

## CHAPTER 1

# Climate Change and Food Systems Transforming Food Systems for Adaptation, Mitigation, and Resilience

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### KEY MESSAGES

- Climate change is a growing threat to our food systems, with impacts becoming increasingly evident. Rising temperatures, changing precipitation patterns, and extreme weather events, among other effects, are already reducing agricultural yields and disrupting food supply chains. By 2050, climate change is expected to put millions of people at risk of hunger, malnutrition, and poverty.
- Aspirations for food systems are extremely high. Global summits in 2021 highlighted the central role of food systems transformation in the world's response to climate change as well as meeting multiple other development goals. Action to address climate change is underway but must be hastened by accelerating innovation, reforming policies, resetting market incentives, and increasing financing.
- Adaptation is urgent, but feasible for food systems. Food production, distribution, and consumption practices must all be adapted to climate change to better support rural livelihoods and provide healthy diets for all, even as population and income growth increase the demand for food.
- Food systems contribute substantially to greenhouse gas emissions and must play a role in mitigation through changes in agricultural practices and land use, more efficient value chains, and reduced food loss and waste.
- Many promising innovations and policy approaches show potential to address climate change in food systems while also increasing productivity, improving diets, and advancing inclusion of vulnerable groups. These range from new crop varieties, clean energy sources, and digital technologies to trade reforms,



landscape governance, and social protection programs. All of these will require substantial increases in funding for R&D and other investments in sustainable food systems transformation.

- Food systems policies that create better market incentives, strengthen regulation and institutions, and fund R&D for climate-resilient technologies and practices are needed to catalyze and accelerate climate action.

Climate change is a growing threat to our food systems, with grim implications for food and nutrition security, livelihoods, and overall well-being, especially for poor and vulnerable people around the world. The imperative for urgent action on climate change – both to achieve the major emissions reductions needed to limit global warming and to increase adaptive capacity and resilience of food systems – is drawing global attention.

The impacts of global warming are becoming increasingly evident. Higher temperatures, changing precipitation patterns, sea level rise, and growing frequency and intensity of extreme weather events such as droughts, floods, extreme heat, and cyclones are already reducing agricultural productivity, disrupting food supply chains, and displacing communities.<sup>1</sup> At the same time, food systems are estimated to contribute more than a third of the global greenhouse gas (GHG) emissions responsible for climate change,<sup>2</sup> placing food production at the center of attention as both a contributor to global warming and a critical sector for mounting an adaptive response to climate change.

Looking forward, modeling scenarios, created by researchers at the International Food Policy Research Institute (IFPRI) together with other CGIAR colleagues, indicate that rising temperatures will negatively impact agricultural yields, driving up prices and resulting in increased hunger, especially in Africa (see IMPACT data in this report for details).<sup>3</sup> The goal of ending hunger will remain elusive even by 2050, especially considering the additional impacts of extreme weather events, local shocks, and global crises, such as COVID-19 and the current war in Ukraine, that will push many more people into poverty and hunger. Thus, beyond its direct impacts on production, climate change will create cascading effects on livelihoods and sustainability through interconnections among economic, environmental, social, and political spheres.

Even in the absence of climate change, food systems face enormous challenges and demands. Hunger and malnutrition are rising, and over 3 billion people currently cannot afford a healthy diet.<sup>4</sup> Food systems are the world's largest "employer," but for many, particularly women, youth, and other vulnerable groups, agriculture-based livelihoods are precarious. In addition, food systems are major contributors to environmental degradation beyond GHG emissions, including deterioration of water resources and loss of habitat and biodiversity, which compromise environmental services that support food production.

Yet global aspirations for food systems are extremely high. As was made clear at the 2021 UN Food Systems Summit (UNFSS), food systems must play a central role in achieving multiple, pressing sustainable development and climate goals, from the

## BOX 1 INTERNATIONAL SPOTLIGHT ON FOOD SYSTEMS AND CLIMATE ACTION

Key international events over the past year have cemented the centrality of food systems transformation in the climate change and Sustainable Development Goals (SDG) agendas. Global calls for "building back better" after COVID-19 include a push for more sustainable, healthy, and equitable food systems. The chorus of voices for change suggests that now may be the moment.

