Food and Agriculture Organization of the United Nations

3

The future of food and agriculture

Drivers and triggers for transformation

SUMMARY VERSION

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CONTENTS

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This report, *The future of food and agriculture – Drivers and triggers for transformation*, is the ultimate output of the Corporate Strategic Foresight Exercise (CSFE), a long-term, forward-looking effort carried out by the Food and Agriculture Organization of the United Nations (FAO) over the last two years, aimed at strengthening the strategic thinking of the Organization and the whole development community, so as to move agrifood systems towards sustainability and resilience.

Overall process. Contributions to the CSFE were provided by several hundreds of FAO staff during meetings, workshops, discussions and interviews, under the overall guidance of Máximo Torero, FAO Chief Economist; with the support of Beth Crawford, Director of the Office of Strategy, Programme and Budget (OSP), FAO; and the technical and organizational leadership of Lorenzo Giovanni Bellù, Senior Economist, Agrifood Economics Division (ESA), FAO. This allowed for the identification of 18 drivers of future agrifood systems and key triggers of transformation that fed into the preparation of the FAO *Strategic Framework 2022–31*. Drivers and triggers identified during the CSFE constitute the conceptual backbone of this corporate report. Based on these findings, most technical divisions of FAO provided technical background papers, and the contents of these enabled the preparation of the first chapter of this report, as specified in more detail below. All these inputs are gratefully acknowledged. The second and third chapters of this report further elaborate on CSFE's findings.

The preparation of this report, as much as the whole CSFE, was coordinated by the Foresight Management Team, comprising: Tomoyuki Uno, Senior Strategy and Planning Officer; Helene Sow and Ahmed Jilani, Strategy and Planning Officers, Office of Strategy, Programme and Budget (OSP); Ayca Donmez, former Statistician, Office of the Chief Statistician (OCS); Vittorio Fattori, Cornelia Boesch and Kosuke Shiraishi, Food Safety Officers, Food Systems and Food Safety Division (ESF); Pedro Morais de Sousa, Political Economist (ESA); and Lan Huong Nguyen, Economist (ESA).

Drafting of the report. This report was written by a drafting team comprising: Lorenzo Giovanni Bellù, Lead Author; Materne Maetz, Senior Editorial Advisor and former FAO Senior Policy Officer; and Pedro Morais de Sousa. Lorenzo Giovanni Bellù conceived and outlined the structure of the whole report, wrote the introduction and the introductory parts of all the sections in Chapter 1, provided

substantive inputs to Sections 1.2 and 1.3, drafted Chapters 2 and 3, and revised the final draft of the whole report by providing additional text and boxes, while incorporating subsequent comments received from reviewers. Materne Maetz, in addition to advising on the structure and logical sequence of the whole report, harmonized, complemented and integrated the contributions received from technical divisions on drivers of agrifood systems, drafted substantial parts of Sections 1.8, 1.12, 1.14 and 1.16, and organized the whole set of references for Chapter 1. Pedro Morais de Sousa, in addition to coordinating the inputs from the technical divisions during the various phases of revisions, supported Materne Maetz in revising selected sections in Chapter 1, provided important inputs in Sections 1.5, 1.7 and 1.10, preliminary drafts for the introduction, parts of Chapters 2 and 3, and drafted parts of the concluding remarks.

Data gathering and analysis. Graphs and numerical tables have been prepared by the data analysis team, coordinated by Lorenzo Giovanni Bellù. The team comprises Lan Huong Nguyen; Isabel Parras, Data and Policy Analyst; Jacopo Di Iorio, Chiara Ghiringhelli and Anja Peebles-Brown, Data Analysts; as well as the former FAO Consultant Dominik Wisser, now FAO Livestock Policy Officer in the Animal Production and Health Division (NSA). The data analysis team has also prepared the web-based dashboard that renders all the data used in this report available in an interactive way.

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The 18 drivers and the key triggers for transformation, which constitute the conceptual backbone of this report, were identified through an Internal Expert Consultation (IEC) held at the early stages of the CSFE process. The IEC and the subsequent phases of the CSFE gathered the contributions from the following FAO Senior Experts: Maya Takagi, Regional Programme Leader of the FAO Regional Office for Latin America and the Caribbean (RLC); Ignacio Moncayo, Expert in Rural Development (RLC); Pablo Rasmussen, Advisor to the Regional and Subregional coordination (RLC); Raimund Jehle, FAO Regional Programme Leader for the FAO Regional Office for Europe and Central Asia (REU); Erzsebet Illes, National Professional Officer (REU); Jean Marc Faures, Regional Programme Leader in the FAO Regional Office for Near East and North Africa (RNE); Rachid Serraj, Senior Agricultural Officer (RNE); David Dawe, Senior Economist in the FAO Regional Office for Asia and the Pacific (RAP); Ade Freeman, Regional Programme Leader in the FAO Regional Office for Africa (RAF); Pablo Rabczuk, Agrifood Systems Officer in the Subregional Office for Mesoamerica (SLM); Ruben Flores Agreda, FAO Representative in Uruguay; Roberto Sandoval, Emergency Focal Point and Disaster Risk Management Specialist in the Subregional Office for the Caribbean (SLC); Xiangjun Yao, Representative in the Subregional Office for the Pacific Islands (SAP); Madankumar Janakiraman, Programme Officer (SAP); Sumiter Broca, Senior Policy Officer in the Subregional Office for Central Asia (SEC); Suffyan Koroma, Senior Policy Officer in the Subregional Office for Eastern Africa (SFE); Adama Taoko, Policy Officer (SFE); Lewis Hove, Resilience Team Leader in the Subregional Office for Southern Africa (SFS); Eugene Rurangwa, Land and Water Officer in the Subregional Office for West Africa (SFW); Mohamed Amrani, Senior Policy Officer in the Subregional Office for North Africa (SNE); Armen Sedrakyan, Economist in the Subregional Office for the Gulf Cooperation Council States and

