view of the impact of the food system measures, as delineated in Chapter 2, on the same key outcome indicators discussed at the global level (Table A.3). The disparities and similarities across regions relative to the global trend are shown as indicated by the colours and legend.

### Sub-Saharan Africa

From today until 2050, FST would spare nearly 99 million people from undernutrition in Sub-Saharan Africa and further safeguard 39 million hectares of primary and secondary forests (and their biodiversity) that would have otherwise been deforested under CT. Measures that increase agricultural wages and recycle emission tax revenues are fundamental to a successful transformation, as they ensure these bold interventions do not endanger the well-being of agricultural workers. Of all world regions, Sub-Saharan Africa is subject to the largest decline in employment in primary production by 2050, with 37 million fewer people working in agriculture compared to the CT pathway. Global dietary change can lower scarcity and prices on agricultural markets, reducing poverty in SSA by 40 million people. Yet, when all food system measures (FSMs) are combined, expenditures for agricultural products will increase by 33 percent over a period of 30 years in FST, caused predominantly by implementing a minimum wage in the agricultural sector, following Goal 2 of FSEC. Should a minimum wage for agricultural workers be implemented, livelihoods for those working in agriculture will improve, but rather than decreasing, overall poverty levels would remain stable.

### Brazil and rest of Latin America

By 2050, the FST pathway shows that increases in the rate of reforestation and afforestation can transform Brazil and the rest of Latin America into the world's largest sequesters of GHG emissions. Fundamental to this evolution is the protection of the Amazon, critical to mitigating climate change and biodiversity protection. To ensure a successful transformation in this region, of particular significance will be a widespread shift in demand away from meat products either pastured on–or fed from–deforested land in the Amazon. This shift carries large co-benefits not only for health, reducing the number of lives lost due to diet and weight-related diseases by 7.6 million through 2050, but also for water scarcity, as environmental flow violations decrease by 15 $km^3$ per year. If FST is accompanied by a broader, cross-sector sustainable transformation and liberal trade policies, Brazil would benefit from increased bioeconomy-related production. If implemented alongside stringent biosphere protection, this sector can capitalize on sustainable forestry and biofuel demand to achieve economic revenues of 134 billion USD per year.

### China

FST in China is characterized by a dramatic abatement in land-based GHG emissions compared to CT, shifting from emitting 753 Mt of $CO_2$eq per year in 2050 under CT to sequestering 472 Mt $CO_2$eq per year in 2050. Measures protecting unique biodiversity hotspots will strongly bend the curve of China's biodiversity loss. These measures would be facilitated by a transformation towards healthy diets, with enormous co-benefits for human health, reducing premature deaths from diet and weight-related disease by 35 million until 2050. A further co-benefit of this dietary transformation–of particular relevance in China–will be the mitigation of nitrogen pollution, as the FST halves total pollution levels in 2050 from 60 Mt $N_r$ to 33 Mt $N_r$ per year. Although employment in agriculture is reduced by 11 percent in the FST, this represents an acceleration of ongoing demographic trends. The agricultural sector does benefit, however, from the diet transition, as the production of legumes increases by 180 percent compared to CT by 2050.

### South and Southeast Asia

South and Southeast Asia (excluding India, as a separate model region) sees a historic reduction in malnutrition in FST, helping 163 million people in the year 2050 achieve healthy weights. This region in particular strongly increases its intake of fruits, vegetables, nuts, and seeds in the FST pathway, more than doubling intake compared to current values. Coupled with interventions increasing nitrogen use efficiency in agriculture, this broader shift towards healthy and sufficient consumption patterns reduces nitrogen pollution in 2050 from 52 Mt $N_r$ per year under CT to 34.4 Mt $N_r$ per year in FST. Over the next 30 years, FST would further eliminate 40.5 Gt $CO_2$eq of land-based emissions from being emitted in the region, turning the region into a net sink of 400 Mt $CO_2$eq per year in 2050.


# Chapter 3
# The Net Benefits of the Food System Transformation

# Chapter 3

→ The hidden costs of food systems are mortgaging our future, undermining future productive potential by well over 10 trillion USD a year.

→ Pursuing the Food System Transformation pathway can yield substantial environmental and health net economic benefits, estimated at a minimum of 5 trillion USD annually. Factoring in the full impact of rising incomes as part of the transformation could potentially elevate net economic benefits to an average of 10 trillion USD per year. Global convergence towards healthy diets would contribute as much as 70 percent of the total economic benefits of pursuing the Food System Transformation pathway through direct effects on dietary health and indirect impacts on the environment.

→ The costs of food system transformation are remarkably modest when compared to the expected benefits. FSEC estimates a cost range of between 200 and 500 billion USD annually, depending on the extent to which the expenses of ensuring food affordability for the most vulnerable are factored in.

→ The transformation is affordable at a global level, but its costs for lower-income countries are beyond their current financing capacity. Lifting their financing constraints is critical to unlocking the global benefits of transforming food systems.

## Introduction[1]

The preceding chapter mapped a Food System Transformation (FST) pathway leading to a more equitable, health-enhancing, and environmentally sustainable global food system. This chapter explores the hidden costs of current food systems and the economic costs and benefits of pursuing FST on a global scale.

The economic benefits of pursuing FST are potentially very large: on the order of at least 5 trillion USD a year. FSEC draws on two complementary methods for economic valuation described in Box 3.1 and later in this chapter to derive this value.

## A bottom-up approach to assessing the net benefits of pursuing the FST pathway: measuring the reduction in hidden costs

A bottom-up approach to estimating the net benefits of pursuing FST divides the evaluation into two components: estimation of the gross benefits resulting from hidden costs avoided and estimation of the costs to transform food systems.

Estimating the gross benefits of pursuing FST from the bottom-up entails calculating the hidden costs avoided by moving from Current Trends to FST. As discussed, the hidden costs are calculated item by item in each scenario. This involves multiplying physical flows by either market or shadow prices (Lord 2023).

1 Unless otherwise specified all monetary values in this chapter are expressed in USD PPP (Purchasing Power Parity) (2020)

BOX 3.1

**FSEC's tools for assessing the economics of transforming the global food system**

The food system pathway analysis in Chapter 2 showed how alternative developments in the global food system pathways lead to a variety of outcomes for people's livelihoods, their health, and the environment. The economic value of those outcomes needs to be visible to decision-makers if they are to choose the best food system pathway for society. However, standard estimates of the economic value of food systems ignore or capture them only marginally. For example, they do not show whether the food produced by a system leads to healthy and productive lives or whether production practices harm local biodiversity or the environment.

Different economic tools can make those largely hidden impacts of alternative food systems visible and comparable with the other economic variables that decision-makers focus on, such as GDP. The FSEC analysis presented in this chapter has used two such tools (Figure 3.1).

**A top-down social welfare function approach.** This assesses the overall value of the food system based on directly estimating the well-being that people derive from it. This approach tries to capture all the ways in which food systems contribute to people's well-being, positive or negative, whether or not these are included in conventional economic statistics, across different pathways.

**A bottom-up hidden cost approach.** This assesses the hidden costs of food systems related to health, environment and poverty, item-by-item. This approach compares the hidden costs of food systems across different pathways to arrive at an estimate of the gross benefits of transforming food systems. To derive the net economic benefits of transforming food systems comparable to the one provided by the top-down social welfare function approach, **estimates of the costs of implementing** a food system transformation are needed.

These two approaches give a "top-down" and "bottom-up" representation of the same effect, namely the economic impact of moving to a particular food system pathway as compared to predicted trends. The former attaches a monetary value to the combined impact of all a pathway's outcomes related to health, the environment and income growth and the latter values those outcomes one by one (Figure 3.1). A notable difference between the two methods, as emphasized in the text, is that the latter values income growth for the poor only, while the former factors in the benefits of income growth for the whole distribution.

In an ideal world, where everything could be comprehensively understood and precisely measured, the top-down and bottom-up approaches would yield identical estimates. In practice, they both encounter distinct challenges and have different strengths and weaknesses. FSEC's view is that using these two conceptually coherent yet operationally divergent approaches to assess the economic impact of the FST should make the analysis more robust overall. The convergence of both approaches in yielding similar results underscores the large economic benefits of the FST compared to the Current Trends pathway. This affirms the FSEC conclusion that pursuing FST to make the global food system more inclusive, health-enhancing, and environmentally sustainability is economically highly beneficial as well as biophysically and technologically viable, as shown in Chapter 2.

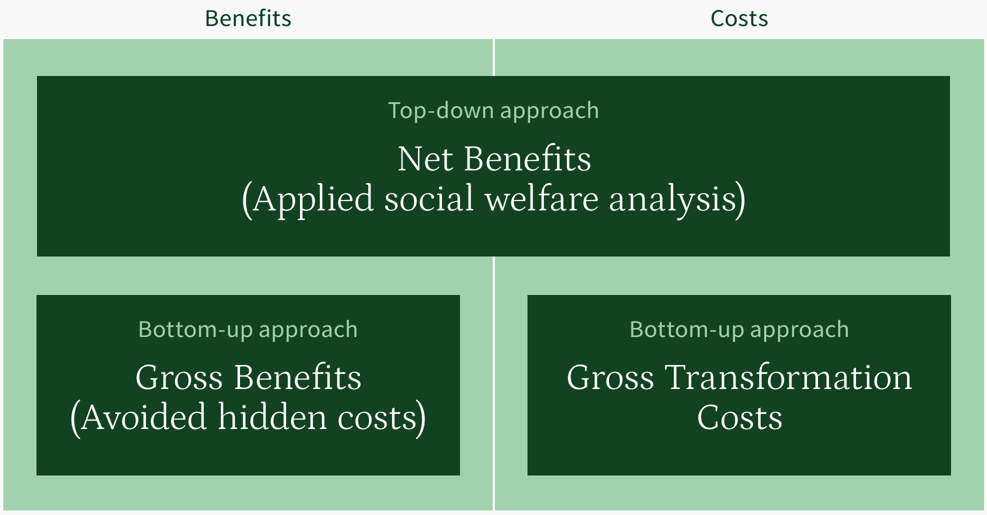
*Sources:* *Dietz 2023; Lord 2023; Passaro et al. 2023*

These gross benefits then need to be compared with the costs of transforming food systems globally (Passaro et al. 2023). A more rigorous estimate of the benefit/cost ratio of transforming food systems globally would require country level analyses. Nevertheless, it is clear that the orders of magnitude involved are such that the costs of transformation are certainly small compared to the potential benefits.

## The hidden costs of the food system

The first step in evaluating the benefits of the FST using the bottom-up approach is to assess the hidden costs of food systems today, that is the present value of their unaccounted for negative im-

FIGURE 3.1
**FSEC's approach to the economics of the food system transformation**




pacts over time and space. The last few years have seen different studies attempt to quantify these hidden costs comprehensively. All estimates point to significant costs, with most of them well above the 10 trillion USD mark (FOLU 2019; Lucas et al. 2023; World Bank 2021; Hendriks et al. 2023). The variation between different hidden cost estimates is driven by differences in the items they consider, their attribution to food systems of specific effects, and in the models they use to estimate the quantities to which they apply the costs of externalities.

FSEC estimates the hidden costs of the Food system arising from GHG emissions, freshwater use, land use conversion, nitrogen pollution, under- and over-nourishment, poverty, and dietary risks. FSEC estimates the value of the hidden costs from these sources in the likely range of 14 to 18 trillion USD PPP a year, with a central estimate of 15 trillion, which is equivalent to 12 percent of GDP PPP in 2020. The costs break down as follows:

- **Health costs** are calculated by estimating the extent of labor productivity lost to poor diets. The health costs of the global food system are 11 trillion USD PPP at least. These costs are largely driven by the high incidence of obesity (730 million people) and the high burden of chronic health conditions such as diabetes, hypertension, and cancer. The impacts of malnutrition are not captured fully as the impacts of other health conditions linked to food, such as maternal mortality due to anaemia, are not included in these estimates.

- **Environmental costs** are the negative effects of today's food systems on ecosystems and climate. Estimation at 3 trillion USD PPP, they include the costs of current agricultural land use and food production practices. Environmental costs also include the costs of biodiversity loss and environmental damage caused by nitrogen surplus, which leaches into waterways and pollutes the air.

→ **Poverty costs** arise from food systems' contribution to structural poverty through the cost of food. Such costs are estimated as the income gap from the poverty line – that is the amount needed to bring all poor people to the 3.20 USD PPP (2011) poverty line. This amounts to 900 billion USD.[2]

## The gross benefits of transforming food systems

FSEC's estimates of the gross benefits associated with the FST pathway are determined by evaluating the extent to which it reduces the hidden costs evaluated under Current Trends. Following this bottom-up method, FSEC estimates that FST provides cumulative gross benefits from avoided hidden costs of 104 trillion USD PPP between 2020 and 2050, equivalent to 5 trillion USD a year (annuitized). Over time, the present value of hidden costs decreases both under Current Trends and the FST pathway. This is mainly due to discounting, which reduces the present value of hidden costs the further in the future they occur. But it is also due to policy actions. In Current Trends, these include the Nationally Determined Contributions pledged by countries to fight climate change. The FST pathway includes a much broader and more ambitious set of actions to transform global food systems. The difference between Current Trends and the FST widens over time, so that the gross benefits grow even in present value terms.