The United Nations convened its first-ever Food Systems Summit (UNFSS) in September 2021, marking an important shift from prior World Food events (1992, 1996, 2002). By moving to a food systems view that encompasses the production, processing, transport, and consumption of food, the UNFSS highlighted the role of global food systems in achieving the SDGs by 2030. The close links among food security and nutrition goals, climate goals, and many of the other SDGs point to the "the need to confront the realities of balancing food production with climate action, affordable food with healthy diets, and stable food supplies with fair and open trade."<sup>a</sup> Likewise, the December 2021 Tokyo Nutrition for Growth Summit highlighted the links between food systems and nutrition and climate change.<sup>b</sup> At the close of the UNFSS, the UN Secretary General outlined the need for concrete follow-up at the national level, as countries prepare pathways to transform food systems and achieve their climate commitments.<sup>c</sup>

The UNFCCC COP26 held in November 2021 stressed that much more action is required to meet commitments to net zero emissions, and countries were asked to strengthen current targets. In the realm of agriculture and land use (AFOLU), 137 countries pledged to halt and reverse forest and land degradation by 2030, and over 100 countries pledged to reduce methane emissions, including those from the agriculture sector.<sup>d</sup> The Koronivia Joint Work on Agriculture, an important workstream of the UNFCCC, highlighted the key role of soil and nutrient management practices and livestock management systems, and signaled that a draft decision on agriculture will be released in 2022. While such promises are encouraging, previous commitments have not been met. The 2009 pledge to provide US\$100 billion per year from 2020 through 2025 for climate change adaptation in developing countries, for example, has been postponed for several years.

The 2021 commitments will require concrete follow-up by national governments to ensure real change. Significant shifts in public and private investment will be essential, an issue that was discussed at both UNFCCC and UNFSS (see Chapter 5, Box 1). The 2022 UN Conference on Biodiversity and the World Trade Organization ministerial conference, also planned for 2022, will provide further opportunities to advance global climate and food systems action.

local to the global level. This message was strongly reinforced at last year's UNFCCC COP26 in Glasgow (Box 1). These aspirations envision food systems that are far more nature-positive, deliver improved and more resilient livelihoods, empower disadvantaged groups, and produce a healthy mix of foods at affordable prices. Food systems are called on to accomplish all these goals in the context of a rapidly changing climate and while making a substantial contribution to achieving net zero GHG emissions by 2050.

Action to address climate change has begun, but it urgently needs to be hastened by accelerating innovation, reforming policies, resetting market incentives, and increasing financing for sustainable food systems transformation. This year's *Global Food Policy Report* sets out a broad range of opportunities for accelerated action that should be considered by international and domestic forums for policy and investment decision-making.

This first chapter has two purposes. First, we ground this report in current realities related to the climate change adaptation and mitigation demands upon food systems. These issues have been highlighted and explored in recent global forums and publications such as the UNFSS, COP26, and the Sixth Assessment Report of the IPCC, so we discuss them only briefly here. The second half of this chapter summarizes the major findings and recommendations presented in this report.

## ADAPTATION AND MITIGATION IN FOOD SYSTEMS

### ADAPTATION IS URGENT, BUT FEASIBLE FOR FOOD SYSTEMS

The world remains far from achieving the emissions reductions needed to constrain warming to 1.5°C above pre-industrial levels. While this goal remains feasible, the longer we wait, the more difficult achieving it will become. For each tenth of a degree that the global average temperature rises above 1.5°C, human and environmental costs are expected to escalate at increasing rates. For the foreseeable future, climate change will continue to disrupt food systems with greater frequency and severity, unless action is taken now.

Food production, distribution, and consumption practices must be adapted to climate change in order to support rural livelihoods and provide healthy diets for all, even as population and income growth increase the demand for food. At the farm level, adaptation must address changing growing conditions, water scarcity, droughts and floods, increased risks of destructive weather events, and related risks of disease and pests. Along value chains, storage and logistics will also be affected by climate change, and price volatility will increase, with implications for processors, traders, and consumers as well as farmers. Climate change will put increasing pressure on scarce resources, which can increase the risk of conflicts. Such conflicts can affect entire value chains and are a major driver of increases in global food insecurity and hunger.<sup>5</sup> Recent experience with the COVID-19 pandemic has shown us how disruptions in one part of a value chain can have wide-reaching impacts. But it has also shown us how food systems, including public and private sector actors, can respond and adapt quickly to severe shocks.