Yemen (SNG); Dunja Dujanovic, Senior Emergency and Rehabilitation Officer in the Office of Emergencies and Resilience (OER); Sasha Koo-Oshima, Deputy Director of the Land and Water Division (NSL); Erdgin Mane, Policy Officer in the Inclusive Rural Transformation and Gender Equality Division (ESP); Farid El Haffar, Technical Officer, Joint FAO/WHO Centre (CODEX Food Standards and Zoonotic Diseases, CJW); Driss Haboudane, Joint FAO/IAEA Centre (Nuclear Techniques in Food and Agriculture, CJN); Jose Valls Bedeau, Policy Officer (ESF); Holger Matthey, Senior Economist in the Markets and Trade Division (EST); Shukri Ahmed, Deputy Director (OER); James Tefft, Senior Economist in the FAO Investment Centre (CFI); Manuel Barange, Director of Fisheries and Aquaculture Division (NFI), Chikelu Mba, Senior Officer in Plant Production and Protection Division (NSP); Mona Chaya, Senior Advisor in the Office of the Chief Scientist (DDCC); Eduardo Mansur, Director of Office of Climate Change, Biodiversity and Environment (OCB); Daniela Kalikoski, Fishery Industry Officer (NFI); Guenter Hemrich, Senior Strategy and Planning Officer (OSP); Henning Steinfeld, Coordinator (NSA); Selvaraju Ramasamy, Senior Agricultural Officer in the Office of Innovation (OIN); Karel Callens, Senior Adviser in the Governance Unit (DDCG); Mette Wilkie, former Director of Forestry Division (NFO); Arni Mathiesen, former Assistant Director-General; Frederic Castell, Senior Natural Resources Officer (OCB); Nancy Aburto, Deputy Director of Food and Nutrition Division (ESN); Margret Vidar, Legal Officer in the Legal Office (LEG); Blaise Kuemlangan, Chief (LEG); Jose Rosero Moncayo; Ewald Rametsteiner, Deputy Director (NFO); Elena Aguayo, Indigenous Women Coordination and Monitoring Support Consultant in the Partnership and UN collaboration Division (PSU); Anne Brunel, Coordinator, Global-Hub on Indigenous Peoples' Food Systems (PSU); Florian Doerr, Programme Manager and Resource Mobilization Specialist (PSU); Mariana Estrada, Programme Manager and Indigenous Women's Knowledge Specialist (PSU); Yon Fernández-de-Larrinoa, Head, Indigenous Peoples Unit (PSU); Kundan Kumar, Indigenous Peoples' Resources and Climate Change (PSU); Maria Paola Rizzo, Land Tenure Specialist (ESP); Mikaila Way, Indigenous Peoples' Liaison for North America in the Liaison Office for North America (FAOLOW), Merelyn ValdiviaDiaz, Young Professional Officer (PSU).

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Technical background papers. The various sections of Chapter 1 draw upon several technical background papers prepared by many authors, who provided critical analytical insights and the necessary technical depth required by the different topics addressed. They comprise:

- *Population dynamics and urbanization (Driver 1).* Main contributors: Kostas Stamoulis, Senior Advisor (ESP). Other contributors: Cecilia Marocchino, Urban Food Agenda Coordinator (ESF); Ahmed Raza, Nutrition and Food Systems Officer (ESN); Pilar Santacoloma, Agrifood Systems Officer (ESN); Libor Stloukal, Policy Officer (ESP); and Lourdes Marie Orlando, Territorial development and food systems consultant (ESP).
- *Economic growth, structural transformation and macroeconomic stability (Driver 2).* Main contributors: Eric Kemp-Benedict, Equitable Transitions Program Director at the Stockholm Environment Institute (SEI).
- *Cross-country interdependencies (Driver 3).* Main contributors: Eric Kemp-Benedict (SEI).
- *Big data (Driver 4).* Main contributors: Nikola Trendov, Digital Agriculture and Innovation Specialist (OIN); Erik Van Ingen, Digital Agriculture and Innovation Specialist (OIN). Other contributors: Paul Whimpenny, Senior Information Technology Officer (CSI), Thembani Malapela, Information Manager Officer (OIN); and Sergio Bogazzi, Information Technology Officer (CSI).
- *Geopolitical instability and increasing impact of conflicts (Driver 5).* Main contributors: Julius Jackson, Technical Officer (OER).
- *Risks and uncertainties (Driver 6).* Main contributors: Sylvie Wabbes Candotti, Emergency and Rehabilitation Officer (OER); Antoine Libert, Climate Resilience Expert (OER); Rebeca Koloffon, Operations Specialist (OER); Roman Malec, Climate Resilience Consultant (OER). Other contributors: Rein Paulsen, Director (OER); Shukri Ahmed; and Dervla Cleary, Emergency and Rehabilitation Officer (OER).
- *Rural and urban poverty and inequalities (Drivers 7 and 8).*

Main contributors: Ana Paula de la O Campos, Economist (ESA), and Lorenzo Moncada, Economist (ESA). Other contributors: Gala Dahlet, Senior Policy Officer (ESP); Leopoldo Tornarolli, former Economist (ESA); Erdgin Mane. Technical inputs in this section on future projections of global inequality were also provided by Dominique van Der Mensbrugghe, Director, Center for Global Trade Analysis, Purdue University, United States of America.

- *Innovation and science (Driver 10).* Main contributors: Preetmoninder Lidder, Technical Adviser (DDCC) and Mona Chaya.
- *Investment in agrifood systems (Driver 11).* Main contributors: James Tefft; Meeta Punjabi, Economist (CFI); and Atisha Kumar, Economist (CFI).
- *Capital and information intensity of production (Driver 12).* Main contributors: Eric Kemp-Benedict and Kevin M Adams, Research Fellow (SEI).
- *Consumption and nutrition patterns (Driver 14).* Main contributors: Fatima Hachem, Senior Nutrition Officer (ESN); Melissa Vargas, Technical Adviser (ESN); and Yenory Hernandez, Nutrition Specialist (ESN).
- *Epidemics and degradation of ecosystems (Driver 16).* Main contributors: Claudia Pittiglio, Disease Ecology and Risk Modelling expert (NSA); Sheila Wertz, Senior Forestry Officer (RAP); Jeffrey Lejeune, Food Safety Officer (ESF); Madhur Dhingra, Senior Animal Health Officer (NSA); and Keith Sumption, Chief (CJW). Other contributors: Buyung Hadi, Agricultural Officer (NSP); Baogen Gu, Senior Agricultural Officer (NSP); Shoki Al Dobai, Senior Agricultural Officer (NSP); Alejandro Dorado García, Animal Health Officer (CJW); Shiroma Sathyapala, Forestry Officer (NFO); Kristina Rodina, Forestry Officer (NFO); Vittorio Fattori; Cornelia Boesch; Martin Heilmann, Veterinary Public Health Specialist (NSA); Sophie Von Dobschuetz, Animal Health Officer (NSA); Timothy Robinson, Senior Livestock Policy Officer (NSA); and Badi Besbes, Senior Animal Production Officer (NSA).
- *Climate change (Driver 17).* Main contributors: Zitouni Ould-Dada, Deputy Director (OCB), and Liva Kaugure, Natural Resources Officer (OCB).
- *Sustainable ocean economies (Driver 18).* Main contributors: Carlos Fuentevilla, Fishery Officer (NFI); Anders Brudevoll, Associate Professional Officer (NFI); Other contributors: Manuel Barange; Vera Agostini, Deputy Director (NFI); and Stefania Vannuccini.

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Narratives of alternative future scenarios. The narratives of alternative scenarios for the future of agrifood systems and related strategic policy options, presented in Chapters 2 and 3, respectively, benefited from the findings of an External Expert Consultation run in November 2021, in collaboration with the UN Foresight Network and the United Nations Educational, Scientific and Cultural Organization (UNESCO) Futures Literacy team. The commitment and contributions of Riel Miller, former coordinator of the UN network and Head of the Futures Literacy Team; Irianna Lianaki-Dedouli, UNESCO Futures Literacy team; and Roumiana Gotseva, futures literacy expert and ESA consultant, are very much appreciated and acknowledged. Materials to develop alternative futures were also provided by Merle Remy, working on the project SHAPE (Sustainable development pathways achieving Human well-being while safeguarding the climate And Planet Earth) at the Institute for Advanced Sustainability Studies, Potsdam (Germany).