Figure 3.2 looks at the evolution of the gross benefits of the FST compared to Current Trends over time, without annuitization. These gross benefits derive from environmental and health factors in equal amounts, even though different effects play out at different times. Early and comprehensive implementation of the environmental measures in the FST leads to an annual reduction in hidden costs of around 500 billion USD, providing lasting benefits over time. These benefits stem from restoring forests and ecosystems, which effectively offsets the residual harm caused by methane emissions and nitrogen pollution from food production. Additionally, the efficiency of nitrogen use significantly improves under FST. In contrast, the reduction in health-related hidden costs becomes more pronounced, steadily increasing FST's impact over time as people gradually adopt healthier diets.

The total reduction in hidden costs between 2020 and 2050 under the FST breaks down as follows:

→ Reducing health-related hidden costs accounts for 55 percent of the total reduction. Less over-consumption reduces the number of years of life lost (YLLs) to non-communicable diseases that it causes.  These estimates do not account for the benefits that changing diets generate indirectly through their effects on food production, such as their impacts on land use.

→ Reducing hidden environmental costs accounts for 45 percent of the total reduction. Hidden environmental cost reductions arise from decreased GHG emissions from agricultural production under the FST (13 percent), halting or reducing the loss of intact habitats (17 percent), and lower nitrogen pollution (15 percent).

→ The hidden costs of poverty are virtually unchanged, accounting for less than half a percentage point of the gross benefits of the FST. This is because food prices increase under FST and while its income support measures compensate for that increase, they do not eliminate poverty. External measures such as those included in the FXT pathway would reduce the hidden costs of poverty more significantly (see Chapter 2).

FST alone does not eliminate the hidden costs of the global food system over time. Residual hidden costs are largely derived from the residual burden of disease. In contrast, under FST, the food system gradually produces net environmental benefits on aggregate as it becomes a net carbon sink. This result displays the balancing interactions between different regions. In particular, initiatives such as afforestation and increased ecosystem services from

2 A more conservative approach could take as a starting point the over two thirds of workers in agriculture alone are estimated to live in poverty. Such an approach would however leave unresolved the issue of how to attribute the poverty of the dependents of those working in agriculture.

restored forest habitats in Latin America effectively counterbalance residual environmental costs linked to nitrogen pollution and the expansion of agricultural land, particularly in China.

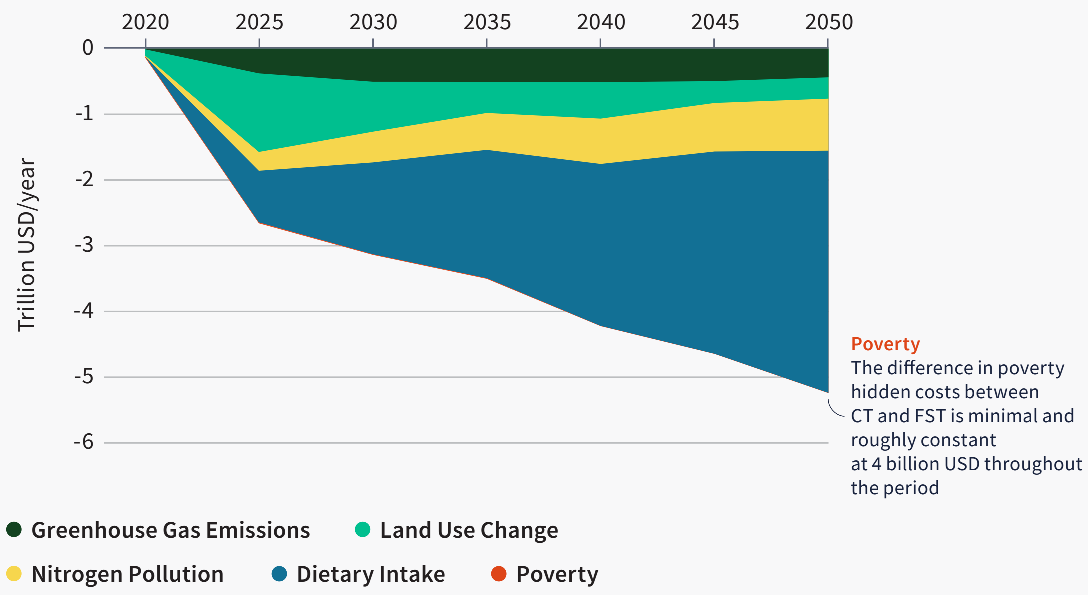
The gross benefits of the FST pathway vary across regions. Most regions experience substantial benefits from better health and better environmental outcomes in the FST, though the main drivers vary by region.

→ In many high-income regions, like the USA and the European Union, the most significant driver of gross benefits is a shift in dietary patterns.
→ In Brazil and Latin America, restoring forest habitats and reducing GHG emissions result in net environmental benefits, which offset remaining diet-related hidden costs in the region.
→ In China, adopting the FST can reduce health-related hidden costs stemming from obesity and non-communicable diseases by 30 percent between 2020 and 2050, amounting to an estimated 300 billion USD average annual benefit compared to the Current Trends pathway. The country can also reduce environmental costs. Being the largest contributor to agricultural nitrogen pollution today, under FST, China manages to reduce the costs of its pollution by 30 percent (equivalent to a benefit of approximately 100 billion USD annually) (see Spotlight on Change 6).
→ Sub-Saharan Africa faces a triple economic burden amounting to 540 billion USD by 2050 under the Current Trends pathway. Its components are the environmental hidden costs of escalating nitrogen use, labor productivity losses from unhealthy diets and hidden costs of persistent poverty. Adopting FST in the region could halve this burden from health-related hidden costs and eliminate environmental costs by 2050.

### The costs of transforming food systems

To compute the net benefits of transforming food systems from the bottom-up, it is necessary to determine the costs associated with the implementation of the food system transformation. Those costs can be derived by identifying the set of specific measures required to make the transformation and pricing those actions using detailed unit

FIGURE 3.2
**Reduction in hidden costs compared to Current Trends**
Trillion USD PPP 2020



price information (Passaro et al. 2023).

To estimate the transformation costs, a list of areas for action aimed at achieving the changes broadly captured by the FST was curated through a series of expert consultations and thorough literature reviews. The additional costs of implementing those packages of measures on top of current expected sectoral expenditures is 215 billion USD (See Figure 3.3). In addition, a broad estimate of the possible safety nets for the most vulnerable people needed to cushion them from impact of FST on food prices and keep food affordable in the transition period has been considered.

This exercise offers a first rough approximation of the costs of global food system transformation. Considerably more detailed and contextual analysis would be needed to cost national food system transformation strategies, as discussed in Chapter 4.

In addition, while FSEC has tried to obtain detailed local unit costs to build up a global picture,

SPOTLIGHT ON CHANGE 6

## Changing gear on nitrogen

Attitudes to synthetic fertilizer are shifting. Where once this source of nitrogen was seen as an unambiguously reliable ally in the global quest for food security, now the environmental impact of excess nitrogen is forcing changes on national policy agendas.

The Netherlands and China are two countries adopting new nitrogen policies.

In the Netherlands, excessive use of nitrogen has been the subject of public policy debate for several years. Before 2018, the management of nitrogen in Dutch agriculture was based on a nitrogen-licensing system. After both the European Court of Justice and the Dutch State Council judged this system insufficient to protect Natura 2000[1] areas, it was suspended. The resulting uncertainty and immediate blockage of thousands of construction projects triggered farmer protests and heated public debate. In 2022, the Government introduced a policy framework for halving pollution from nitrogen emissions by 2030. This includes a transition fund of 25 billion euro until 2035 to compensate farmers and reduce the number of livestock in the country. The highly confrontational nature of policy debates on nitrogen in the Netherlands shows the importance of including farming communities in transformational policymaking (Selnes 2023).

China also has a nitrogen problem. It is the largest consumer of synthetic fertilizer in the world, using an average 226 kg per hectare–3.3 times more than the global average–but at only half the world's average efficiency. In 2015, the Ministry of Agriculture and Rural Affairs launched a "Zero Growth in Synthetic Fertilizer Use" policy. This removed subsidies on fertilizer manufacturing and introduced four new measures: fertilization standards for different regions; adjustments to the structure of N, P, and K fertilizers and application of high-efficiency fertilizers; improved fertilization methods; and substitution of organic manure for synthetic fertilizer. This approach of combining new technologies for more efficient use of nitrogen with taxes on surplus nitrogen has already proved effective in several European countries at cutting nitrogen use without compromising yields.

*Sources: Selnes 2023; Wang et al. 2022; Zhang et al. 2015.*

1 Natura 2000 is a network of core breeding and resting sites for rare and threatened species, and some rare natural habitat types which are protected in their own right, established across Europe by the EU member states.

information is irregular, making it difficult to scale costs between local, regional, and national levels. Finally, the quantities to be considered can also vary widely across contexts and policies, depending on the level of ambition and implementation capacity assumed. For example, a new program might be introduced gradually, reflecting the time needed to create new delivery mechanisms, or it might be introduced rapidly, where need is urgent and all the necessary interventions can be made immediately.

The need for further contexual analysis is particularly strong for our estimates of the safety nets provision, which are based on the average global income gap and the share of food in the consumption basket of the poor in low income countries, approximated with evidence from Sub-Saharan Africa (World Bank 2021). This estimate needs to be refined depending on local circumstances, including national programs' ambition and how they are scaled up over time, the specific income groups expected to benefit, local household vulnerability to price increases and the availability of resources and capacity needed to operate transfer programs.

Taking those caveats into account, FSEC estimates the costs of transforming food systems at between 200 and 500 billion USD PPP a year to 2050. This broad range is comparable to the 300 to 400 billion USD a year estimated by the UNFSS finance lever (World Bank 2021).

The estimated costs of safety nets account for the

FIGURE 3.3
**FSEC transformation costs, by operational goal**

| Operational Goal | Intervention/Measure | Average transformation cost per year (in billion USD PPP 2020) |
|---|---|---|
| Diets<br>Consumption of healthy diets by all | Diversification of protein supply | 3 |
| | Behavioural interventions for shift in demand | 1 |
| | Child nutrition | 17 |
| | Restrictions, taxes and regulations | 1 |
| Livelihoods<br>Strong livelihoods throughout the food system | Rural infrastructure development | 24 |
| | Training of agricultural entrepreneurs | 1 |
| | Financing of smallholder farmers | 6 |
| Biosphere<br>Protection of intact land and restoration of degraded land | Protection of forests and other ecosystems | 78 |
| | Management of forests and other ecosystems | 3 |
| | Restoration of forests and other ecosystems | 7 |
| Production<br>Environmentally sustainable production throughout the food system | Reduction of emissions | 28 |
| | Improvement of emission sequestration | 42 |
| | Agricultural public research and development | 3 |
| | Reduction of food loss and waste | 2 |
| | **Total** | **215** |
| | **Safety nets**<br>(Measures to ensure food affordability for the poor) | **292** |

largest share of FST costs – beyond the actual value of these interventions, this is an important pointer to the significance that FSEC attaches to addressing the distributional impacts of food system transformation, both for justice reasons and because the political feasibility of transformation is jeopardized within the implementation of safety nets (Chapter 5). Next come measures to protect and restore degraded land and those needed to shift to environmentally sustainable food production. These comprise annual expenditures of almost 90 billion USD for managing and restoring forests and ecosystems, below 70 billion USD to reduce greenhouse gas emissions in crop and livestock production through improved management practices, agroforestry, soil organic carbon enrichment of croplands and grasslands, and biochar applications. Measures targeting the reduction of food loss and waste and investments in public agricultural research and development account for the rest of the projected costs of shifting to sustainable food production.

Spending to ensure the transformation is inclusive is expected to absorb some 30 billion USD per year. This money would go towards providing small producers with training and better access to financial resources, as well as developing vital rural infrastructure such as roads, electricity, internet connectivity and irrigation systems.

Finally, over 20 billion USD a year is expected to be needed for measures to support shifts to healthy diets. As Chapter 4 discusses further, action in this area encompasses a range of measures including support for diversifying protein supply, promoting child nutrition through breastfeeding and school feeding programs, informational campaigns and regulation of trans-fatty acids and sugar-sweetened beverages.

As the main elements of the food system transformation differ by region, so do regional implementation priorities. In low- and lower-middle income countries, four areas are critical: forest and ecosystem protection; improved emission sequestration in agriculture; rural infrastructure development; and child nutrition. Within SSA, forest protection accounts for over a quarter of total transformation costs. In Southeast and East Asia, forest protection and rural infrastructure development each represent one quarter of the total costs. In high-income regions, emission reduction in agriculture accounts for the largest fraction of transformation costs. And in middle-income regions, almost half of total costs are absorbed by safeguarding forests and other ecosystems, with emission sequestration improvements in agriculture requiring more than 20 percent of transformation spending.

## A top-down approach to assessing the net benefits of pursuing the FST pathway: applied social welfare analysis

The top-down approach to assessing the net economic benefits of transforming food systems uses an applied social welfare function.  The first step entails directly estimating global social welfare under Current Trends and the FST pathways (Dietz 2023). The difference in welfare between these two pathways is then translated into monetary terms to quantify the net economic benefits under FST. This comprehensive approach encompasses the impacts on welfare stemming from health and environmental improvements within the food system, as well as from real income growth along the whole income distribution.