A number of promising innovations show potential to support adaptation and build resilience while also increasing productivity. New crop varieties can better withstand climate shocks as well as improve yields. Solar energy can be used to improve product storage as weather conditions worsen, and also contribute to mitigation. Digital technology can expand access to knowledge and services in rural areas, allowing producers to adapt practices to local conditions and improve market access. Many climate-smart innovations, such as no-till farming, agroforestry, and landscape management, will also support mitigation by sequestering carbon or reducing emissions. However, technical innovations will never reach their full potential without the right enabling environments, including policy incentives and governance approaches that promote climate-positive change and inclusion of all food systems actors. Policies and institutions at the local, national, and international levels need to incentivize the development and adoption of new technologies and practices and ensure adequate finance. They must recognize potential trade-offs – in terms of yields and efficiency – between sustainable systems and existing or other modern farming practices and between sectors, such as water and energy.

Policies must also facilitate coordinated action across stakeholders and ensure equitable systemic transformation for all.

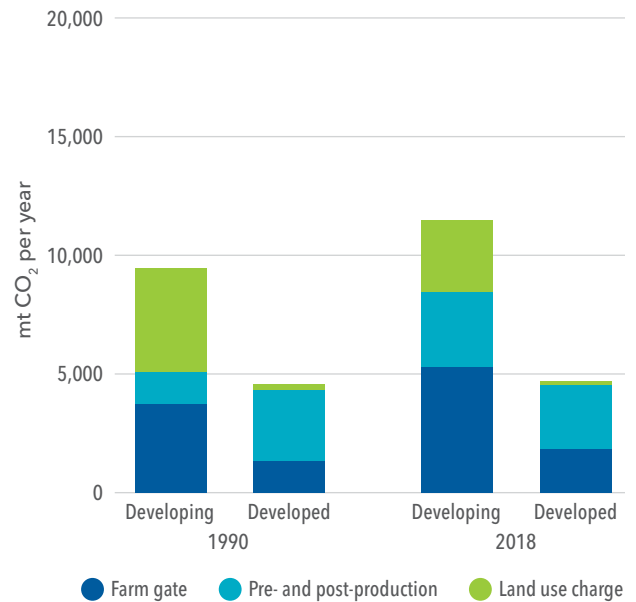
### FOOD SYSTEMS HAVE A VITAL ROLE TO PLAY IN MITIGATION

Despite international commitments to reduce GHG emissions, total net anthropogenic GHG emissions continue to rise. Stepped-up efforts to reduce GHG emissions are required of developed economies, and progress by developing and emerging economies is also necessary, but it is important to bear in mind that the least developed countries accounted for only 3.3 percent of global GHG emissions in 2019.<sup>6</sup> Absolute emissions from fossil fuels in some developed countries (Western Europe, North America, Australia, and New Zealand) have been trending downward, largely as a result of policy support and technological advances, including development of clean energy sources.<sup>7</sup> For now, developed countries are leading the way in these innovations, but as these and other technologies mature, they must be swiftly adopted in developing country markets.<sup>8</sup>

Food systems account for as much as 34 percent of total greenhouse gas (GHG) emissions stemming from agriculture and land use, storage, transport, packaging, processing, retail, and consumption.<sup>9</sup> Continued technological progress in the energy and transport sectors can reduce fossil-fuel use and emissions throughout food systems, including in irrigation, processing, transport, cold storage, and waste recycling, where emissions are currently increasing. But two-thirds of food system GHG emissions – or about 21 percent of total emissions from all sources – are from agriculture, forestry, and other land use (AFOLU) (Figure 1).<sup>10</sup>

AFOLU can deliver substantial emissions reductions and carbon sequestration.<sup>11</sup> It is the *only* economic sector with serious potential to become a net emissions sink – pulling more GHGs out of the atmosphere than it emits – through creation and protection of carbon sinks such as forests.<sup>12</sup> Given that some sectors (energy, industry, transport, buildings) will not reach net zero emissions by 2050, AFOLU must reach negative emissions to achieve the topline goal of COP26: *Secure global net zero emissions by mid-century*. Viewed in this way, AFOLU must achieve significantly larger total emissions reductions than other sectors.