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ACRONYMS AND ABBREVIATIONS

AFU	adjusted future (scenario)
AI	artificial intelligence
CSFE	Corporate Strategic Foresight Exercise
FAO	Food and Agriculture Organization of the United Nations
GDP	gross domestic product
GHG	greenhouse gas
HICs	high-income countries
IEC	Internal Expert Consultation
IoT	Internet of Things
IPCC	Intergovernmental Panel on Climate Change
LICs	low-income countries
LMICs	low- and middle-income countries
MOS	more of the same (scenario)
PPPs	public-private partnerships
R&D	research and development
RAB	race to the bottom (scenario)
SDGs	Sustainable Development Goals
TOS	trading off for sustainability (scenario)
UNESCO	United Nations Educational, Scientific and Cultural Organization

FOREWORD

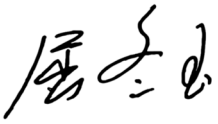
This corporate report *The future of food and agriculture – Drivers and triggers for transformation* is the culmination of efforts that mobilized hundreds of technical experts in domains related to agrifood systems, both within and outside the Food and Agriculture Organization of the United Nations (FAO). All of them contributed to the Corporate Strategic Foresight Exercise (CSFE), a forward-looking effort aimed at identifying possible transformative patterns for agrifood systems towards sustainability and resilience. It is a foresight exercise whose ambition is to enable all readers to gain a vision that encompasses potential alternative futures and inform decision-making processes. It does so knowing that shedding light on the complexities of agrifood systems and their interrelations with broader socioeconomic and environmental systems is a tall order.

All these experts engaged in identifying key "triggers" for transformation and their impacts on socioeconomic and environmental outcomes, including food security, nutrition, natural resources, ecosystems restoration and climate change. They were conscious of the crucial role that agrifood systems play in achieving the "four betters" to which the Organization aspires: better production, better nutrition, a better environment and a better life. The findings of these efforts contributed to elaborate FAO *Strategic Framework 2022–31*. The logical next step of this endeavour was to share them with all stakeholders that have common values and aspirations. As such, this report presents the richness of the discussions, analyses and findings that emerged during the entire CSFE to all those who are concerned with the future of agrifood systems.

As pointed out by the United Nations Secretary-General, many Sustainable Development Goals (SDGs) are off-track, including those to which agrifood systems are expected to contribute. The COVID-19 pandemic, economic downturns and ongoing conflicts all add to the creation of even greater challenges in achieving such SDGs. The previous FAO reports on the future of food and agriculture had already clearly stated that a "business as usual" approach would lead to a worrying future, characterized by increasing uncertainties and exacerbated inequalities. There is an urgent need to accelerate transformative processes in which agrifood systems interact with broader socioeconomic and environmental systems.

Consequently, this report highlights four key triggers for the transformation of agrifood systems: improved governance; increased consumer awareness; better income and wealth distribution; widespread technological, social and institutional innovations. All of them will have to be activated by means of suitable public strategies and policies, and through the participation of all stakeholders. Along this transformative pathway, choices will have to be made to trade off contrasting objectives, such as increasing immediate consumption and well-being versus investing to ensure a better future, or deciding how to charge the costs of unsustainable development to wealthier societies to assist poorer ones. This implies overcoming vested interests and reconciling different visions.

The key message of this report is that it is still possible to move agrifood systems along a pattern of sustainability and resilience. The broader socioeconomic and environmental systems could move in the same direction – which means short-term unsustainable achievements will have to be traded off for longer-term sustainability and resilience. Along this pattern, one can always find recourse by recalling the words of the Italian philosopher Antonio Gramsci: "…my mind is pessimistic, but my will is optimistic. Whatever the situation, I imagine the worst that could happen in order to summon up all my reserves and will power to overcome every obstacle." I hope this corporate report is a positive contribution in this direction.



QU Dongyu

FAO Director-General

The future of food and agriculture: the overarching concern and key messages

Overarching concerns

- Will global agrifood systems sustainably nourish humanity in the future, while also meeting the non-food demand for agricultural products and the demand for required environmental services?
- Will socioeconomic systems evolve in such a way that income-earning opportunities will be assured to everyone, and that enough income will be universally assured to afford healthy diets that comprise food produced in a sustainable way?
- Will the emergence of a critical and informed civil society, and active citizenships, be able to determine governmental action to set off effective triggers leading to transformative processes of agrifood systems?

KEY MESSAGES

Agenda 2030, including agrifood-related targets, is tremendously off-track.
If current trends of drivers affecting agrifood systems do not change, the sustainability and resilience of agrifood systems will be seriously under threat and food crises are likely to increase in the future. Trends such as increasing population and urbanization, macroeconomic instability, poverty and inequalities, geopolitical tensions and conflicts, fiercer competition over natural resources and climate change are wreaking havoc in socioeconomic systems and damaging environmental systems. In the words of the Secretary General of the United Nations (UNSG), the world is "tremendously off-track" to meet Sustainable Development Goals (SDGs).

The development paths followed by high-income countries are not replicable in low- and middle-income countries…
Past conditions are no longer available to replicate the development formula adopted by current high-income countries (HICs). Very few low- and middle-income countries (LMICs), perhaps none, will have the possibility of achieving hegemonic power and the status of empires that many HICs made use of to benefit their well-being and welfare. Future global development patterns depend on the resolution of key questions: institutions providing solutions for sharing the "global commons"; the distribution political power and wealth; and the resolution of the extensive inequalities present in today's economies.

The future of food and agriculture: the overarching concern and key messages

...and they are not sustainable

There is growing evidence that currently prevailing agricultural practices, which rely on the intensive use of agrochemical inputs and energy, are endangering the future of agrifood systems. As a result of the persistent overuse of natural resources, huge greenhouse gas (GHG) emissions and unprecedented loss of biodiversity, hunger and food insecurity are on the rise and billions of people lack access to healthy diets.

A change of mindset is needed – "more of the same" will lead the world to the point of no return

As it fatally compromises agrifood systems, the short-termism era will inevitably end either abruptly, with inestimable costs for everyone, or with a gradual and costly transition instigated by new mindset that prioritizes long-term objectives. Partial or local quick fixes resulting from uncertain decisions and commitments, piecemeal approaches and patchy reactive strategies are not up to the challenge. Neither can changes in production alone secure the sustainability and resilience of agrifood systems. They all fail to address the root causes of overall unsustainability and lack of resilience.

Changing the course of actions is far from easy, given the difficult trade-offs this entails

Achieving the four aspirational "betters" that FAO has placed at the heart of its strategic framework (better production, better nutrition, better environment and better life) requires balancing major trade-offs, such as: short-term productivity gains against greater sustainability and reduced climate impact; or efficiency, against inclusiveness; or short-term economic growth and well-being against greater long-term resilience and sustainability.