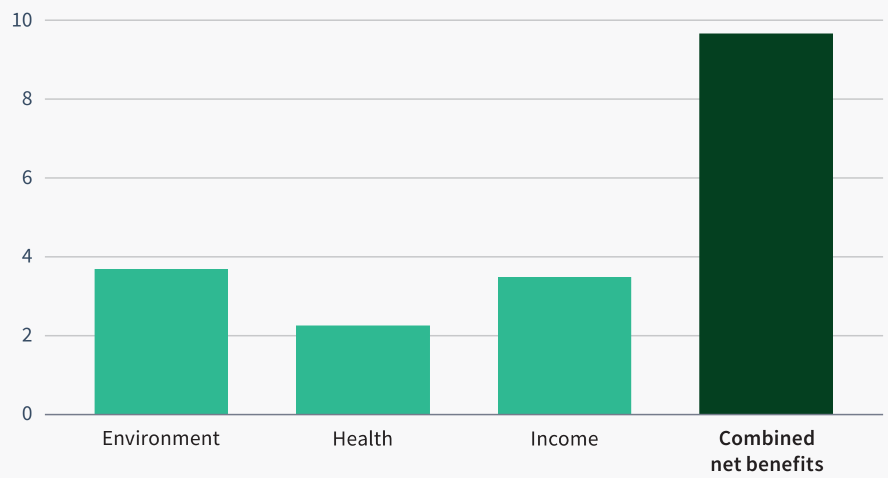
Using this top-down approach, the estimated net economic benefits of FST amount to approximately 10 trillion USD a year until 2050, roughly equivalent to 8 percent of global GDP PPP in 2020 (see Figure 3.4). Accumulated net welfare gains would amount to 270 trillion USD by the middle of the century.

Like the bottom-up approach, the social welfare analysis captures FST outcomes linked to critical changes in environmental quality and human health. But this methodology takes a broader approach to valuing the income component of FST than the bottom-up approach does since it values income changes in the population as a whole rather than among the poor only. This difference between the two approaches accounts for the much higher valuation of benefits under the top-down than the bottom-up approach.

Figure 3.4 shows the decomposition of net benefits of pursuing FST globally by its final outcomes. It values improvements in two of the three social welfare outcomes targeted by the FST, environmental quality and incomes, at approximately 4 trillion

FIGURE 3.4
**Net benefits of the FST compared to Current Trends, overall and disaggregated by food system outcome, top-down approach**

Trillion USD PPP 2020




USD per year each, equivalent to about 3 percent of global GDP in 2020. Improvements in health, the third outcome targeted by FST, can contribute up to 2 trillion USD per year (about 2 percent of global GDP in 2020) to the increase in social welfare.

Crucially, the results of assessing the net economic benefits of pursuing FST using the top-down approach are remarkably consistent with the findings from the bottom-up approach. Notably, in both exercises, the environmental and health benefits of the transformation are in the range of 5-6 trillion USD PPP a year. This convergence of results is both remarkable and reassuring as it underlines the reliability of the findings.

In addition to FST and Current Trends, the top-down approach has been applied to pathways implementing bundles of measures each targeting directly one specific operational goal. The measures considered affect both production and consumption, illustrating the likely overall effectiveness of each individual bundle. Figure 3.5 shows that the bundle of measures targeted at shifting diets by itself achieves about 70 percent of the overall impact of the FST, roughly equivalent to a 5 percent increase in global GDP in 2020. This is because a dietary shift not only produces the direct health benefits on the demand side but facilitates the reallocation of land, enabling countries to invest in forest protection and reforestation which result in the far-reaching societal benefits of climate change mitigation, more biodiversity and less agricultural pollution.

Implicit in Figure 3.5 is that by integrating bundles of measures targeting different operational goals, the welfare benefit from the different bundles adds up to a value higher than the welfare benefit from the FST. This is due to the decreasing marginal utility of an increase in one bundle; income, health, or environment. As more measures are added, the additional benefit derived increases at a decreasing rate and the initial implementation of measures will have a larger effect on the welfare benefits than later ones.

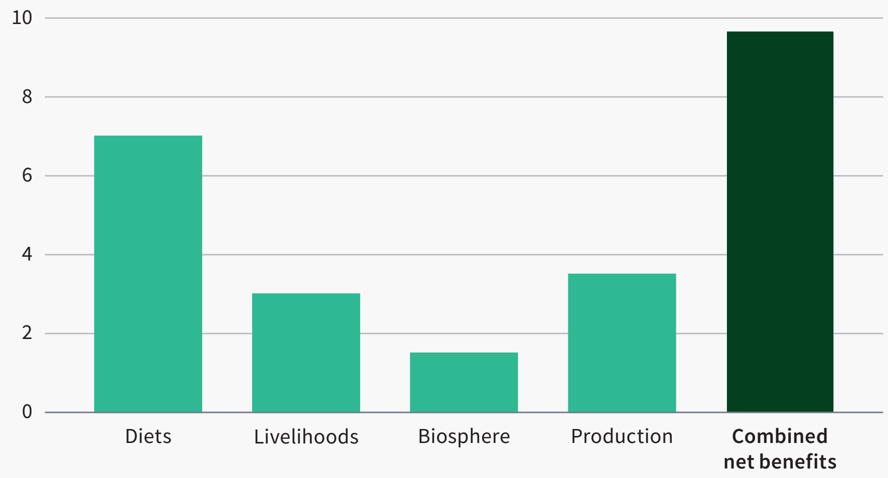
## The financing gap of the transformation as a major barrier towards reaping its benefits

This chapter has shown that investment to make food systems inclusive, health-enhancing and environmentally sustainable is likely to produce very large economic benefits.

The additional annual costs of such a transfor-

FIGURE 3.5
**Net benefits of the FST compared to Current Trends, when implementing seperately bundles of measures and overall, top-down approach**

Trillion USD PPP 2020




mation worldwide are equivalent to between 0.2 and 0.4 percent of global GDP PPP in 2020, so the necessary investment is clearly affordable at a global level. However, these costs burden low-income countries disproportionately and are beyond their financing capacity. To reap all the potential benefits of a global food system transformation, it needs to be financed in full everywhere.

Figure 3.6 shows how the transformation costs, as assessed by FSEC, are unevenly distributed among different country income groups. Even at the lower bound cost estimates, paying for the transformation in low-income countries would require the equivalent of almost 2 percent of their GDP PPP in 2020. The financial burden of financing the food system transformation becomes even greater for them if it includes the cost of safety nets to ensure food affordability. In contrast, the financial burden on high- and upper-middle-income countries is proportionally much lower, at 0.03 percent and 0.26 percent of their GDP respectively.

This suggests that funding a long-term, comprehensive food system transformation will be hard for many countries. There are a number of options for closing their financing gaps, some national and others involving international redistribution.

At the national level, all governments could reallocate public expenditures, target spending more accurately to vulnerable populations and strengthen both tax law and compliance with that law. However, low- and lower-middle-income countries might find that funds yielded by these measures fall short of their requirements, particularly since they face many competing needs. Private investment via the banking system and capital markets could also be a significant source of funds for transformation investments. However, private flows from banks and capital investors in low- and middle-income country (LMIC) food systems has so far been limited: for instance the annual flow of formal loans to LMICs for agriculture, forestry, and fisheries between 2015-2019 is estimated at 14.2 billion USD (Díaz-Bonilla 2023), although this figure would be higher if informal finance flows are included.

A lot of attention has recently been paid to the potential funding that could be released by repurposing environmentally damaging subsidies (Damania et al. 2023);

→ Developing countries allocate approximately 300 billion USD per year to fossil fuel subsidies, which

FIGURE 3.6
**Gross Transformation Costs (without safety nets), by income country classification**

| Income regions | Annual transformation costs (billion USD) | GDP in 2020 (billion USD) | Transformation costs as share of GDP PPP (in %) | Investments in 2020 (billion USD) | Transformation costs as share of investments (in %) |
|---|---|---|---|---|---|
| **High-income** | 22 | 63,282 | <0.1% | 14,041 | 0.2% |
| **Upper-middle-income** | 126 | 48,241 | 0.3% | 16,704 | 0.8% |
| **Lower-middle-income** | 42 | 21,532 | 0.2% | 5,786 | 0.7% |
| **Low-income** | 25 | 1,338 | 1.9% | 315 | 8.0% |
| **World** | **215** | **134,748** | **0.2%** | **36,846** | **0.7%** |

**Table 3.3:** The table shows the annual transformation costs in billion USD 2020 PPP necessary to transform the food system per country income group (World Bank classification), compared to key macroeconomic indicators such as GDP and investments in billion USD per country income group. Sources: Passaro et al. (2023) for the transformation costs, and Díaz-Bonilla (2023) for the estimates based on World Bank WDI for savings and investment.

is about two thirds of the total of 455 billion USD in 2021 spent on such subsidies globally (Parry et al. 2021). The Glasgow Climate Pact, established at COP 26 in 2021, calls for all fossil fuel subsidies to be gradually phased out.

→ Globally about 400 billion USD of public resources are allocated to agricultural subsidies (OECD 2023). Those could be reallocated to promote environmental public goods and the shift to sustainable diets, as well as target resources more effectively towards agriculture and social assistance programs for the impoverished and vulnerable (Díaz-Bonilla et al. 2021; Díaz-Bonilla & Echeverría 2022; Parry et al. 2021; Laborde et al. 2020).

Unlike the repurposing of fossil fuel subsidies, this latter strategy is less relevant to lower-income developing countries, which have limited agricultural subsidies to reallocate. Laborde & Pineiro (2023) explore a scenario in which international redistribution adds to repurposed subsidies as a source of finance for a global food system transformation. This additional source ensures that as production moves to low-income countries there is available finance to invest in closing their productivity gap, which in turn reduces the potentially damaging environmental impact of that geographical shift in production. This scenario highlights that reaping the global benefits of the food system transformation calls for new ways of doing things.

It seems inescapable that profoundly reshaping the global food system will involve some element of international redistribution. Currently, international funding for food systems is very low. Only 4.5 percent (approximately 12 billion USD) of all international development funds are earmarked for agriculture, forestry, and fishing (Díaz-Bonilla 2023). And currently, only 3 percent of public climate finance is dedicated to food systems, despite these systems contributing one third of global greenhouse gas emissions. This is astonishingly low compared to the financial amount allocated to greening the energy and transport sectors which is 22 times larger (GAFF 2022). A good starting point for mobilizing additional financing for food systems could be the ongoing discussions on the multilateral development banks' agenda for reforming.


# Chapter 4
# Designing Strategies to Make Change Happen: Incentives and regulation, Innovation and Investments

# Chapter 4

→ Transforming food systems calls for wide ranging and coordinated national strategies, informed by science-based, quantitative pathways and setting monitorable targets.

→ National strategies should include bundles of policy interventions as to ensure coherence, to maximize synergies including with transformations outside food systems, focus on areas of maximum impact, be based on coordinated governance and be supported by adequate implementation capacity.

→ Policy bundles can span incentives and regulation; innovation; and investment. The specific combination of policies adopted needs to reflect local needs, though global priorities emerge in terms of favoring a shift towards healthy diets, repurposing government support and targeting revenues from new taxes to support the transformation.

→ Adopting an inclusion lens through the choice of specific policies, compensation schemes, and measures to ensure that poor and disadvantaged groups can access new opportunities, is essential to address the pervasiveness of trade-offs between different transformation objectives and the interests of more vulnerable and marginalized groups.

## Introduction

Previous chapters have highlighted that a food system transformation towards inclusive, health-enhancing and environmentally sustainable outcomes is biophysically and technologically possible and could deliver enormous economic benefits. Such a transformation would require major shifts in dietary behaviour, rural livelihoods, nature conservation, and the management of production. This chapter asks how public policy can help make those major changes happen.

Given the diversity of food systems around the world, there can be no universal policy blueprint for reshaping them. Food systems vary greatly in the ways they are regulated (Lowder et al. 2022b; 2022c) and the extent to which their activities are informal and thus largely fall beyond the direct reach of regulation (see Box 1.1).

This chapter synthesizes principles for designing successful food system transformation strategies drawn from the literature. It then discusses the available policy tools broken down into three categories: (i) incentives and regulations; (ii) innovation; and (iii) investment. Box 4.1 provides an example of how co-ordinating action across these three levers can inform the design of policy strategies to address obesity. Lastly, the chapter examines the need to apply an inclusion lens to the choice and design of policies. The policies highlighted in the chapter are supported by either robust evidence where this is available or widespread agreement among scientists that implementing them will be effective and feasible.

While the chapter's recommendations aim to help with the choice of policies for a national food system strategy, successful implementation depends on grounding strategy design in a clear understanding of the political economy[1] of food systems. The recommendations in this chapter therefore complement those in Chapter 5, which focuses on the roles of interests, institutions, and ideas and information in shaping the political economy of food systems and how to work with different stakeholders to effect planned changes. National food system strategies need to combine effective policies, local context and political viability in order to be feasible.

## Designing food system transformation strategies

This report calls for all countries to put in place wide ranging and coordinated strategies for transforming national food systems aimed at realizing a vision for change shared by all system stakeholders. The design of national strategies needs to be informed by pathway modeling exercises similar to those presented in Chapter 2 and tailored to the local context. Strategies that offer long-term goals and monitorable progress indicators will set investment expectations and also make accountability for progress towards the goals transparent.