**FIGURE 1** Greenhouse gas emissions from food systems, 1990 and 2018

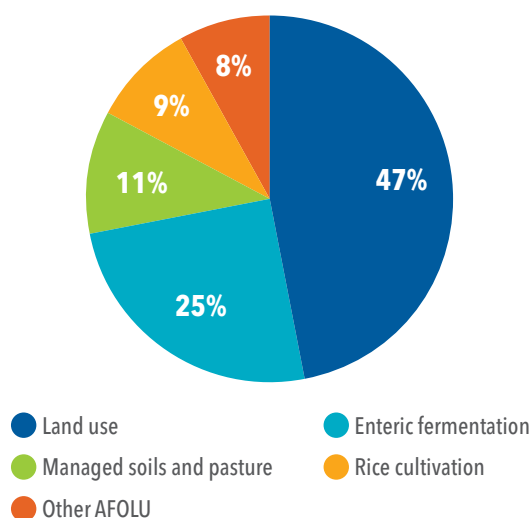


**Source:** Constructed using data from F.N. Tubiello, K. Karl, A. Flammini, et al., "Pre- and Post-production Processes along Supply Chains Increasingly Dominate GHG Emissions from Agri-food Systems Globally and in Most Countries," *Earth Systems Science Data Discussion* [preprint 2021].

Yet realizing this potential requires addressing substantial barriers, such as insufficient institutional and financial support, uncertainty regarding long-term increases in sequestration, risks of carbon sequestration reversal, and our ability to measure and verify sequestration.<sup>13</sup>

Globally, land use change and management accounts for almost half of total CO<sub>2</sub> emissions from AFOLU (Figure 2).<sup>14</sup> Net agricultural land expansion is concentrated in the developing world,<sup>15</sup> and between 2003 and 2019, cropland expanded by about 9 percent globally, principally due to agricultural expansion in Africa and South America. Conversely, land use change in the United States is providing a net sink, offsetting about 12 percent of total US emissions (and more than all US emissions from agriculture).<sup>16</sup> For developed countries, the top priority should be measures that will turn their landscapes into larger net sinks for emissions. For developing countries, the priority should be fostering agricultural practices that both raise productivity and turn the tide on AFOLU emissions.

**FIGURE 2 Global AFOLU emissions shares by source**



**Source:** Constructed using data from W.F. Lamb, et al., “A Review of Trends and Drivers of Greenhouse Gas Emissions by Sector from 1990 to 2018,” *Environmental Research Letters* 16, 7 (2021): 073005.

**Note:** AFOLU = agriculture, forestry, and other land use.

Significant GHG mitigation can also be achieved in AFOLU by reducing nitrous oxide emissions from fertilizers and methane emissions from paddy rice and enteric fermentation (from cattle and other ruminant digestion) as well as decreasing emissions intensity within sustainable production systems and reducing food loss and waste. From the demand side, shifting food consumption toward healthy diets has also been found to have substantial potential for emissions reduction.<sup>17</sup> Combined, these efforts could move the world toward net zero emissions.

## POLICY RECOMMENDATIONS

Promising policy responses for adaptation, mitigation, and resilience to climate change are explored in this *Global Food Policy Report*. Eleven thematic chapters and a regional section, covering six major developing regions, examine policy options and opportunities for change. These are arranged in three broad groupings: 1) Global frameworks for policies and incentives (Chapters 2-5), 2) Inclusion and diversity, livelihoods, and resilience (Chapters 6-8), and 3) Sustainable production and consumption (Chapters 9-12). Here we review broad findings and recommendations from these chapters that can support climate change

responses in the short term and build resilience and capacity for the future.