The gradual transition will have to be perceived as fair to be economically and socially viable

Countries and social groups that can reasonably shoulder the costs involved in the necessary transformations should provide support to those already affected by the negative effects of unsustainable development. However, selling to the public the message that well-off people have to lose out economically in the short run in order to reap environmental benefits and resilience for all in the medium and long run, is counterintuitive in this short-termism era. The size and potential of transformative actions are significantly influenced by the current and future preferences of political economy dynamics. Stakeholders need to understand and effectively "outsmart" these dynamics.

Agrifood sectors are key, yet no longer enough on their own, to ensure sustainable development and equitable access to food

Increasing labour and land productivity in agriculture is just a precondition for economic growth. Crops, livestock, fisheries and forestry continue to be important for employment and income generation everywhere. However, these sectors alone no longer provide enough jobs or income-earning opportunities, particularly in view of the increasing economy-wide capital and information intensity of production and distribution processes. Strong institutions, supported by efficient fiscal systems, are needed to support the emergence of other sectors, ensure economy-wide income-earning opportunities, effective social protection, protection of savings for capital accumulation and widespread asset ownership. In addition, interventions to reduce GHG emissions of agrifood systems will not pay off significantly if efforts to boost energy efficiency are not simultaneously undertaken on an economy-wide basis.

Indigenous Peoples' food and knowledge systems can help nourish the world but are at risk of disappearing in the future

In 2021, the Scientific Group advising the UN Food Systems Summit recognized Indigenous Peoples' food and territorial management systems as game changers for sustainability and resilience. Their territorial management and governance systems enable them to achieve high levels of food self-sufficiency, an efficient use of resources, to adapt to seasonality, domesticate wild species, and enhance biodiversity and in situ genetic resources. A number of lessons can be learned from their food systems about sustainability and resilience that can be useful for agrifood systems and for food security. Yet, Indigenous Peoples' food and knowledge systems are at risk of disappearing in the near future due to lack of dedicated policies and programmes supporting them. Internal and external drivers are jeopardizing their continuity: Extractive industries, deforestation, migration, violence, displacement, climate change and urbanization, among others, exert mounting pressure over the future of these ancestral food systems.

Key priority "triggers" of transformation are available and strategic policy options exist to activate them

Institutions and governance, consumer awareness, income and wealth distribution, and innovative technologies and approaches are key priority triggers that influence important drivers of agrifood

systems. Given their potentially highly transformative impacts, activating these triggers in the complex multilateral and global arena can be politically sensitive and requires outsmarting political economy dynamics and handling trade-offs. International organizations need to be fit-for-purpose to support countries and civil society bodies in this endeavour.

The future of agrifood systems may look like one of the four paradigmatic alternative future scenarios produced by this strategic foresight exercise…

More of the same (MOS), that envisages continuing muddling through by reacting to events and crises; **adjusted future (AFU)**, where some moves towards sustainable agrifood systems occur at a slow, uncertain pace; **race to the bottom (RAB)**, that portrays a world in disarray in the worst version of itself; and **trading off for sustainability (TOS)**, where short-term gross domestic product (GDP) growth and immediate final consumption are traded off for inclusiveness, resilience and sustainability of agrifood, socioeconomic and environmental systems.

…but will depend on the strategic and policy orientations directed at achieving an effective transition towards sustainable and resilient agrifood systems

The choices to be made are between the following: more international cooperation in a multilateral context or pursuit of national interest within few siloed spheres of influence confronting each other; accepting or refusing to change the dominant development paradigm that gives priority to short-termism and productivism, and high-energy and resource intensity; strengthening global governance to address common issues and frame large transnational corporations or leaving global commons unregulated and at the mercy of the most powerful; supporting and joining action with civil society movements to promote sustainable agrifood systems at global, national and local levels to regulate the economy, or disregarding or even silencing them. These choices could all trigger or undermine an effective transition towards sustainable and resilient agrifood systems and the concretization of the “four betters”.

Better production starts from better, critical and informed consumption…

Consumers hold the power to trigger transformative processes by shifting demand towards more environmentally and socially responsible, and nutritious products. Dietary patterns with better nutritional and environmental outcomes can trigger environmental impacts on a scale not achievable with supply side technological changes

only. The emergence of a critical and informed civil society, and active citizenships able to determine governmental action are effective triggers for transformative processes of agrifood systems.

...but producing more with less will also be unavoidable

It is reasonable to expect billions of additional people on the planet in the next decades. However, agrifood systems are already exceeding planetary boundaries for key natural resources, thus undermining the natural resource base on which they depend. Producers of agricultural commodities and food must improve land and water use, increase efficiency of their energy use, protect biodiversity, and restore soils and forests, thus contributing to reduced GHG emissions. These are just some of the challenges that a variety of strategic options need to take into consideration in any search to attain sustainability.

Technological innovations are part of the solution – provided new technologies and approaches are also accessible to the more vulnerable

With current technologies forming one of the factors of unsustainability of agrifood systems, research and development (R&D) and resulting technologies and approaches have major roles to play in triggering and supporting the transition towards sustainability. The reality is, however, that the bulk of R&D spending is concentrated in only few countries, with a considerable share in the hands of private corporations. This poses a risk of technological dependency and difficult access to innovations for a large part of the world.

Investment in agrifood systems is attracting new investors, but disparities across countries and regions are considerable

Investment plays a central role in driving change in agrifood systems. Investment in agrifood systems has recently grown and has attracted new investors such as pension funds, specialized investment funds, endowment funds and impact investors, in addition to traditional private and public investors. However, in HICs, investment per capita in agriculture is five times what it is in sub-Saharan Africa (SSA). A reason for this disparity is that small-scale producers in LMICs have to rely mostly on self-financing as their access to formal credit is constrained.

During the transition towards sustainability, food prices are likely to increase...

Resource degradation and climate change affect negatively agricultural supply, contributing to pushing up prices of agricultural commodities. Moreover, if only part

of the externalities generated by the production and consumption of agricultural products – GHG emissions, loss of biodiversity, degradation of natural resources, health impacts and social costs – is taken into account, food prices are likely to increase significantly.

...yet environmental sustainability and food security can still go hand in hand if more equitable income and wealth distribution are pursued

As the transition towards sustainable agrifood systems is likely to drive up prices, policies that favour of a more equitable distribution of income and wealth within and across countries need to be pursued, in the quest for food security, better nutrition and the environmental sustainability of agrifood systems. Some options to fulfil this goal include: securing an equitable access to assets, such as land, water, forest and capital, as well as to inputs; enhancing skills and know-how to increase human capital; implementing effective social protection schemes and equitable fiscal systems; reducing illicit financial flows that drain resources from low-income countries (LICs); and, last but no less important, developing sustainable technologies and adapting them to small-scale producers. These, and other measures, will significantly contribute to broadening the earning potential for poorer strata of society, both within and outside agrifood systems.