Evidence suggests that for best effect, national food system transformation strategies should adhere to the following principles:

**Make sure new and existing policies affecting food systems are coherent and tackle inconsistencies.** For example, a new tax on sugar-sweetened beverages to reduce national sugar consumption could be undermined by long-standing subsidies on corn production which aim to support farmers' incomes but produce a large supply of inexpensive corn syrup as well (Dilk & Savaiano 2017). Starting the design of a national food system strategy with a policy audit to identify such policy inconsistencies helps to ensure the strategy itself addresses them (Parsons 2021).

**Use "policy bundles" to maximize synergies between different interventions and offset adverse effects** (Lowder et al. 2022 a). The pathway analysis in Chapter 2 has highlighted trade-offs and synergies between pursuing different operational goals, for example between the protection of pristine habitats and changing diets towards healthier patterns. Translating this insight into national food system strategy design means combining complementary policies in "policy bundles" tailored to optimize potential synergies in the local context. Detailed simulations of the impacts of a standardized set of policy bundles across the world indicated that in some food systems, particularly those classified as "rural and traditional" (largely located in Sub-Saharan Africa and South Asia), income support or subsidies targeted to low-income households would have to be added to the bundles to mitigate the impact on those households of potential food price increases (Kuiper et al. 2023).

**Exploit synergies with transformations taking place in other systems,** such as energy or water. As discussed in Chapter 2, meeting all the goals of a sustainability transformation in food systems calls for complementary measures in interrelated systems. A concrete example is offered by the Paris food system strategy, which uses the transformation of local food production to improve the city's water quality at the same time (see Spotlight on Change 7).

**Focus on areas of food systems where policy will have maximum impact.** These are areas where policy intervention is likely to speed the pace of change and/or trigger related changes in other parts of food systems (Lenton et al. 2022). Action in these areas of food systems, often through downstream links in food value chains, will have disproportionate effects on the system as a whole because of the leverage of their demands on other areas (Lenton et al. 2022). For example, supermarket retailers have

1 Political Economy is an analytical approach that focuses on agency, power relations, and institutional structures. The concept is used to analyse the interaction of political and economic processes by primarily looking at the interests and constellations of relevant actors, the power relations between them, the structures and institutions that influence these relationships, the resulting inequalities, and how these dynamics change (Duncan et al. 2019; de Schutter 2019; Swinnen 2018).

SPOTLIGHT ON CHANGE 7

## An integrated strategy for food system change

**The city of Paris**

Several cities are already developing integrated food system transformation strategies. This may have something to do with complex reforms with multiple objectives being easier to coordinate in cities than at a national level because city populations live close together and are relatively small. More than 250 cities have signed the Milan Urban Food Policy Pact and 16 cities have signed the C40 Good Food Cities Declaration, which commit them to reforming their food systems as a means of tackling climate change and extending access to healthy foods.

The Paris plan sets targets to increase the amount of food both consumed and produced in the Paris Basin to 50 percent of the total, compared to 25 percent now. It also aims for 20 percent organic production and 75 percent organic consumption. In addition, the strategy aims to eliminate food insecurity (which affected 6 percent of the population in 2016), reduce the incidence of obesity to less than 5 percent of the population and support a general shift to a diet rich in fruit and vegetables with less meat and fish.

The local public sector is investing significantly to achieve these targets. Municipally owned Eau de Paris is providing 37 million euro and the city itself providing 10 million euro over twelve years to help farmers shift to organic and less polluting forms of production. This shift will also reduce the cost of water treatment. The initiative is just one example of how the Paris food system strategy is helping the city to progress towards multiple civic goals in an integrated fashion, all the while reinforcing the local economy and its relationships with adjacent communities. Paris noted that Europe's Common Agricultural Policy (CAP) would have been an appropriate source of funding for the strategy but the city had to act on its own as the CAP does not yet provide for such investment.

*Source: Mairie de Paris 2018*

sufficient buying power to impose their strategies on their suppliers further downstream (Reardon 2006; Humphrey 2006). However, the distribution in food value chains has so far rarely been targeted by policies aimed at reshaping food systems (Lowder et al. 2022c).

**Ensure governance of food system reform is co-ordinated** by establishing governance mechanisms that span government departments, different levels of government and key stakeholder groups. Drawing representatives from all these areas into the governance of food system transformation is a means of ensuring that the transformation's guiding vision for change is shared by all the relevant actors (see also Spotlight on Change 11). Switzerland's citizen assembly on food policy (Bürgerrat 2022) and Ireland's agri-food system stakeholder committee (Government of Ireland 2021) both demonstrate this approach.

**Have enough implementation capacity to carry out and enforce the strategy.** The complexity of food system reform requires countries to have adequate implementation capacity at relevant levels of government to carry out and monitor complex and multi-sectoral strategies, to enforce regulations and to provide supporting infrastructure. Implementation capacity comprises three elements: organizational capacity, such as the expertise and know-how to implement the changes; technical capacity, such as the digital infrastructure and information technology needed to monitor policy performance or compliance with new rules; and financial capacity, to pay for all the public sector workers and the public services and investments needed to transform food systems (Bardhan 2022).

**Apply an inclusion lens to policy design.** This critical requirement for successful food system transformation strategies is discussed in detail below.

## Incentives and regulations

Government policies and regulations create incentives that steer the choices of all food system actors – producers, processors, transporters, intermediaries, consumers, and investors. Ideally, these incentives would align with the true economic value of what is being produced and consumed. As highlighted in Chapter 3, today they rarely do, resulting in USD trillions of economic damage unaccounted for in economic statistics. Designing incentives to reduce negative externalities[2], increase positive ones[3], and make food systems generally more responsive to the revised incentives is therefore a top priority for any food system transformation design team.

A variety of policy tools for creating incentives is available: fiscal tools such as taxes or subsidies; mandatory instruments such as restrictions or bans; and market-based policies such as trading schemes and voluntary certification. The choice of tools needs to be closely tailored to each food system context as the evidence for their effectiveness varies notably in different circumstances (Lowder et al. 2022b; Willenbockel 2023). Policymakers also need to be alert to the risk that new incentives may increase burdens on disadvantaged groups.

Individual policies for incentivizing specific changes are discussed below. As noted above, bundles of policies tailored to the context can maximize synergies among interventions. This might involve, for example, combining fiscal policy interventions to reduce food waste and losses with public investment in equipment and training that help food system actors to achieve reduction targets.

### Reducing negative externalities

Possible policy responses to a food system's pervasive externalities include taxing harmful substances, imposing mandatory restrictions or bans on their use and repurposing agricultural support.

**Taxing.** Taxes on sugar-sweetened beverages and on nitrogen fertilizers, have proved effective in reducing the use of both by making them more expensive. Evidence for the effects of these measures is robust and generally consistent across different settings, although larger in some places than others.

- → Research on the effects of taxes on sugar-sweetened beverages is starting to identify positive but small health benefits beyond reduced consumption, including decreasing prevalence of overweight and obesity and fewer adolescent girls with a high Body Mass Index (Gračner et al. 2022). However, such findings are not universal (Fletcher et al. 2010) suggesting that this policy would need to be bundled with other interventions, such as behavioural incentives or urban planning directed at increasing physical activity, to reduce obesity significantly (see also Box 4.1 at the end of this chapter).
- → Taxing nitrogen is similarly considered an effective way to reduce negative environmental effects, including ground water pollution and GHG emissions, especially when accompanied by measures to make nitrogen use more efficient (Henseler et al. 2020). So far, policies to limit GHG emissions have rarely been applied to agriculture sectors for fear of raising food prices. However, this may be changing. New Zealand is considering a carbon tax on agriculture and the European Union is discussing whether to extend emission trading schemes to the sector. Modeling shows that imposing a tax on agricultural GHG emissions or bringing the agricultural sector into a carbon pricing scheme in just a handful of countries would

2 Negative externalities are the costs or harmful consequences caused by the consumption or production of a good which are experienced by a third party and which are not reflected in the price of the good.

3 Positive externalities are the benefits generated by actions of a producer or consumer which are experienced by a third party, and which are not reflected in the price of the good.

reduce global agricultural emissions significantly, especially if the tax revenues were reinvested in abatement technology (Stepanyan et al. 2023; Henderson & Verma, 2021).

**Imposing mandatory restrictions.** The restriction or banning of the industrial use of transfatty acids (TFA)–food ingredients with negative externalities–provides evidence for the effectiveness of this type of policy. Countries pioneering such a ban have seen dramatic reductions in the TFA content of foods and TFA-related disease, particularly among the most vulnerable socioeconomic groups (see Spotlight on Change 10 in Chapter 5).

**Repurposing agricultural support.** Agricultural support is often misaligned with the objectives of efforts to transform food systems. Such support programs, estimated to cost 470 billion USD in public resources a year worldwide (OECD 2022), largely incentivize the production of staples rather than more diverse and nutrient-rich crops. They also encourage inefficient use of inputs and cause environmental degradation and excessive GHG emissions (Rosegrant 2023). New modeling commissioned by FSEC shows how redirecting agricultural support currently linked either to production volumes of specific commodities or the use of certain inputs ("coupled" producer support) towards boosting farmers' incomes would result in global rises in GDP, lower food prices and less poverty, and also make healthy diets more affordable (Laborde & Pineiro 2023). However, subsidy repurposing strategies have an important global dimension to ensure that to the extent that production is displaced to less efficient countries, investments are in place to improve productivity and contain environmental impacts.

### Supporting positive externalities

Costa Rica pioneered the use of payments for environmental services with great success in 1996. Since then, the idea that incentives and regulations can support the provision of public goods has started to infiltrate the design of food system policies in the form of instruments that are mandatory, market-based, or voluntary (Moros et al. 2022).

Two common mandatory incentive instruments for nature conservation are emissions trading sys-

tems and the clean development mechanism (CDM). Both raise finance for carbon sequestration or emission reduction projects in developing countries. Payments for Ecosystem Services (PES) schemes are an example of market-based instruments. These are conditional payments made to groups or individuals to encourage the restoration or enhancement of ecosystem services. They are used, for example, to dissuade farmers from turning uncultivated land into farmland or encourage them to adopt sustainable agricultural practices such as silvo-pastoral systems. Other market-based instruments are the REDD+ schemes that incentivize forest rich countries in the tropics to keep forests standing and manage forest and agricultural systems sustainably. Lastly, voluntary approaches include voluntary sustainability standards, such as supply chain codes of conduct and certification schemes, and stricter voluntary bans or moratoria, which incentivize producers to meet to forest conservation standards in order to be included in a supply chain (Moros et al. 2022).

All these incentive instruments can be both publicly and privately financed. For instance, in publicly financed PES schemes, governments finance the provision of ecosystem services through taxes and fees whereas in private PES schemes, companies make direct payments to ecosystem protectors because the company's business relies on the ecosystem in question continuing to provide services (Moros et al. 2022).

While these three types of incentive instruments have been found to improve environmental conservation and promote more sustainable agricultural practices to varying degrees, they have also drawn many criticisms. To make them more effective and inclusive, they need better accompanying compliance and monitoring mechanisms along with secure payment systems (Moros et al. 2022). Payment strategies and compliance mechanisms for specific schemes also need to prevent leakage effects[4] in areas not targeted by the schemes. To increase their beneficial impact, they should target areas providing a greater density of ecosystem services or at higher risk of degradation and do more to make sure their intended outcomes do not undermine other goals, such as protecting biodiversity, water or agricultural productivity (Moros et al. 2022).

Making payment-for-nature schemes truly inclusive entails making them easier to join for small-scale farmers and preventing unintended consequences that would exacerbate rural poverty, for instance, increases in local land values or restrictions on access to previously common goods. It may be necessary to bundle these schemes with social protection and compensation measures and to align payment schemes with the opportunity costs to farmers of preserving protected lands, i.e., the loss of income they would otherwise gain from converting the protected land to agricultural uses (Vorlaufer et al. 2017; Moros et al. 2022).

**Reduce transition costs and increase system responsiveness.** Revising incentives and regulations might not produce intended changes if some or all food system actors lack the resources to respond. Constraints in their general environment might prevent them. For example, restricted access to markets, credit, technology, or information can all limit farmers' ability to adopt new agricultural practices. Individual constraints might also hold them back, particularly not having enough money to shift to the new practice. Governments can invest to make the general environment more enabling of the desired response to revised incentives and regulations. They can also use certain policy instruments as "carrots" to complement regulatory "sticks."

Policy bundles that combine interventions on both the supply and demand sides of a market are a case in point. For instance, a government introducing a tax on sugar-sweetened beverages to reduce their negative health outcomes may offer complementary behavioural interventions to help consumers reduce their demand for sugary drinks. In addition, giving people the resources to adapt to a new

4 Leakage is said to have occurred where, for example, a policy or project designed to protect forests leads to a shift of deforestation to another region.

policy, for example, subsidizing some of the costs of shifting to a new production practice, makes the policy more effective (Pilditch et al. 2023). Bundling complementary policies to create positive feedback loops and entrench change is also likely to reduce the overall costs of the change. Lastly, it makes change more politically feasible as citizens are likely to support even burdensome policies when they are combined with attractive complementary measures (Fesenfeld et al. 2020; Fesenfeld 2024, see also Chapter 5).