**R&D FOR CLIMATE-RESILIENT, RESOURCE-EFFICIENT, AND SUSTAINABLE INNOVATIONS IN FOOD SYSTEMS.** A promising portfolio of technology innovations could accelerate sustainable food systems transformation. Many of these innovations have proven potential to both raise productivity and reduce GHG emissions intensity in agrifood production. Irrigation technologies, such as drip irrigation and solar power pumps, can both improve yields and reduce emissions (Chapter 9). New genome-editing technologies, such as CRISPR, have proven capable of rapidly developing crop and animal varieties suited for climate change adaptation and mitigation (Chapter 10). Improved cold chain technologies, powered by solar energy, and new drying methods are increasing food quality and availability and reducing food loss and waste, particularly for perishable nutritious foods (Chapter 11). Digital innovations are revolutionizing production, markets, and delivery throughout food systems, with great potential for improving productivity and quality and reducing natural resource use and food loss and waste. This broad array of innovations in data use stretches from precision agriculture, improved weather forecasting, and use of robotics to blockchain-based product quality and sustainability traceability and to e-logistics and e-commerce for enhanced value chain efficiency (Chapters 11 and 12).

Development and adoption of such “disruptive” innovations requires investment in R&D. A review of evidence on the benefits of past investments in R&D for innovation in agrifood systems finds that the benefit-cost ratio of such investments can be at least 10 to 1, contributing much more to reducing poverty and hunger than other development investments (Chapter 4).<sup>18</sup> Looking forward, an investment in R&D equivalent to just 1 percent of agricultural output could produce a sustained increase of 30 percent in food production (Chapter 2).<sup>19</sup> In addition, investment in development and adaptation of such “green” innovations for use in low- and middle-income countries (LMICs) could help reduce AFOLU emissions by some 40 to 50 percent.<sup>20</sup> Despite these substantial benefits, food systems R&D is notably underfunded, especially in LMICs (Chapter 4), with only a tiny fraction of

Appropriate design of policies, institutions and governance systems at all scales can contribute to land-related adaptation and mitigation while facilitating the pursuit of climate-adaptive development pathways (*high confidence*)

– International Panel on Climate Change 2019

agricultural innovation investment targeting environmental outcomes. Based on this evidence, this report recommends that:

- Public investments in R&D for productivity-increasing and emissions-reducing innovations should be doubled from current levels, with at least \$15 billion of the increase for innovations benefiting food systems in LMICs.
- R&D investment should focus on innovations for sustainable intensification in LMICs, both on and beyond the farm.
- Global and regional mechanisms for knowledge sharing, such as the CGIAR system, should be enhanced and strengthened to facilitate technology diffusion that benefits countries with limited domestic research capacity (Chapter 4).
- Governments should create stronger enabling environments to attract private sector investment for agrifood innovations and to spur adoption of improved technologies and practices, including resetting distortionary market incentives created by agricultural support and trade regulations (Chapter 2, 3, 5) and improving regulation for safe adoption and market acceptance of new technologies (Chapter 10).

**HOLISTIC, INCLUSIVE GOVERNANCE AND MANAGEMENT OF WATER, LAND, FORESTS, AND ENERGY RESOURCES.**

Improved efficiency of natural resource use will be

essential to increasing productivity while reducing environmental degradation and GHG emissions. The close links among water, energy, land use, and food systems require integrated policy responses to climate change in order to prevent undesirable trade-offs among development goals. Use of modern energy technologies, for example, is essential for raising productivity – including for pumping of irrigation water and storage, transport, and processing of food products – but fossil-fuel use contributes to GHG emissions. Expanding access to “clean” energy sources, including solar power, in the agrifood sector is therefore critical, but brings its own risks of increased exploitation of water and other farm inputs (Chapter 9).

Governance through integrated landscape approaches has potential to achieve sustainable use of land, water, forest, and energy resources (Chapter 7), including long-term productivity and greater sequestration of CO<sub>2</sub>. However, integrated landscape management is complex; it requires effective stakeholder engagement, inclusive governance, adequate coordination among local, regional, and cross-border natural resource management, and compromise among diverging economic and political interests (Chapter 7). To promote integrated landscape approaches and sustainable resource use, this report recommends that:

- Agricultural, food, and climate change policies should explicitly consider landscape dimensions

and provide incentives for integrated landscape management through local governance, including development of multistakeholder platforms that can build support for collective action on climate change.