Immense masses of digital data and unprecedented analytical capabilities could trigger transformation of agrifood systems – this, however, is not free of potential hazards

There are great hopes that digitalization will help improve the operational efficiency of agrifood systems (input use, disease control, supply chains management, automation, etc.), thus reducing their environmental impact. Big data platforms have recently entered into agrifood systems and may have already acquired dominating positions. Novel and disruptive business models may threaten traditional operators, as illustrated by the changes since the beginning of the COVID-19 pandemic. Concerns also arise, however, as both big data and analytical capabilities are concentrated in the hands of a few players. Unless duly regulated, this may accelerate power concentration and imbalances, generate more inequality, and exclude poor and unskilled workers.

Agrifood systems should no longer be considered from the rural perspective only – urbanization, rural and urban areas should be seen as integrated entities

The rural–urban dichotomy does not appear to be an adequate axis along which analysing recent evolution of agrifood systems. The borders

between rural and urban areas are increasingly blurred and these areas are becoming more interdependent. To reduce their vulnerability and improve access to services and employment, households adopt strategies that cross rural–urban boundaries. For territorial transformations to be inclusive, particularly for small-scale farmers, strong institutions will be needed.

The "sustainable ocean economies" approach aims at developing sustainably all aquatic sectors, including fisheries – yet, several constraints hamper its implementation

Fisheries, and particularly aquaculture, have been growing at a fast rate over the last three decades and have become a major source of high-quality animal proteins, polyunsaturated fatty acids and micronutrients. This is especially true for aquaculture that is now the main provider of fish products. The practical application of the "sustainable ocean economies" approach, also referred to as the "Blue economy" approach, requires that the governance of aquatic activities become more inclusive. Potentially diverging interests between fisheries and other "Blue economy" activities (e.g. tourism, maritime transport, water desalinization and bioprospecting) may need to be reconciled, otherwise the adoption of the "Blue economy" concept could benefit only large economic operators, rather than fish worker and fish farmer communities.

Competitive and equitable domestic and international markets for inputs and outputs are a precondition for trade to become a trigger of development

International trade is essential for sustainably expanding food availability in countries where the population is expected to increase significantly. Trade has also a role to play in income generation if commercial agreements are set within a solid institutional context that ensures the respect of all stakeholders, including future generations. However, commodity dependence of LICs has to be broken by investing in economic diversification within and outside agrifood systems. Basing decisions on what to produce and trade only on narrowly-defined, short-term comparative advantages may well lead to distorted decisions. More holistic assessments, that also consider resilience and sustainability, are needed, as recent pandemics and conflicts show. Strong global and national institutions are also needed to coordinate efforts across countries and prevent unfair competition against countries that adopt more stringent environmental, social and fiscal regulations.

The future of food and agriculture: the overarching concern and key messages

The COVID-19 pandemic and the emergence of new conflicts both reveal the fragilities of agrifood systems, but lessons learned could trigger positive changes

On the one hand, the COVID-19 pandemic and its successive periods of lockdown have accelerated changes in consumption, particularly in HICs. Previously reluctant consumers have become platform clients, creating a boom of orders, including for food. This has provided incentives for retailers to venture into the digital market, and contributed to shift the retail and catering sectors towards more digital transactions. On the other hand, the pandemic has revealed the fragility of recent achievements in food insecurity and poverty reduction. In addition, recent conflicts have shown that excessive dependence on essential food items from few countries poses a serious threat to global food security. Specialization and ensuing short-term efficiency need to be carefully traded off for longer-term resilience and sustainability.

Global governance for globally shared issues is needed

An overall institutional vacuum is perceived due to the discrepancy between the global level of issues at stake, on the one hand, such as international capital flows, global climate change, international conflicts or local conflicts fed by external dynamics, big data generation, storage, use and control, and, on the other hand, the increasing weakness of most of sovereign countries in governing such issues. With few exceptions, the size of most countries is actually clearly too small to be able to influence, at least to some extent, these global dynamics. Therefore, transformative processes require, as a precondition, much stronger, more transparent and accountable institutions and governance across all domains of agrifood systems and their socioeconomic and environmental contexts.

All countries, starting from wealthier ones, must commit to implementing fundamental structural changes and shoulder their costs

Agrifood transformative processes require that each country decipher how to trigger engines of sustainable growth for broad economic development. Fundamental changes in the way all societies consume and produce are needed. Starting from wealthier societies that consume more, all countries have to renew the assets they use to produce goods and services, develop new solutions, implement innovative technologies and move along sustainable consumption patterns. In addition, in the spirit of solidarity enshrined in Agenda 2030,

countries and social groups that can reasonably shoulder the costs involved in the necessary transformations have to provide support to those already affected by the negative impacts of unsustainable development, and help them construct a more equitable and better future for generations to come.

INTRODUCTION

Goals. The report, *The future of food and agriculture – Drivers and triggers for transformation*, aims at enriching the strategic thinking about, and inspire actions for, the necessary transformation that agrifood systems require, not only to progress towards FAO's global objectives and SDGs of Agenda 2030, but also, and perhaps more importantly, move agrifood systems towards sustainability and resilience. Indeed, agrifood systems face uncertainties that give rise to serious questions and concerns regarding their current and future performances and sustainability. For this reason, countries, international organizations, civil society and academia are increasingly requesting authoritative foresight exercises that outline alternative scenarios and highlight potential pathways for food and agricultural systems.

Background. This report is grounded on a comprehensive Corporate Strategic Foresight Exercise (CSFE) that benefitted from various consultations, surveys and thematic work, notably: an Internal Expert Consultation (IEC), that engaged more than forty FAO experts at headquarters and in Decentralized Offices; a Staff Sample Survey (SSS) that involved around 300 randomly selected FAO staff, through which visions about possible futures were elicited; a call-for-papers, addressed to FAO's technical divisions, which deepened the analysis of each of the drivers identified by the IEC; and an External Expert Consultation (EEC), that engaged representatives from civil society, academia, the media, the Informal Strategic Foresight Network of the United Nations High Level Committee on Programmes (UN HLCP), of which FAO is an active member, and the Futures Literacy Team of the United Nations Educational, Scientific and Cultural Organization (UNESCO), which coordinates this UN network. While providing the conceptual and technical backbone of this report, the findings of the above exercises contributed to the preparation of FAO *Strategic Framework 2022–31*. This report provides a thematic and technical deepening of the analyses of drivers, triggers and challenges provided by the CSFE in the Strategic Framework and proposes pointers on how to achieve the four aspirational "betters" of the Organization: better production, better nutrition, better environment and better life.[1]

Key drivers of agrifood systems and priority triggers for transformation. It was already clearly stated in the first report of the series, *The future of food and agriculture – Trends and challenges*, that "business as usual