## Innovation

Food systems innovation is progressing at an unprecedented rate, with new technologies ranging from Artificial Intelligence (AI) to sustainable processing technology, from dietary additives for livestock to enhanced fertilizers (Herrero et al. 2021). This trend bodes well for food system transformations. However current food system research and innovation (R&I) needs strengthening in several ways to make sure its results support system transformations that are sustainable and inclusive.

Food system R&I needs to extend beyond production, its current focus, to other areas such as food waste, logistics and distribution, food consumption and healthy diets. Instead of concentrating on single objectives—for instance, increasing yield from a particular crop—innovations should be directed at multiple food system objectives and address trade-offs between them (Barrett et al. 2020). For this reason, and to account for complexity of food systems in general, food system R&I needs to enable collaboration across a wider range of stakeholders. More transdisciplinary R&I is needed using integrated approaches, which stimulate knowledge sharing between different scientific and technical communities (den Boer et al. 2021). Consistent support and funding for international multistakeholder innovation platforms and networks would accelerate this shift towards more participatory agricultural R&I (Rosegrant 2023).

Public funding can be particularly significant in effecting these changes in low- and middle-income countries, where public money pays for the lion's share of food system R&I. It accounts for 60-70 percent of the yearly spend in those countries on innovation in agriculture, estimated at 50-70 billion USD a year (Prasad et al. 2023). Public sector bodies may also draw on the finance, expertise and drive of private sector actors as long as public-private partnerships for innovation address the needs of smaller-scale and marginalized groups, such as smallholder farmers, women, and youth, which are the least likely to benefit from privately funded innovation today. Most private investment goes to globally-traded commodities, such as maize and soybeans, and bypasses crops like cassava, yams and sweet potatoes that are economically significant in many low- and middle-income countries, particularly in Africa.

Progress in the following seven areas of food system R&I is particularly important to accelerate sustainable and inclusive food system transformations (Rosegrant 2023).

**Modernizing plant breeding** in low- and middle-income countries (LMICs). This requires investment in innovative data collection, digitization, and information management systems in LMICs to increase the efficiency of R&I undertaken in them[5]. Institutional reforms are also needed to support modern information platforms (Kholová et al. 2021). These improvements should be implemented by partnerships between national and international public research systems, universities, farmer-led breeding initiatives and, where appropriate, private sector bodies. Strengthening research capacity in LMICs in this way would help to improve development of locally relevant crops and overcome the barriers to technology transfer currently created by international protection of intellectual property rights.

5 These include high-throughput phenotyping, GIS, genomic-wide association selection, meteorology, and soil characterization as well as monitoring of farm management practices, including the performance of cultivars.

**Developing more environmentally sustainable farming systems.** Farming systems can incorporate a variety of practices to become more environmentally sustainable, notably: rotation of a wider range of crops including legumes and cover crops; conservation tillage and residue management; improved water management through precision agriculture and water harvesting; improved pasture management; applications of natural pesticides and biofertilizers; and improved manure management systems in livestock-crop systems. Over time, these practices improve productivity and produce a variety of environmental benefits. New precision agronomy technologies can help in tailoring the design of sustainable farming systems to local agroclimatic conditions at subnational and field scale (Rosegrant 2023).

**Digitizing agriculture for small farmers.** Advanced digital technologies such as satellite imaging, remote sensing and in-field sensors can all support precision farming for small farmers, and especially precision agronomy, by delivering essential information to them at a practical scale (Rosegrant 2019). To date, these technologies have been mostly used by larger farmers. Rapidly reducing their costs and embedding them in applications that address smallholders' problems will make them more useful and accessible to small farmers. Easily accessible digital advisory services can help small-scale producers to manage climate risks or crop disease threats (see Spotlight on Change 8). Government investments are key to extending digital technologies to small farmers at scale. They are needed to provide the

SPOTLIGHT ON CHANGE 8

## Digital climate informed advisory services build small farmers' resilience to climate change

Climate change makes the kind of extreme weather events that can decimate crops more frequent and intense in many geographies. Changes in weather patterns also make the spread of some crop diseases more likely. Digital climate-informed advisory services (DCAS) can build small farmers' resilience to such potential calamities. These early warning systems provide farmers and governments with advance information about bad weather, pests and diseases, giving them more time to prepare. Data from around 50 projects in Africa suggests that DCAS there have resulted in productivity gains ranging from 23 to 168 percent and increased incomes by 30 to 57 percent (Ferdinand et al. 2021).

A new early warning system in Nepal and Bangladesh shows how DCAS work. The system uses weather information, field surveillance data and disease modeling to give farmers regular updates on their future risk from fungal wheat diseases, such as wheat blast or wheat rust. These are highly damaging to crops and can spread quickly across large distances. Advance warning gives farmers time to apply fungicide to the parts of their crop most at risk from disease. The risk updates and accompanying advice go first to expert advisory groups, comprising national farming bodies like the Nepal Agricultural Research Council and Bangladesh Wheat and Maize Research Institute. These disseminate the updates in their countries using SMS, radio and other channels. By 2022, over 500,000 farmers were receiving information directly from the service and passing it on to other farmers (Ogoi et al. 2022).

More than 300 million small farmers worldwide have limited or no access to DCAS, according to estimates. Getting DCAS to all of them would greatly boost their resilience to the risks of climate change and associated disruption to local food supplies. It needs significant investment (Ferdinand et al. 2021).

*Sources: Ferdinand et al. 2021; Ogoi et al. 2022.*

essential digital infrastructure as well as access to electric power for those small farmers who still lack electricity (Goedde et al. 2021).

**Integrating small producers into modern value chains** through improved digital information systems. These extend small producers' access to markets and affordable inputs by improving links between farmers and processors, reducing post-harvest losses, tracking provenance, and improving access to cheap credit and crop insurance (USAID 2017). Their further integration into modern value chains will depend on institutional innovations, such as aggregating and contract farming. For instance, small producers can increase their power in input and output markets by aggregating in cooperatives or farm clusters. These give them competitive scale in inspection, packaging, food safety regimes and quality management. They also give farmers access to agricultural inputs at lower costs and to microfinance, thanks to economies of scale, as well as facilitating knowledge sharing among members (Rosegrant 2023).

**Developing clean cold chains to reduce post-harvest losses** by scaling efficient, zero-emission cooling technologies. These include the "Dearman engine" a novel cooling unit for delivery trucks that could replace traditional diesel-powered systems, and adopting the "Cold economy" concept across cold chains. This concept calls for innovations in both technology and business models to exploit the vast potential to improve cold chain efficiency that lies in using "waste" or surplus energy and coldness to produce liquid air or liquid nitrogen for storage (Center for Sustainable Cooling 2020).

**Supporting the shift to healthier and more sustainable diets.** "Gamifying" for consumers the tasks of improving their diets and nutritional knowledge and choosing sustainably-produced food is one option. "Gamifying" means using applications, programs and services with game-based elements, such as interactive challenges, rewards and progress tracking, to encourage consumers to change their behaviour (Suleiman-Martos et al. 2021). Another option is to motivate investment in supply chains for alternative foods, such as fermentation-derived microbial proteins (Humpenoeder et al. 2022; Linder 2019). For instance, the Danish plant-based food fund is incentivizing the supply chain investments needed to provide "planetary health diets" at scale and make high-quality, sustainable alternative proteins more accessible, complementing private investment in meat substitutes, which is already quite substantial (Fesenfeld 2024).

**Smart scaling of critical innovations.** To diffuse useful technologies at speed across food systems, institutional innovations will be just as important as the new technologies. Policymakers need to pay attention to both, as the experience of the Green Revolution illustrates. The new agricultural technologies this revolution introduced would probably not have spread without their accompanying package of targeted policies and sociocultural accelerators. These provided the rural infrastructure, agricultural extension services and secure land tenure that made it possible for farmers to grow the new cereal seeds. They were tailored to mobilize all the actors and interests involved in adopting a new way of producing cereals, ranging from farmers, input suppliers and wholesalers to researchers and governments. Policymakers today need to tailor similarly innovative socio-technical policy bundles to particular food systems, in all their social complexity, to increase the chances of new technologies leading to beneficial change at scale. The bundle of policies being used to combat micronutrient deficiencies offer a contemporary example of this approach (Barrett et al. 2020b; Spotlight on Change 9).

## Investment

Chapter 3 presented FSEC's estimates of the costs of implementing a global food system transformation. While public investment is needed to finance some of those costs directly, public policy and spending can also support additional investment in and implementation of the food system transformation by acting as an enabler, a catalyst and a stabilizer.

SPOTLIGHT ON CHANGE 9

## Scaling innovation

**Lessons to be learned from the development and diffusion of biofortified sweet potatoes**

Biofortifcation is the process of selective breeding to improve a crop's nutritional content. Getting biofortified crop varieties to malnourished rural populations is a cost-effective way to diversify and improve their diets since these populations generally have limited access to food supplements and commercially fortified foods. One successful example of this approach is the development and dissemination of biofortified pro-vitamin A varieties of orange-fleshed sweet potatoes undertaken by the International Potato Center (CIP) and its partners.

The initiative had five phases: from 1991 to 1996 the new idea emerged; its potential was then proved to the nutrition community between 1997 and 2005; then the possibility of scaling the idea cost-effectively was evaluated between 2006 and 2009; from 2010 to 2014, significant investment went into research to address breeding and other bottlenecks and to launch the Sweet potato for Profit and Health Initiative (SPHI); lastly, the new varieties of biofortified sweet potatoes were disseminated at scale to rural populations across Africa and South Asia from 2015 to mid-2019.

Intensive piloting of the new varieties on farms and rigorous biomedical research demonstrating their nutritional efficacy were both key to the success of the whole process.

CIP's collaboration with national sweet potato breeding programs accelerated breeding for biofortification and helped to develop more than 100 pro-vitamin A varieties adapted to local agro-ecologies and consumer preferences. CIP and its partners followed an integrated "agriculture-marketing-nutrition" approach, combining innovations in seed quality and nutrition management technologies with partnerships in marketing and food processing to boost acceptance of the orange-fleshed sweet potato in Africa and South Asia and speed its dissemination. This approach was supported by an array of integrated activities. Planting material, gender-responsive agronomic training and nutrition education were all distributed through health programs and schools. Raised awareness of the importance of diversified diets boosted consumption of orange-fleshed sweet potatoes, benefiting families at risk of vitamin A deficiency. Promotional campaigns, cooking classes, and increased use of sweet potato in processed food products continued to raise demand, consumption and the market returns to growing sweet potatoes, inspiring more farmers to cultivate the crop. Over 6.8 million households in Africa and South Asia now grow and consume vitamin-A-rich sweet potatoes, making their development and dissemination an object lesson in how to scale innovation using the power of policy bundling.

*Source: Low & Thiele, 2020*

**Public investment as an enabler.** Changes in food systems are influenced by developments well outside them (see Chapter 2). A food system transformation is much more likely to attract investment in an environment that enables equitable growth, and public policy and related public investment is critical to creating such an environment. Macroeconomic stability is one essential element, in part because it fosters private investment. Another is the market and physical infrastructure that allows actors in all segments of a food system to respond to new incentives and take advantage of new opportunities. Growing evidence that once basic infrastructure, such as roads and an electricity supply, is in place the middle segment of food supply chains develops rapidly reinforces this point (Reardon 2015). So do advances in digital service delivery within and outside agriculture. Guaranteed property rights can have a similarly galvanizing effect on change (Post et al. 2021). Another crucial but often neglected activity in need of public investment is building the capacities required to implement a food system transformation at all levels of government.

**Public investment as a catalyst.** Public funding can catalyse private investment through public private partnerships (PPPs), by providing an accelerator or an incubator for innovations, or by using blended finance instruments to de-risk private investment in food system projects.

Public-private partnerships in food systems combine the resources of public and private bodies to reach a specified objective, often in a particular locality. Typical objectives for such PPPs are to develop agricultural value chains, promote the uptake of agricultural innovations and technology, build and upgrade market infrastructure, and to provide business development services to farmers and small enterprises (FAO 2016). There are concerns that PPPs can increase the already large influence of corporations on food systems. However, PPPs also augment limited public resources for improving operational efficiencies and reducing costs, especially when they are designed to be fully transparent, accountable and trustworthy (Fanzo et al. 2020). Private partners in PPPs provide capital, technical expertise and know-how. Public partners can act as catalysts by providing complementary investment, access to land, research or extension services, and enabling regulations such as environmental standards which provide a level playing field for competing businesses (Obayelu 2018; Dunning et al. 2015).

Business accelerator and incubator programs help innovations to scale by providing start-up developers with guidance, financial and technical support, and access to networks. Such programs typically concentrate on specific types of innovation or purpose. Several focus on supporting ‘impact-oriented entrepreneurs’ in food systems in ventures that could improve food security and environmental sustainability. Accelerator and incubator programs have been launched by both private food companies and public actors. They offer opportunities to align private innovation and market development with public policy goals (Newell et al. 2021).