- Land tenure and access rights to other natural resources for farmers, rural households, and communities should be strengthened to motivate investments in sustainability and participation in landscape governance (Chapter 7).
- Governments should promote adoption of clean energy sources in agrifood systems through an enabling environment and appropriate financial incentives for the use of wind and solar power and decentralized electricity grids (Chapter 9)
- Identification of productive-use locations that could jointly support energy, water, and food security can be used to attract investments that increase productivity and sustainability (Chapter 9).

#### **PROMOTING HEALTHY DIETS AND INCREASED SUSTAINABILITY OF FOOD PRODUCTION.**

Globally, undernourishment and micronutrient deficiency continue to rise even as overweight and obesity are becoming more prevalent. Both forms of malnutrition now affect about a quarter of the world's population, with some people suffering from both, and poor diets are among the largest global health risks.<sup>21</sup> Making healthy diets affordable and influencing consumers to make healthier choices is key to overcoming these global nutrition challenges and can be well aligned with addressing climate change (Chapter 8). The ecological footprint of healthy diets – those without excessive consumption of highly processed foods and red meats – has been found to be much lower than that of prevailing diets across the world, but especially those in advanced countries.<sup>22</sup> Changing dietary habits is not easy, however. Key policy directions include the following:

- All countries should adopt national food-based dietary guidelines. These can be a key policy instrument to translate global evidence on healthy and sustainable diets into practical, culturally appropriate, and context- and population-specific dietary recommendations (Chapter 8).

- Innovation policies should prioritize R&D for nutrient-rich foods (including fruits and vegetables) to make healthy diets more affordable (Chapter 2). Targeted consumer subsidies and removal of taxes on healthy foods will also help to lower the costs of healthy diets for low-income households (Chapter 8).
- Consumers can be encouraged to make healthy, sustainable food choices through changes in the food environment, including use of food standards, labeling, and certifications that warn of unhealthy foods and signal the nutritional value and environmental footprint of foods (Chapter 8).

#### **IMPROVING VALUE CHAIN EFFICIENCY, FACILITATING TRADE, AND REDUCING FOOD LOSS.**

Climate change impacts – including shifts in crop production, rising temperatures, changing humidity levels, and more frequent extreme weather – will affect whole value chains through which agricultural products are traded, aggregated, processed, and sold to consumers. Incentives for producers and other value chain actors will be altered as climate change reduces the effectiveness of some inputs, increases risks, and impacts transaction costs. International trade can play a key role in softening these impacts – by reducing price volatility and providing access to food for countries that have suffered a drop in production. Trade and investments in climate-smart practices all along value chains can support adaptation through increased efficiency of resource use and reductions in food loss. Climate-smart practices in value chains can also support mitigation. A large share of agrifood sector GHG emissions (35 percent) is generated beyond the farmgate, largely by energy use in long supply chains and food waste and loss (Figure 1).<sup>23</sup> Policy priorities include:

- While efforts to reduce transport-related GHGs should be continued, free and open trade should be an integral part of climate-smart agricultural and food policies. Trade allows countries to obtain nutritious foods at the lowest cost and can be a key tool for adaptation in the face of weather-related shocks. Globally, trade can also promote more efficient use of natural resources and thus help

reduce GHG emissions from agrifood production (Chapter 3).

- Investments along value chains for efficient and safe storage and transport of food crops and products, including low-emissions cold chains for perishable products and other measures to prevent spoilage and safety hazards, can improve access to healthy diets and reduce food waste and loss (Chapter 11).
- Increasing consumer demand for sustainably produced foods, for example through certification programs, can create incentives for changing practices along entire value chains (Chapter 11).

**INCLUSION AND SOCIAL PROTECTION.** Poor rural populations who depend on agrifood systems for food and livelihoods are among the most vulnerable to the impacts of climate change. These groups remain underserved in many ways, including access to markets, finance, and knowledge, as well as infrastructure, energy, and natural resources, and hence have limited capacity to benefit from innovations in food systems. The precariousness of their livelihoods leaves them likely to lose income, experience hunger and malnutrition, and suffer long-term impacts on well-being when climate-related shocks occur. Policy reforms must both improve access to services, markets, and financial tools, particularly for women and other vulnerable groups, and ensure a secure safety net for all vulnerable populations. Social protection systems now cover about 2 billion people around the world, and while their potentially important role in addressing climate change challenges has been recognized for more than a decade, they now need to be expanded to do so more effectively. Increased resilience, empowerment, and agency among the disadvantaged can support multiple social, economic, and environmental benefits.