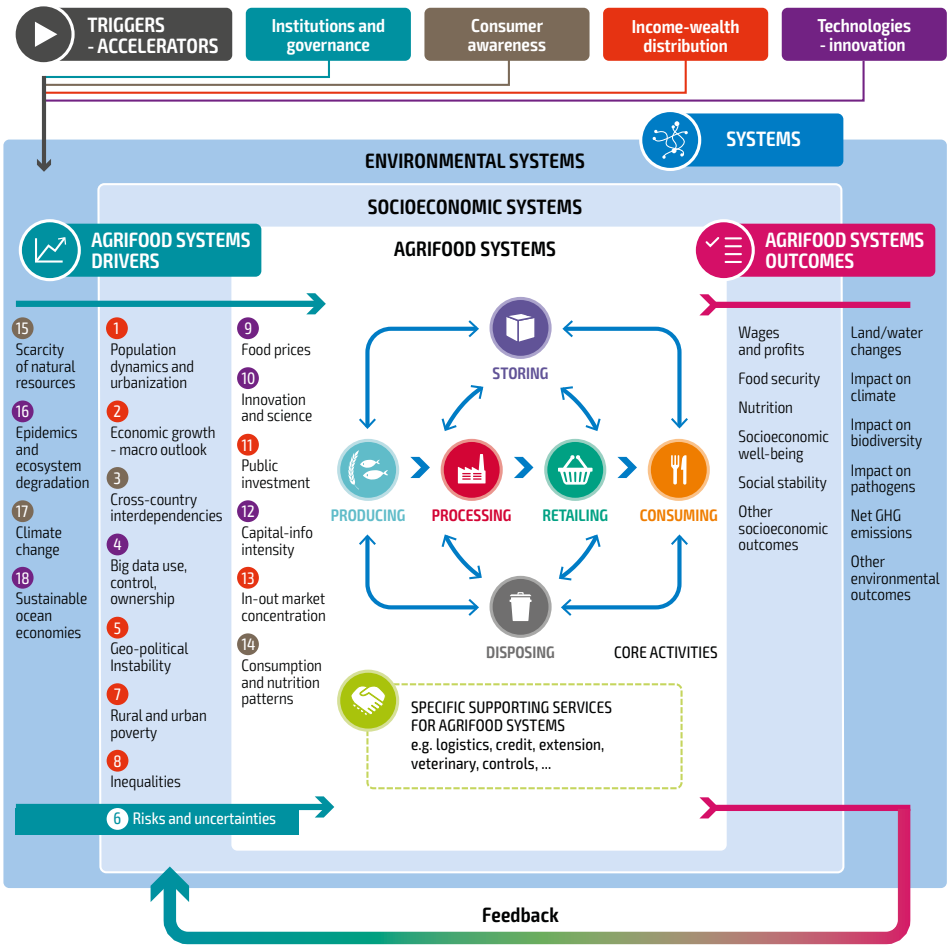
[1] The CSFE was implemented in synergy with the Strategic Framework process, with mutual relationships and continuous interactions between the teams in charge of the two processes. CSFE's contributions are reflected in FAO *Strategic Framework 2022–31* (see Section B, paragraphs 24–41; Table 1 "Critical drivers of agrifood systems and related trends"; and related annex on pages 31–36).

is no longer an option". If agrifood systems remain on their current paths, the evidence points to a future characterized by persistent food insecurity, degrading resources and unsustainable economic growth. To trigger transformative processes to reverse these negative trends, it is imperative to understand which forces drive the pathways of agrifood systems, the way these forces interact, possible ways to shift their patterns, how to address trade-offs among different objectives that may emerge along transformative processes, and the actions needed to balance them in order to achieve desired objectives.

The CSFE identified 18 interconnected socioeconomic and environmental drivers, and the related trends that can shape the future of agrifood systems (see **Figure 1.1**, left-hand side part). This report analyses each of these drivers in detail, thanks to the contributions of the relevant FAO Technical Divisions. Throughout the report, the systemic nature of these drivers is underlined by highlighting their mutual linkages and interdependencies. The systemic approach adopted to investigate the future of agrifood systems also justifies the vast scope of the matters covered by the report. Refraining from considering and analysing key socioeconomic and environmental forces that are likely to influence the future patterns of agrifood systems is not advisable. Omitting some of them would have resulted in a simplistic and limited view of the complexity of agrifood systems, their mutual relationships with the broader socioeconomic and environmental systems, their causal linkages and dynamics.

The CSFE also identified key families of "triggers of change" to be considered in this process. They are effective starting points or boosters (depending on the context) for transformative processes to move away from "business as usual". These families of triggers include: i) institutions and governance; ii) consumer awareness; iii) income and wealth distribution; and iv) innovative technologies (see **Figure 1.1**, top part). These triggers, to be still further articulated, complemented and made context-specific, are expected to influence important drivers of agrifood systems (see **Figure 1.1**, right hand-side part). Given their potentially high transformative impacts, activating these triggers in the complex multilateral arena can be politically sensitive.

FIGURE 1.1 **AGRIFOOD SYSTEMS: KEY DRIVERS, ACTIVITIES, OUTCOMES AND PRIORITY TRIGGERS FOR TRANSFORMATION**



Notes: Core activities of agrifood systems (production, processing, retailing etc.), which are interlinked through flows of goods and services (items in the white box at the centre), occur within broader socioeconomic and environmental systems (light blue and dark blue boxes). Socioeconomic and environmental drivers, as well as selected drivers determined within the agrifood systems themselves, (labels on the left-hand side of the figure), influence the state and dynamics of agrifood systems and their socioeconomic and environmental outcomes (labels on the right-hand side of the figure). Triggers of change (top of the figure) affect agrifood systems and their outcomes through their impacts on selected environmental, socioeconomic and agrifood drivers (labels on the left of the figure in the first, second and third columns, respectively). The different colours of drivers reflect their relationship with the trigger affecting them. The trigger designated "Institutions and governance" affects all drivers and directly impinges on the functioning of the whole agrifood system and its relationships with the other systems. Given the systemic relationships among drivers, core activities of agrifood systems and their outcomes, the various triggers may concurrently affect different drivers, while each driver can be also affected by different triggers of change. The overall graph, core activities and outcomes were adapted from the Foresight4Food website (https://foresight4food.net/the-dynamics-of-food-systems-a-conceptual-model).

Source: Drivers and triggers based on FAO. 2020. *Transforming agri-food systems in an evolving socio-economic, political, and environmental context.* Report of the Internal Expert Consultation, June-October 2020. Corporate Strategic foresight exercise. Unpublished. Rome.

1 DRIVERS OF AGRIFOOD SYSTEMS

This chapter delves into the 18 key socioeconomic and environmental drivers that impact agrifood systems and related performances. Each section outlines the issues at stake, articulates the fundamental questions regarding the sustainability and resilience of agrifood systems raised above, provides facts and figures regarding the driver, looks at forward-looking work being done by others, and discusses some anticipatory signals that could reveal possible future trends and events.

Given that the analysis of drivers is supported by a large amount of quantitative data and the scenario narratives, albeit qualitative, rest on a set of projections of key variables, this report is complemented by a web-based data dashboard (available at www.fao.org/global-perspectives-studies/FOFA-dtt-dashboard), where users can visualize graphs and tables, download data files and interactively personalize their analyses.