Finally, public investment can catalyse private finance for food system projects through blended finance instruments. Blended finance is the term used for a combination of public and/or philanthropic and private capital in a project where the public or philanthropic element bears a sufficient proportion of the project’s risk to make it "investable" for commercial private investors who would otherwise not have participated. Typical blended finance instruments are tailored to mitigate risks arising from project-specific technical, institutional, political, demand/off-take, operational, currency or liquidity issues. They are especially useful for projects in their early stages to help make them attractive investment opportunities. Instruments used in blended finance packages include public or philanthropic grants and technical assistance as a precursor to investment; impact investment, various debt and equity instruments; and first-loss capital and guarantees (Bove et al. 2023). To succeed, blended finance instruments must include strong accountability mechanisms.

**Public investment as a stabilizer.** Food system transformations can put private companies’ assets at risk of becoming stranded. Rapid implementation of new regulatory norms, such as the recent nitrogen regulations in several countries in Europe, or arrival at consumption tipping points (as may now be the case with consumption of plant-rich diets), can suddenly turn production assets into liabilities. If several companies decide to wind down obsolescent production plants at the same time, a sudden unanticipated gap in essential supply may open up before it can be filled by new producers (Jain & Palacios 2023). Public investment can help to stabilize such transitional shocks in a number of ways. For example, it may support development of optimal pathways for retiring specific assets and expanding their substitutes to guide investment and retirement decisions in highly capital-intensive areas of food

systems such as fertilizer production.

Public funds could speed the diffusion of innovations by financing schemes for getting rid of obsolete machinery and owning or renting new, environmentally sustainable equipment, such as no-till machinery, or precision fertilizer applicators. Public investment may also fund the retraining, redeployment and general support of workers displaced by innovations.

## Applying an inclusion lens to food system transformation

Transforming food systems to make them more inclusive is a matter not only of social justice but also necessity: 3.8 billion people's livelihoods depend on food systems (Davis et al. 2023) and their opposition to reforms can easily slow down or halt progress. This report highlights the pervasiveness of trade-offs between different transformation objectives and the interests of more vulnerable and marginalized groups. Making sure new opportunities from food system transformation are inclusive is a constant challenge and one central to FSEC's approach to transformation strategy design.

To address this challenge, policymakers need to examine the design of their food system transformation strategies through an inclusion lens. They can apply this lens to; their choice of policy instruments and strategy design, to ensure these minimize negative effects and maximize benefits for lower income groups; the combination of policies in policy bundles, to check that these include sufficient compensation for any negative effects on the most vulnerable including on food affordability; any measures that take effect beyond food systems, to be sure these help the poorest and most disadvantaged groups to access new opportunities.

**Choosing policy instruments and design through an inclusion lens.** The choice of incentives, innovations and investments in a food system strategy needs to prioritize the needs of marginalized and lower income groups. To this end, public research can focus on the development or diffusion of new practices that will benefit small producers while improving environmental outcomes or the nutritional content of food; new incentive schemes can be combined with information strategies tailored to the cognitive and behavioral characteristics of small-scale farmers so these groups get the full benefit; and policy can favor production models that rebalance market power disparities in value chains (Pilditch et al. 2023).

Policy design can also explicitly promote inclusion. For instance, the energy transition strategy in Canada distributes rebates from its carbon tax scheme disproportionately to lower-income groups (Environment Journal 2023). Such a bias towards the poorest does not necessarily disadvantage other income groups. Modeling shows that if a similar carbon tax and rebate approach was adopted in Latin America, targeting resources to the poorest groups would absorb only one third of the total revenue raised, leaving the other two thirds to be spent on public goods which could also benefit the rest of the population (Feng et al. 2018).

**Compensating poor and marginalized groups for any negative effects of policies.** Transformation strategies need policies promoting a broad set of objectives, including changing how food is produced and distributed, shifting food consumption towards healthy diets, and supporting food system actors in adapting to change. Trade-offs between these objectives and the interests of poor and marginalized groups are pervasive. Policies that have negative effects on poor and marginalized groups, in terms of incomes, jobs, or food affordability, call for complementary compensating policies in comprehensive, policy bundles (Gatto et al. 2023; Willenbockel 2023).

One set of simulations conducted for FSEC models the effects of carrying out a basic set of food system transformation interventions[6] uniformly across the globe. This shows that trade-offs between different food system transformation objectives and the interests of vulnerable groups vary depending on local contexts. The analysis illustrates the need to tailor short-term social protection measures, such as transfers or subsidies, to certain income groups or demographic cohorts and their local circumstances.

The simulated policies have different effects in different food system settings. Price interventions are less effective in shifting consumers towards healthy diets in more industrialized settings, where demand is less responsive to prices. In these contexts, price incentives need to be complemented by non-price measures to accomplish substantial changes in behaviour of consumers and producers. By the same token, the need for targeted compensation is lessened in these settings because of the limited effects of the price interventions on consumers. However, in more traditional food systems, there is a risk that the same price policies have negative effects on nutrition as demand for food will be more responsive to prices. In these settings, targeted income support for low-income households and subsidies on staples are needed alongside the new price policy to maintain and improve nutrition (Kuiper et al. 2022).

In the medium term, new jobs arising from a food system transformation will be central to its delivery of inclusive outcomes. As discussed in Chapter 2, transforming food systems is likely to amplify the ongoing structural economic transformation, particularly in lower income regions where this transformation is less advanced (FSEC Africa Brief). Specific interventions may be called for where significant and localized job losses occur, for instance when a production plant becomes obsolete and closes. In locations at risk, job guarantees, or priority placements could be effective off-setting measures. Relevant public bodies need to engage with the local community to plan and provide services before and after a plant closure, coordinating multiple stakeholders and agencies in drawing up the plans. Additional research is needed to identify how opportunities can be created in settings where vast numbers of people work in the informal food economy.

**Taking complementary measures beyond food systems to make sure poor and disadvantaged groups can access new opportunities.** These measures are essential because of the impact of the food system transformation on jobs. While new employment opportunities for displaced farm workers are

6 The policy bundle includes subsidies on fruit and vegetables financed by a tax on non-perishable food items; a carbon tax to reduce GHG emissions from the food system; and subsidies on low-skilled labor in agriculture.

likely to open up downstream in food systems, or in labor-intensive nature-based food system projects, interventions are needed to create additional employment opportunities for displaced workers within and beyond food systems.

Investments in infrastructure and skill development, together with innovation, can help to change practices within the agricultural part of food systems and develop new income opportunities. Measures to secure property and tenurial rights, which reinforce livelihoods by giving rightsholders an incentive to invest in their land, can have the same effects. They encourage the diffusion of innovations and uptake of farming practices with longer term environmental and health benefits rather than less beneficial practices with immediate returns, such as burning forest to gain land for cultivation. Addressing land rights insecurity can also significantly empower women (see Spotlight on Change 2 in the introduction to this report). More broad-based measures within and beyond food systems are needed as well. These include investment in human and infrastructural capital, so less advantaged actors in food systems can access new livelihood options, and adequate transfers to the poor to mitigate any negative impacts of the transformation on them, as described above.

BOX 4.1

### The three policy levers of Incentives and regulation, Innovation and Investment to transform food systems: an application to strategies to tackle obesity

This chapter presents the policy levers for a food system transformation in terms of a “Three I's policy framework” focused on Incentives and regulation, Innovation and Investment, complemented by an Inclusion lens.

This box offers an application of this framework to identify the constituent elements of a strategy to tackle obesity, based on existing evidence.

**Incentives and regulation:** Taxes and subsidies that make unhealthy products more expensive and healthier ones cheaper can significantly alter consumption patterns (Powell et al. 2012; Willenbockel 2023). For maximum effect, governments would need to harmonize their health-promoting taxes on sugar-sweetened beverages, alcohol and tobacco across countries (WHO 2015; Thow et al. 2022), drawing on policy learning (WCRF 2023). They should also consider taxing ultra-processed foods (Finkelstein et al. 2014; Leicester & Windmeijer 2004; Barnhill et al. 2018). And they might want to redirect agricultural subsidies towards healthy high-fiber and high-protein crops, like fruits, vegetables and nuts, to increase supply and lower prices (Springmann & Freund 2022; Franck et al. 2013).

Strict regulation of food marketing also changes consumption patterns (Boyland et al. 2016; Smith et al. 2019). To complement such regulation, food companies should spend more on marketing healthier foods (Kraak et al. 2019).

Behavioural incentives can work too. These include changing the menu and placement of foods in school, work and community canteens to make healthy foods more available and attractive (Bucher et al. 2016; Deliens et al. 2016; Roy et al. 2015; Mikkelsen et al. 2021; Arno & Thomas 2016; Nugent et al. 2023; Acker e.V. 2022). Digital health apps successfully use behavioral “nudges” and also “gamification” to encourage people to eat better and exercise more (Patel et al. 2017).

**Innovation:** Evidence suggests governments need to back R&D on reformulated foods that are both nutritious and palatable (Gressier et al. 2020; Onyeaka et al. 2023). They might also want to support the discovery of additional anti-obesity drugs to increase the range available and bring down prices (Levi et al. 2023). Research on the effects of school- and community- programs to prevent obesity needs funding as well (Mazzucca et al. 2021).

BOX 4.1

**The three policy levers of Incentives and regulation, Innovation and Investment to transform food systems: an application to strategies to tackle obesity**

**Investment:** Fighting obesity calls for a broad range of intervention, including interventions outside of food systems. Urban planning and urban infrastructure can support healthier lifestyles and weight loss. One study in Chennai, India, found that living in a neighbourhood where walking was impractical made inhabitants 1.8 times more prone to overweight or obesity (Adlakha et al. 2020). So investing in urban infrastructure that encourages walking makes sense (Howell & Booth. 2022; Buregeya et al. 2019). Women or other minorities in cultures that limit their movement in public need targeted initiatives, such as group exercise programs (Adlakha et al. 2020) or dedicated spaces for physical activity (Danielli et al. 2021; Bouch et al. 2011). Introducing exercise spaces to communities in Massachusetts brought overweight and obesity down almost 30 percent below the level seen in communities without them (Economos et al. 2013). European cities have applied bundles of interventions to reduce car travel in urban centers. These include reducing speed limits to 30 km/h, making public transportation free (and adding new routes), doubling the density of bicycle lanes, providing vouchers for the purchase of electric bicycles, requiring advertisement for both cars and fast food to include disclaimers that physical mobility is good for health, complemented by public service announcements on the increased safety, air quality, and environmental impact of pedestrian and bicycle transportation. Shifting food environments to more dispersed, neighbourhood stores, rather than concentrated big-box stores further combines physical mobility, with increased access to healthy foods.

*Sources: Powell et al. 2012; WHO 2015; Thow et al. 2022; Finkelstein et al. 2014, Leicester & Windmeijer 2004; Barnhill et al. 2018; Springmann & Freund 2022; Franck et al. 2013; Boyland et al. 2016; Smith et al. 2019; Kraak et al. 2019; Bucher et al. 2016; Deliens et al. 2016; Roy et al. 2015; Mikkelsen et al. 2021; Arno & Thomas 2016, Nugent et al. 2023; Patel et al. 2017; Gressier et al. 2020; Onyeaka et al. 2023; Levi et al. 2023; Mazzucca et al. 2021; Adlakha et al. 2020; Howell & Booth, 2022; Buregeya et al. 2019; Danielli et al. 2021; Bouch et al. 2011; Economos et al. 2013; WCRF 2023; Acker e.V. 2022; Willenbockel 2023*


# Chapter 5
# Designing Strategies to Make Change Happen: Negotiating Interests, Institutions, and Ideas

# Chapter 5

→ Transforming food systems will give rise to unavoidable tensions among potential winners and losers. Such tensions are shaped by the different interests, institutions and ideas and information characterizing food systems.

→ The concentration of power among few market players in the food system, the close connections with other parts of the economy, and governments' direct interests in food systems heavily shape the political economy of a food system transformation.

→ The political feasibility of transformation strategies can be bolstered by: building coalitions of stakeholders; establishing new governance arrangements that facilitate balanced stakeholder representation and policy coherence; shaping narratives and providing information; calibrating policies to gain acceptance from key stakeholders; and holding governments and businesses to account for progress.

## Introduction

Transforming food systems offers significant benefits but will also give rise to unavoidable tensions among potential winners and losers. These tensions are intrinsic to the political economy[1] of food system transformation. Concerns over food price rises or job losses can paralyse reforms if left unaddressed. This chapter explores how the design of transformation strategies can manage these tensions and identify policy bundles that are not only effective and appropriate for the local context but also politically feasible.

This chapter describes the political economy of food systems in general in terms of the interests of their constituent groups; the institutions including organizations, rules and processes which shape them; and the ideas and information surrounding potential changes, which also shape different interest groups' responses. It then sets out particular food systems features that make their political economy so complex. Despite this complexity, evidence from successful efforts to change food systems suggests that including five distinct elements in the process can increase their political feasibility, making transformative change achievable. These elements are detailed in the chapter's final section.

## Interests, institutions and ideas shape the political economy of food systems

To explain the general nature of the political economy of food systems, this section draws on the so-called "Three I's framework" presented in Vos et al. (2022), comprising interests, institutions and ideas and information.