- Climate-positive food systems transformation will require development of context-appropriate institutions and in “soft” infrastructure inclusive of rural and urban food system actors, including equal access to digital climate services, innovative insurance tools, advisory services and actionable information, and financial services to support

increased productivity and sustainability (Chapters 9 to 12).

- Women’s participation, along with that of other vulnerable groups, should be strengthened across resource governance, including in clean energy systems, water systems, landscapes, crop development, and digital innovations (Chapters 7, 9, 10).
- Social protection programs can provide a safety net for vulnerable groups and support sustainable food systems transformation, including the transition to more climate-resilient crops and to off-farm and urban employment (Chapter 6).
- Expanding “adaptive” social protection programs that comprise traditional social assistance, humanitarian responses, and disaster relief, and that are integrated with complementary climate investments targeted to the poor, can immediately reduce the impact of shocks and support inclusion in food systems transformation (Chapter 6).
- Improved real-time monitoring of food crisis risks is needed to take early and preventative action to protect vulnerable populations in contexts affected by conflict, natural resource scarcity, and exposure to climate shocks (Chapter 6).

#### **REORIENTING FINANCIAL FLOWS AND ATTRACTING**

**NEW FINANCE.** The future of food systems depends on access to sufficient funding to facilitate a shift to sustainable production and consumption and to better livelihoods. Current financial flows – including agricultural support, international development funds, and private investment – are at best insufficient and at worst counterproductive to climate-resilient development. They often support unsustainable and unhealthy production while undervaluing environmental impacts. As much as \$350 billion per year will be needed to meet climate-related goals in food systems (Chapter 5), much of which could be “reoriented” from existing sources. In addition, many smallholders and small and medium enterprises lack access to finance needed to transform their production practices and to weather climate shocks. Moving forward, investment for environmental, social, economic, and nutrition goals could be increased in several ways.

- Reform of existing counterproductive incentives created by current agricultural, trade, and investment policies can mobilize both public and private finance for climate-positive food systems transformation and reorient funds toward climate finance (Chapters 2, 3, and 5).
- Public support to agriculture, totaling an estimated \$620 billion per year worldwide, should be repurposed toward R&D for green innovations and incentives to producers to adopt and invest in climate-smart technologies and practices. Such innovations should focus on increasing productivity, reducing emissions, and enhancing resilience in food production (Chapter 2).
- International development funds should be clearly targeted to meeting climate and sustainability goals, and used to leverage or crowd-in private funds from global capital markets (Chapter 5).
- Reorientation of consumer demand – through better information, food environments, and fiscal tools – will also create incentives for producers to adopt and invest in sustainable and climate-resilient practices (Chapters 5 and 11).
- Innovative mechanisms for tapping additional resources, such as publicly guaranteed “green bonds” or climate-change transparency

requirements for banks and investors, should be explored to ensure climate finance needs will be met (Chapter 5).

Achieving these reforms and ensuring widespread adoption of innovations will be politically challenging. Policy solutions, including incentives, institutions, and financing, will need to be tailored to a wide range of contexts and to balance environmental, nutritional, economic, and social goals. Regions, countries, and local landscapes will need to establish their own priorities, address potential trade-offs, build constituencies for reform, and ensure that reforms generate widespread benefits. The Regional Developments section of this report discusses the varied context of the large global regions, and points to some promising opportunities.

Investing in policies and innovations to support sustainable food systems will contribute significantly to global economic prosperity, poverty reduction, food security, and healthy diets as well as to planetary health.<sup>24</sup> Reaching the ambitious goals set for food systems will require inclusive, holistic approaches that consider all components of our food systems, from local to global and from farmer to consumer. Charting optimal pathways for sustainable food systems transformation will be challenging, but we must step up our efforts now to ensure our global future.