The drivers analysed in Chapter 1 are summarized in **Table 1.1** and briefly outlined below.

TABLE 1.1 CRITICAL DRIVERS OF AGRIFOOD SYSTEMS AND RELATED TRENDS

A. Systemic (overarching) drivers
1. Population dynamics and urbanization. A recent United Nations report on megatrends states that "between 2020 and 2050, globally, the portion of people living in urban areas will shift from 53 percent to 70 percent", while by that date the world population could reach 9.8 billion people, with implications for agrifood systems.
2. Economic growth, structural transformation and the macroeconomic outlook may not always be conducive to the inclusive economic transformation of societies. The United Nations Conference on Trade and Development (UNCTAD) has acknowledged that "if the current policy stances continue, [...] as labour shares across the world continue on their decreasing path, household spending will weaken, further reducing the incentive to invest in productive activities."
3. Cross-country interdependencies tie together agrifood systems globally with both positive impacts and drawbacks. For instance, *The State of Food Security and Nutrition in the World 2019* report states "eighty percent of the countries (52 out of 65) with a rise in hunger during recent economic slowdowns and downturns are countries whose economies are highly dependent on primary commodities for export and/or import."
4. Big data generation, control, use and ownership enable real-time innovative technologies and decision-making in agriculture, but also raise some concerns because "a few players have come to dominate large shares of the market" and there are "big data platforms that are able to amass extraordinary amounts of information on consumer behaviour and preferences."

5. Geopolitical instability and increasing conflicts, which include resource- and energy-based conflicts, undermine food security and nutrition. *The State of Food Security and Nutrition in the World 2017* report, for instance, highlights that the vast majority of the chronically food-insecure and malnourished people live in countries affected by conflicts.

6. Uncertainties materialize in sudden occurrences that are unpredictable, the COVID-19 pandemic being a critical case in point. As per the FAO 2018 report *The future of food and agriculture – Alternative pathways to 2050*, "the future of food and agriculture faces uncertainties that [...] revolve around different factors, including population growth, dietary choices, technological progress, income distribution, the state of natural resources, climate change, the sustainability of peace".

B. Drivers directly affecting food access and livelihoods

7. Rural and urban poverty, characterized by a high proportion of rural people living in poverty or extreme poverty. The number of food-insecure people is increasing and malnourishment is widespread because, as stated in *The State of Food Security and Nutrition in the World 2020*, "the cost of a healthy diet is much higher than the international [extreme] poverty line."

8. Inequalities are widespread and deep-rooted with regard to income, job opportunities, access to assets and basic services, which tend to affect women relatively more. There are also inequalities that emerge from the ways the fiscal burden affects people. The International Monetary Fund (IMF) and the Organisation for Economic Co-operation and Development (OECD) have highlighted that increased inequality can erode social cohesion, lead to political polarization and ultimately lower economic growth.

9. Food prices – measured by the FAO real Food Price Index (FFPI), that calculates the average of the price indices of five commodity groups and deflates it with a price index of manufactured goods – after following a declining or stagnating trend until the end of the century, significantly increased in the last two decades, despite the fact that prices still fail to capture the full social and environmental costs of food.

C. Drivers directly affecting food and agricultural production and distribution processes

10. Innovation and science, including biotechnologies, digitalization and systemic approaches (e.g. agroecology, conservation and organic agriculture), open up interesting avenues for agrifood systems, but also pose challenges, as highlighted in a recent report of the United Nations Secretary-General.

11. Public investment in agrifood systems, which is often insufficient, decreased significantly in the last 15 years, as shown by the FAO Agriculture Orientation Index (AOI) for Government Expenditures.

12. Capital and information intensity of production is increasing in agriculture as a result of mechanization, automation and digitalization, which, other things being equal, lowers labour demand. At the same time, a traditional absorber of excess agricultural labour, such as the manufacturing sector, is itself undergoing the same intensification.

13. Input and output market concentration poses a challenge for the resilience and equitability of agrifood systems. A recent United Nations Conference for Trade and Development (UNCTAD) report highlights that "increased market concentration and rising mark-ups have become commonplace across many sectors and economies, with rent-seeking behaviour dominating at the top of the corporate food chain".

14. Consumption and nutrition patterns are shaped by consumer behaviour and, for them to become more sustainable, changes in global governance are needed. For instance, "carbon labelling could help shape consumer preferences, [but] would require an internationally recognized approach in setting the related standards".

D. Drivers regarding environmental systems
15. Scarcity and degradation of natural resources. The GEO-6 report of the United Nations Environment Programme (UNEP) states that "inefficient or unsustainable farming systems are often associated with environmental and soil degradation and biodiversity loss, and an increase in crop specialization and distribution can raise the risk of poor harvests."
16. Epidemics and degradation of ecosystems may increase because of the encroachment of agriculture in forests, antimicrobial resistance, and the production and consumption of animal products. According to a report by UNEP and the International Livestock Research Institute (ILRI), the "pathogens originate in animals, the emergence or spillover of the diseases they cause in humans is usually the result of human actions, such as intensifying livestock production or degrading and fragmenting ecosystems."
17. Climate change is affecting agrifood systems and natural resources. However, as stated in a recent International Panel on Climate Change (IPCC) report, "an estimated 23 percent of total anthropogenic GHG emissions (2007–2016) derive from Agriculture, Forestry and Other Land Use (AFOLU)".
18. The "sustainable ocean economies" approach notes that the development of economic activities related to the fisheries and aquaculture sector is increasing globally. A recent IPCC report highlights the importance of a reorganization and enhancement of ocean industries to reduce GHG emissions, adapt to climate change and achieve environmental, social and economic sustainability, and resilience.

Sources: Adapted from FAO. 2020. *Transforming agri-food systems in an evolving socio-economic, political, and environmental context.* Report of the Internal Expert Consultation, June–October 2020. Corporate strategic foresight exercise. Unpublished. Rome; and FAO. 2021. *Strategic Framework 2022–31.* Rome. www.fao.org/3/cb7099en/cb7099en.pdf

Population dynamics and urbanization (Driver 1). People are at the heart of agrifood systems, and few drivers are as crucial as population dynamics in shaping them. While the number of people and the structure of population only evolves slowly over time, the spatial distribution and occupation of people may change rapidly and impact agrifood systems. The world's demographic centre of gravity is shifting to LICs.[2]