### Interests

Economic and technical considerations may dominate the content of food system policies, but the

1 Political Economy is an analytical approach that focuses on agency, power relations, and institutional structures. The concept is used to analyse the interaction of political and economic processes by primarily looking at the interests and constellations of relevant actors, the power relations between them, the structures and institutions that influence these relationships, the resulting inequalities, and how these dynamics change (Duncan et al. 2019; de Schutter 2019; Swinnen 2018).

process of policymaking is also heavily influenced by the interests of actors who stand to gain or lose from potential changes. Depending on whether they are winners or losers from a given policy or program, they are likely to mobilize to support or hamper its adoption and implementation (Vos et al. 2022).

Potential losers can stymie progress by exerting direct influence over policy decisions. They may also exert indirect influence, for example, by funding research that shapes discussion of the policy and/or public outreach that communicates a specific framing of food system reform to stakeholders. Different stakeholder groups whose interests on certain policies intersect tend to form coalitions that conduct collective lobbying to halt policy interventions or spur them on. These coalitions are not static: the same actors may join forces with members of different interest groups along food value chains depending on the issue (Swinnen 2018).

The degree of stakeholder mobilization for or against a proposed change depends on the anticipated distribution of its benefits and costs among the stakeholders it affects, the concentration of those benefits and costs among particular interest groups, and the groups' ability to coordinate action. Policy changes that lead to diffused benefits and concentrated costs are less likely to succeed. For example, policies to reduce dependence on animal-sourced food in regions where these are over-consumed offer large benefits in terms of health and the environment to whole populations but relatively small perceived benefits to individuals. They would also lead to high costs for global food processors. Although a relatively small group, global food processors are likely to mobilize strongly against such policies, while their myriad beneficiaries are less likely to mobilize in favor of them because they perceive the net personal benefits as too small.  Similarly, dairy and sugar industries, which often comprise small groups of closely coordinated processing firms, have historically achieved high levels of political support in contrast to the vegetable industry, which comprises large numbers of smaller firms and farmers who are more geographically spread out (Cerrutti et al. 2022; Vos et al. 2022).

## Institutions

Institutions[2] shape how reform policies are designed and implemented. They also mediate the influence of interest groups on policymaking. The scope for actors to influence political processes depends on the nature of the relevant institutions, such as prevailing forms of decision-making, political participation, and financing rules. Changes in any of these factors can change the pace and character of reform.

For instance, in Europe, the 2001 Treaty of Nice introduced majority voting on decisions concerning the European Union Common Agricultural Policy. By removing the veto power of countries opposed to agricultural policy reforms, this institutional change ushered in an era of major reform (Swinnen 2018). Institutional change can also spur broader policy changes. After accession to the World Trade Organization, many countries have shifted away from using market-distorting agricultural subsidies in favor of "green box" direct income transfers that do not distort markets (Swinnen 2018).

## Ideas and information

Ideas, including economic theories, narratives, norms and beliefs, also shape interests and policy preferences (Campbell 1998). In food systems, social attitudes towards different types of food production and consumption are highly influential. For example, emerging public concern regarding modern slavery in food systems or the environmental impacts of food systems have recently been important in driving policy change (Cerrutti et al. 2022). Similarly, the formerly prevailing idea that food security depended on food self-sufficiency had far-reaching impacts on policies shaping food systems. In particular, many low-income countries focused their agricultural policies on subsidizing fertilizer and also on protecting home markets. For some, the resulting isolation from trade led to

2 Institutions describe the rules and processes according to which changes are negotiated, as well as the arenas where these negotiations take place. Examples are political regime types, established decision-making processes, forms of political participation, the characteristics of governmental agencies or international organizations, and international agreements (Cerrutti et al. 2022).

high food costs and volatile prices (Vos et al. 2022).

In the US and Germany, the growing media debate about meat consumption and meat substitutes over the past ten years has been changing the policy environment: statements favoring plant-based foods and meat substitutes have become more prominent in the media, as have links between meat consumption and climate change, human health and animal welfare. And ideas can change quickly: during the peak of the COVID-19 pandemic, bad working conditions, pandemics, and epizootic diseases became prevalent in framing public discourse on meat consumption (Fesenfeld 2024).

Information about the impacts of policies in general and on the most vulnerable stakeholders in particular can shape the public perception of reforms, depending on the credibility of the information's source and on its diffusion (Dechezlepretre et al. 2022). For instance, in experiments in China, Germany, and the US, Fesenfeld & Sun (2023) found that providing information on the benefits of policies to transform food systems and reduce meat consumption compared to their costs can significantly increase public support for ambitious policies on food systems and meat consumption (see also Spotlight on Change 10).

SPOTLIGHT ON CHANGE 10

## Ideas have been powerful drivers of the dramatic drop in consumption of trans-fatty acids

Consumption of trans-fatty acids (TFA) is linked to an increased risk of cardiovascular disease. Worldwide, more than 500,000 deaths were attributed to TFA consumption in 2010 (WHO 2021) and in the US it causes one in five heart attacks (Amico et al, 2021). For this reason, in 2018 the WHO called on governments to remove TFA from the global food supply by 2023. National policies adopted in response include calls for voluntary bans, mandatory labelling, limits on TFA in restaurants, and mandatory TFA bans. The latter have been particularly effective in cutting out TFA and greatly reducing the risk of diet-related disease – especially among the most vulnerable socioeconomic groups (Downs et al. 2017). For instance, Denmark's ban on industrial TFA accounted for 11% of its total fall in coronary heart disease deaths between 1991 and 2007, with the most deprived groups benefitting the most (Bjoernsbo et al. 2022). In the US, the Food and Drug Administration banned the use of partially hydrogenated oil – the primary origin of artificial TFA – in 2018 (Amico et al. 2021).

The widespread acceptance of these successful policies was driven by changes in social attitudes and public narratives about TFA. Two factors made people change their minds: the expanding body of scientific evidence of the health risks of TFA and the persistence of scientists and advocacy organizations in raising awareness of these risks (Amico et al. 2021). Forward-thinking food companies helped defuse opposition in their industry by voluntarily reducing TFA in their products and demonstrating that it was feasible to replace it with healthier substitutes (Amico et al. 2021). Careful policy sequencing also helped, as in the US, where a gradual introduction of TFA labelling rules in the early 2000s followed by state and local limits on TFA prepared the ground for the 2018 national ban.

*Sources: Amico et al. 2021; Bjoernsbo et al. 2022; Downs et al. 2017; WHO 2021.*

## What is special about the political economy of food systems

Interests, institutions, and ideas and their interactions are relevant in analysis of system change in general. In the case of food system change, interactions between these three I's are subject to three particular features: the concentration of power over food systems among large corporations, the close links between food and other systems, both economic and political, and the role of governments in shaping food systems through regulation and incentives.

### Concentration of power to shape food systems

Food is a universal need and concern, but the power to shape food systems is paradoxically highly concentrated. An estimated 3.8 billion people worldwide depend on agri-food systems for their livelihoods (Davis et al. 2023), either in production or further along the complex and diverse value chains of the world's food industries. In contrast, a few large corporations control key segments of food systems. For example, over 60 percent of the international agrochemical market is controlled by just four firms (Global Agriculture 2022), while four other corporations have controlled over 70 percent of the global grain market for decades (Clapp 2023).

Market concentration per se cannot conclusively be linked to market power, narrowly defined as the ability to influence prices. But large actors can mobilize and lobby against regulation and they can shape the relationships between food buyers and suppliers. Increased market concentration has also strengthened the significance of private governance arrangements. For instance, a change in the sourcing policy of a big player may become de facto standard across the sector and influence both upstream production and downstream markets (Hernández et al. 2023; de Schutter 2019). Corporations' ability to exert power is also closely related to their ability to coordinate action in coalition with other companies who share their interests.

The power of corporations and the nature of institutions are often intertwined. While institutions can affect the level of concentration in a market and, therefore, the distribution of power in food systems, in markets that are already concentrated, the resulting corporate power can also shape institutions.

Despite the concentrated nature of power in food systems, a growing number of diverse interests are emerging. Topics of policy debates concerning food have shifted beyond food security to embrace nutrition, health, profits, job security, and environmental protection as well (Selnes 2023; Vos et al. 2022). An increasing plurality of interest groups is seen in both national and international food policy forums. National governments, transnational NGOs, corporations, business associations, trade unions, and banking and investment institutions are all pursuing their particular interests with regard to global trade and food system governance.

### Close connections with other systems

Close connections between food and other systems, both economic and political, yield opportunities for actors in different systems but with similar interests to influence policy. Such links are particularly strong between food systems and the energy sector. For example, the growth of biofuel demand and supply in various regions has created an opportunity for new political alliances between grain farmers and biofuel industries, but their common interests are at odds with those of livestock farmers, consumers and other sectors hurt by rising feed and food costs (Swinnen 2018). Broader coalitions are also visible. One example from the US is the "iron triangle of food aid" comprising NGOs, agribusinesses, and maritime transport businesses who all benefit from current food aid policies and regulations. These three groups of actors have resisted calls for food aid reform for more than 60 years (Swinnen 2018).

Food systems' close connections to other systems also mean that food system reforms might gain from new ideas, political as well as economic, taking hold in adjacent systems. For example, the introduction of subsidies for producing environmental services on farms (or Payments for Ecosystem Services, see Chapter 4) may have been enabled by the rising importance of sustainable development on the international political agenda after the Rio Earth Summit of 1992 (Cassou et al. 2018). Recent global discussions covering the relationship between food systems, climate change, the environment and public health, such as the United Nations Food Systems Summit and the COP26 on climate change in 2021, have broadened opportunities for repurposing agricultural support (FAO et al. 2022).

## Role of governments and of a complex web of regulatory institutions

Governments are major stakeholders in food systems, even though they rarely produce food directly. Agricultural support is the most common form of policy directed at food systems (Lowder et al. 2022c) with roughly 400 billion USD a year of transfers to producers from public budgets (OECD 2023). Governments also influence food systems through the regulations and other policies discussed in Chapter 4, general business regulations, the public procurement of food, and regulations and incentives governing private investments. In addition, through their international engagement national governments play a part in international food system governance and regulation. For example, European Union food regulation has catalysed the integration of horticultural value chains in Africa and growth in vegetable exports from the continent (Swinnen 2015).

The complex set of interests shaping food systems is mirrored by a complex web of institutions regulating them. The regulation of national food systems is generally carried out by a range of government departments including finance, environment, health, planning, industry, external affairs, and welfare as well as the more obvious agriculture department (Vos et al. 2022). For instance, in England, responsibility for policies affecting food systems is held by as many as 16 key government departments and public bodies (Parsons 2021). On the international level, food systems are ostensibly shaped by a complex global governance architecture. But this highly fragmented arrangement lacks the capacity to address some of the most urgent issues. Despite international statements on the right to adequate food for all, international institutions have yet to prioritize and implement principles of global fairness and equity that would address imbalances in states' capacity to manage crises, improve livelihoods, ensure food security, and make the transformation of food systems inclusive (Ocampo et al. 2022). Their fragmentation impedes coordination between international institutions, reducing their effectiveness and efficiency. For example, there are still multiple international arrangements and agreements on food aid, with separate rules, reporting mechanisms and norms, and little coherence between them (Ocampo et al. 2022).

In addition, while no single international treaty regulates food systems per se, food systems directly affect the international community's capacity to achieve the global conventions. The Paris Climate Agreement cannot be achieved without transforming food systems, which currently produce about a third of global GHG emissions (Crippa et al. 2021). Similarly, the Global Biodiversity Framework and its recently approved Kunming-Montreal Convention on Biodiversity include multiple targets that cannot be met without a worldwide transformation of food systems.[3]

## Designing politically feasible food system transformation strategies

Understanding the interests, institutions and ideas shaping a particular food system gives policymakers and food system stakeholders a better chance of designing transformation strategies that are embraced by their key actors and successfully implemented. Acknowledging the importance of that understanding, we suggest five elements to include in designing food system transformation strategies: building coalitions of stakeholders; establishing new governance arrangements that facilitate balanced stakeholder representation and policy coherence; shaping narratives and providing information; calibrating policies to gain acceptance from key stakeholders; and holding governments and businesses to account for progress. By influencing the nature and distribution of interests, ideas and

3 Including Target 1, which calls for halting the conversion of remaining wilderness areas and intact lands, Target 10 on sustainable production and scaling of biodiversity friendly production practices, Target 7 on reducing pollution from nutrients and pesticides; Target 16 calling for sustainable consumption, and Target 18 which aims to eliminate subsidies harmful for biodiversity, and reducing them by at least 500 billion USD per year by 2030.

institutions in food systems, these elements help to produce politically feasible policy choices (Vos et al. 2022; Resnick & Swinnen 2023).

**Building coalitions of stakeholders.** Policy changes generate winners who are likely to support them and losers who will oppose them. So it makes sense to identify winners from proposed changes to food systems, make them aware of what they stand to gain, and mobilize their support. For instance, underscoring the intended public benefits of a diet shift, such as better child health and lives saved by healthier diets, can help build constituencies for reform. Indeed, broad-based, multi-stakeholder coalitions to challenge corporate power were instrumental in persuading governments across Latin America to raise taxes on sugars despite corporate lobbying (Colchero et al. 2016). It also makes sense to create more winners, if possible. This might entail offering compensation to losers, or investing in new opportunities that would benefit them.

Case studies from China, the US, the EU, Israel, and Singapore demonstrate that NGOs and "green business" entrepreneurs have formed coalitions to push for policies fostering the sustainable practices and product alternatives along the food supply chain which both groups want. Highlighting new business opportunities arising from innovations such as cultivated meat, regenerative agriculture and agri-photovoltaics can shift perceptions of the innovations among interests vested in the status quo from "certain cost" to "potential benefit" (Fesenfeld 2024). Concrete incentives to turn losers into winners can help. For instance, financial measures such as the "Danish Fund for Plant-based Foods" that supports farmers and businesses in the transition to plant-based production, support for R&D on plant-based foods, and lower VAT on plant-based products could all build support for a shift to lower meat consumption. Such incentives not only create new business opportunities. They can also generate new interest groups and change beliefs about the costs and benefits of the shift (Fesenfeld 2024).

Reframing narratives to highlight a commonality of interests among groups hitherto agnostic to a change, may also help to create new coalitions for the change. The harnessing of major faith denominations to the cause of climate change by highlighting the planetary stewardship role given to humankind in religious texts offers a powerful example. Similarly, identifying the impacts of food systems on a broad variety of outcomes can help mobilize constituencies interested in only a subset of those outcomes. Finally, advocacy to increase the visibility of diffused costs and benefits can increase the ranks of those who feel they have a stake in the transformation of food systems and help to coordinate diverse stakeholders.

**Establishing new food system governance arrangements to balance stakeholder representation and ensure policy coherence.** Institutional barriers to change will be different in different food systems but two are likely to be present in most. The first is the imbalance of power over food systems among stakeholders. This imbalance has been instrumental in shaping food systems that optimize the production of calories at lowest cost without taking the resulting costs to health and the environment into account.

New food system governance arrangements that facilitate inclusive political consultation can help challenge this paradigm. New governance bodies should comprise multiple interest groups, be independently moderated and base their deliberations on evidence. Ideally, such bodies would be given formal responsibilities by national parliaments so they have long-term legitimacy beyond electoral cycles (Fesenfeld et al. 2023). The Food System Dialogues of the UNFSS have added a richness of perspectives on food systems to UN deliberations that similar national bodies could contribute to the design of national food strategies. Similarly, the creation of a broad-based coordination forum to revive the fortunes of cocoa production in Liberia enabled coordinated action among its members against disruptive changes to export regulation in the country (Kazadi 2022).

The second ubiquitous barrier to change in food systems is the general lack of coherence in policies affecting them because of the fragmentation of food system governance. New governance arrangements are needed that facilitate thinking across traditional silos, a shared understanding of the many interlinked challenges, and the provision of the capacities needed to implement reform policies. Such arrangements can take different forms, e.g., cross-government food-themed working groups, overarching food policy strategies, dedicated food policy bodies, or even "Super-Ministries" that combine multiple policy sectors (Parsons 2022). Their performance can be enhanced by independent monitoring bodies set up to evaluate policy progress and make evidence-based suggestions for policy reforms (Fesenfeld et al. 2023) (see Spotlight on Change 11).

**Shaping narratives and providing information.** Information about the costs of the status quo and the benefits of reform can catalyse action (see Spotlight on Change 12).

Information about the expected impact of a policy can similarly change perceptions of its worth. Experimental evidence has shown that support for a climate policy increases when respondents perceive that the policy is effective in reducing emissions, does not adversely affect lower-income households' costs of living and does not hurt the respondent's household financially (Dechezlepretre et al. 2022). This suggests that strategic communication about a food system transformation that highlights its effects on the interests of current and future system stakeholders is crucial to winning support for the transformation. Ensuring that the dynamic benefits of the transformation are broadly communicated can unlock opportunities for dialogue. For example, in discussions of crop diversification, more attention can be paid to how this helps to diversify income sources and make farmers more resilient.

**Calibrating policies to gain acceptance from key stakeholders.** The distribution of a policy's costs and benefits can be adjusted to make them accept-

SPOTLIGHT ON CHANGE 11

## Political coordination mechanisms for food system change

**Recent examples from Uganda and Vietnam**

Both Uganda and Vietnam have recently introduced new governance arrangements to make sure policies affecting their food systems are coordinated and complementary.

Uganda launched its National Food Systems Coordination Committee (NFSCC) in 2022. This is chaired by the Prime Minister's Office and includes representatives from the Ministries and government agencies that cover agriculture, health, water and environment, gender, and local governments. The committee also speaks to food system actors and influencers including farmers, youth leaders, academics, and private businesses. The Committee helps to coordinate the different policy sectors' contributions to transforming Uganda's food system, prevent 'siloed' policymaking and reduce capacity bottlenecks. It has undertaken strategic analyses to inform a shared transformation roadmap and action plan and drive implementation of planned measures. It is now establishing reporting mechanisms and indicators to track progress towards the plan's objectives.

The Government of Vietnam has taken a similar approach. In March 2023 it issued a "National Action Plan to establish a Transparent, Responsible and Sustainable Food System in Vietnam until 2030". The plan recognizes that the food system is interdisciplinary, so different ministries and diverse food system actors need to collaborate to transform the system coherently. An intra-governmental partnership coordinates the plan's development and implementation. This partnership, led by the Ministry of Agriculture, comprises the ministries responsible for industry and trade, natural resources and the environment, and health. As in Uganda, the partnership is chaired by the Prime Minister. Its work is supported by collaboration with international partners including UN agencies, NGOs and other national governments, as well as ongoing and wide-ranging dialogue with representatives from local and national civil society and business and industry associations. The plan's main objectives are to shift to more environment-friendly food production, facilitate vibrant rural communities and innovation among farmers and address food loss and food waste.

*Sources: FSEC Governance Brief*

able to key stakeholders. Appropriate compensation mechanisms for losers are one form of adjustment that can be essential to making a food system transformation feasible (see Chapter 4). Similarly, active labor market policies and investment can be harnessed to address the additional farm job losses resulting from the food system transformation.

To win wider support for a reform policy, links between the policy and the compensation also need to be clearly visible to all and compensation itself readily accessible to those eligible. Experiments in China, Germany, and US show that a majority of people support demand-side food policies that will add to living costs (e.g., higher taxes on meat) if they are combined with targeted compensation policies (e.g., discounts for fresh or minimally processed whole foods, plant-based alternatives and meat substitutes) and supply-side regulations (e.g., higher animal-welfare standards) (Fesenfeld et al. 2020). Canada's decision to reward lower carbon emissions with a simple cheque instead of income tax rebates is one example of a highly visible compensation strategy (Government of Canada 2021).

Other policy design features may also help to make measures more widely acceptable (Box 5.1). In regulating emissions, policies that give stakeholders flexibility, such as emissions quotas, allow stakeholders to identify solutions that are lowest-cost for them. In addition, when incentives are changed by new taxes or other fiscal measures, like reductions in subsidies, spending the revenues gained directly on interventions that command broad support, such as the provision of public R&D, can help to make the fiscal changes more acceptable. For example, Bolivia finances its healthy school meal programs from a tax on hydrocarbons, converting natural capital into human capital (The Education Commission 2022). In the same vein, policies that offer financial benefits to those who take up desirable practices–through conditionality or subsidies–are more likely to be accepted than taxes and mandatory regulations.

Both in China and the EU, recent agricultural policy reforms have been accompanied by such benefits for shifting to more environment-friendly practices instead of penalties for failing to. The Chinese government introduced subsidies to promote the use of organic fertilizers instead of chemical fertilizers and pesticides. EU reforms under the

SPOTLIGHT ON CHANGE 12

## The role of stakeholder coalitions in the adoption and development of Brazil’s soy moratorium

The Amazon Soy Moratorium was established in 2006 in the wake of a Greenpeace report on the dangers of agricultural encroachment on the rainforest called “Eating up the Amazon”. The moratorium is a voluntary agreement made between a diverse group of signatories to refuse to buy soybeans grown in areas of the Amazon deforested from 2008 onwards. It was drafted by the Soy Working Group (SWG), a forum for dialogue that initially comprised representatives from civil society organizations and from companies affiliated to the Brazilian Association of Vegetable Oil Industries and the National Grain Exporters Association. In 2008, the Brazilian government joined the Soy Working Group, raising it to a new level of influence and paving the way for it to develop effective long-term strategies. Shortly afterwards, the National Institute for Space Research, Banco do Brasil, and the European Soy Consumer Group became members too.

Expansion of the SWG’s membership has gradually enhanced the moratorium’s effectiveness, especially through better monitoring and greater transparency. Advances in land registration, high-resolution mapping and trade data have all boosted compliance. By 2020, 98 percent of land planted with soybeans lay outside the area protected by the moratorium, a measure of its success. The scheme’s impact has prompted new regulatory ideas focused further downstream. For instance, the EU wants to make companies identify the suppliers of all agricultural commodities they purchase.

The moratorium could still improve in some areas. For instance, it has yet not been adopted into Brazil’s national legislation. Deforestation data is still monitored and evaluated by Brazil’s space and environmental agencies alone, which means indigenous groups, the most important stewards of biodiversity in the Amazon, are largely excluded from the monitoring process. This process also does not yet record small-scale land conversions, which in aggregate may cause significant deforestation. That said, the moratorium has already done a great deal to protect the world’s largest tropical rainforest from further encroachment. It shows how much dialogue between diverse stakeholders with a common interest in protecting the environment that supports them all can achieve.

*Source:* *Rausch & Gibbs 2022*

Farm-to-Fork strategy include payments to farmers conditional on them reducing their use of pesticides and fertilizers, shifting to organic farming practices, and adopting new technologies that reduce GHG emissions from agriculture (Vos et al. 2022).

In addition, the technical content of policies must match the capacity of targeted stakeholders to make required technical changes. Transformative policies also need to be sequenced in line with growing support for them won by earlier measures: when the benefits of "softer" policies become visible and stakeholders have had time to adapt, the use of more stringent policy instruments becomes feasible over time. Take the shift to plant-based diets in the EU. Initial policies could establish a targeted EU transition fund for plant-based food (like the Danish Fund for Plant-based Foods described above) to win initial support. This could be followed by a more fundamental reform of the current CAP funding scheme and eventually the introduction of emission pricing schemes and stricter nitrogen regulation (Fesenfeld et al. 2023, Fesenfeld 2024).

**Holding governments and businesses to account for progress.** Finally, transforming food systems is a long game. Clear transformation pathways, clear targets to direct progress along the pathways and transparent monitoring of progress are all essential to set shared expectations among stakeholders and make sure the decisions of economic and political decision-makers keep pulling in the same direction over

BOX 5.1

### Financing the sustainable intensification of beef production in Brazil

Transforming the global food system depends in large measure on transforming Brazil's. Not only is Brazil the world's largest net exporter of food products, it is also the world's most biodiverse country, with extensive forests and natural lands threatened by agricultural encroachment.

Transforming Brazil's food system is therefore not straightforward. While the country stands to gain significant environmental and health benefits, transformation threatens to negatively impact Brazil's GDP and employment. In particular, it puts pressure on Brazil's beef farmers. Demand for Brazilian beef will fall along with global demand for meat, as food systems transform worldwide, while stricter environmental standards for beef exports will raise the competitive bar for Brazilian beef. Livestock farmers will also need to use land much more efficiently and reduce the area under feed crops and pasture if they are to halt and reverse encroachment.

Sustainable intensification of beef production offers Brazil's beef farmers a solution that will also make their beef more competitive on tightly regulated international markets. However, the necessary innovation, capacity-building and physical capital will all cost money. Brazilian beef farmers, especially smallholders and family farmers in remote regions, need better access to credit. Both government programs and private instruments can fill the finance gap. They can help by designing attractive, investable projects, issuing green bonds, constructing public credit programs linking (subsidized) loans to environmental conditions, and introducing payment for ecosystem services (PES) schemes. Blended finance instruments can de-risk investments, making them more attractive to private investors. However, private investment is unlikely to flow freely without more work to strengthen institutions and to enforce laws against deforestation. Brazilian beef must guarantee its detachment from deforestation to meet international investors' concerns and comply with international rules protecting forests. Brazil has recently introduced several helpful incentives including a Green Beef Stamp, which allows sustainable beef producers to charge a premium, and new PES schemes following the introduction of its PES Law in 2021.

*Source: Köberle et al. 2023*

the long term. Equally crucial is holding relevant food system players to account for progress. Independent agencies can hold governments to account for the coherence of their short-term policymaking with overarching policy goals. Corporate boards and investors can hold management teams to account for aligning strategic decisions with societal objectives.

Establishing credible, ambitious, long-term commitments and sticking to them is particularly important to avoid the kind of sudden policy reversals that often follow external shocks to food systems. Shocks such as an outbreak of war or a flood can push economic decision-makers into making short-term policy adjustments to protect those worst affected by the consequences, for instance, food price spikes or shortages. Similarly, when shocks suddenly improve returns to "old" system assets, investors may reconsider their commitment to new ways of producing.

Such reversals risk delaying food system transformations and any delay will erode the possibility of success. Making sure key decision-makers in food systems "stick to the transformation pathway" in rough times is all the more important as the dynamics of a system transformation may generate additional volatility (Jain & Palacios 2023). Expectations about future policy developments inform producers' long-term investment decisions, which are often made with a planning horizon of several decades. Managing these expectations is important to mitigate volatility and the risk of reversing course (Pilditch et al. 2023).

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All background papers are available at https://foodsystemeconomics.org/science/working-papers/


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## Chapter 1

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