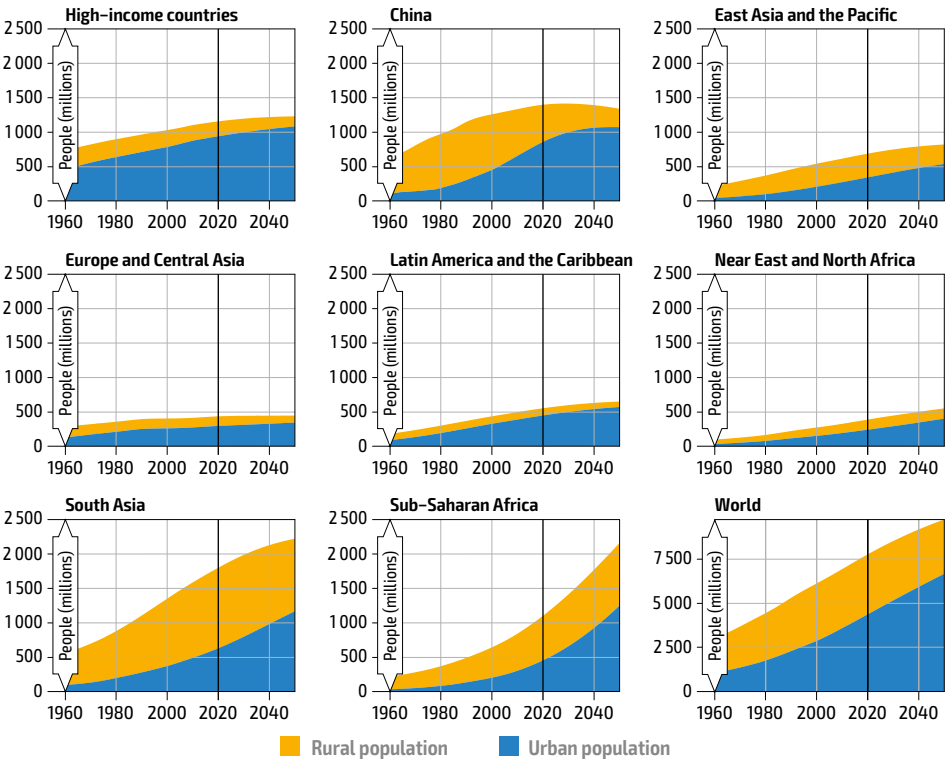
World population has multiplied by 2.5 since 1960 and reached an estimated 7.8 billion people in 2020. **Figure 1.11** depicts the considerable demographic diversity with respect to population growth rates in the various country groups considered in this report.

[2] Country grouping is based on the World Bank Country Groups of 2021, downloaded on from http://databank.worldbank.org/data/download/site-content/CLASS.xlsx. High-income countries (HICs) are classified in a single group, regardless their geographical location. All other countries, qualified as low- and middle-income countries (LMICs), are classified by geographical region, notably Europe and Central Asia (ECA), East Asia and the Pacific (EAP), South Asia (SAS), Latin America and the Caribbean (LAC), Near East and North Africa (NNA) and sub-Saharan Africa (SSA). If not otherwise specified, LMICs and EAP exclude China, which is considered as one country which comprise the Special Administrative Regions (SARs) of Taiwan, Hong Kong and Macao. Country groups and China are hereafter generally referred to as "regions" (see Annex 1). In some parts of the report, reference is also directly made to the World Bank classification: low-, lower-middle-, upper-middle- and high-income countries. In such instances, unless otherwise specified, no acronyms are used for lower- and upper-middle-income countries, while low-income countries are referred to as LICs. Furthermore, throughout the report the terms "developing countries" and "developed countries" are not adopted, apart from cases where other works are quoted. Even in those cases, no value judgement is implied regarding the level, stage or state of development of any country implicitly or explicitly referred to.

Food consumption has been growing even faster than population because of changes in demographic structure, income and food preferences. Population increase, limited access to resources, the low quality of public goods and services, little or no increase in agricultural productivity and the lack of growth in non-agricultural activities are all factors that push people to migrate towards urban areas, especially megacities. This constitutes an overall aggravation of poverty, environmental degradation and vulnerability.

The provision of employment to youths is a major challenge now and it will be in the future, particularly in regions such as sub-Saharan Africa (SSA), where the development of industries and services is not taking place fast enough to offer decent jobs to new urban dwellers.

FIGURE 1.11 **URBAN AND RURAL POPULATION BY REGION: HISTORICAL (1960–2020) AND PROJECTED (2021–2050)**



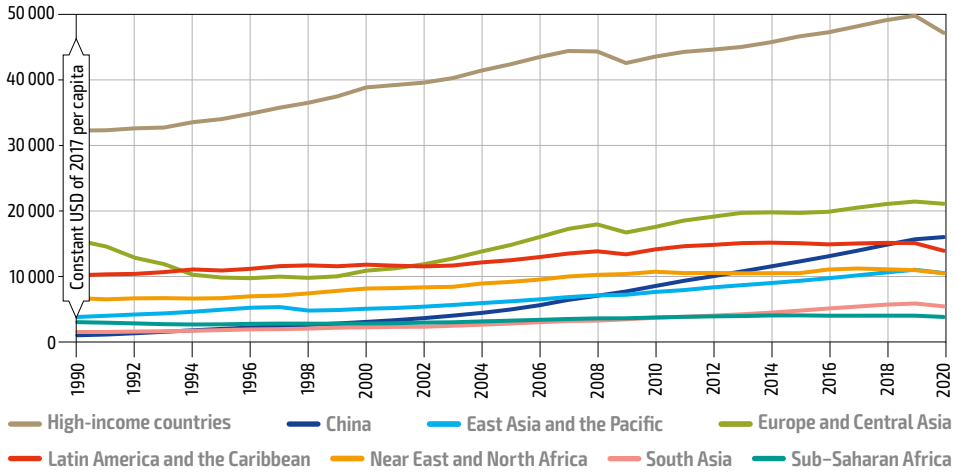
Note: Projected population refers to the United Nations medium variant projection.

Source: Authors' elaboration based on United Nations. 2018. World Urbanization Prospects: The 2018 Revision, Online Edition. Department of Economic and Social Affairs, Population Division. New York, USA. Cited 18 May 2022. https://population.un.org/wup/Download

Economic growth and structural transformation (Driver 2).
The narrative of the shift of labour out of agriculture and into higher productivity economic activities that bring higher wages, growth and well-being, is the conventional wisdom regarding structural transformation and development. Yet, this interpretation faces two deep problems today: first, the benefits of the transformation are failing to materialize for many LICs (and people), thus revealing its social unsustainability; and second, economic activities, specifically in today's HICs, are unsustainable on environmental grounds. From an ecological economics perspective, this implies that economic growth, and, in fact, the maintenance of the economic results achieved so far, have to be reconciled with the biophysical boundaries of the planet.

Figure 1.12 shows that despite the decline in GDP per capita in HICs after the 2007–2008 financial crisis, and the impressive growth in middle-income countries, particularly China and India in the 2000s, the gap among HICs and LMICs remains extremely wide, with little evidence of convergence between these countries. SSA appears to be in a desperate condition as there is no sign of growth in per capita terms. From an ecological economics perspective, taken as a whole, humanity is exceeding biophysical "planetary boundaries", leading to calls for a transition to "prosperity without growth", specifically in HICs. For the world as a whole, a goal of sustainable development is to live within a "safe and just space", remaining within the Earth's ecological ceiling while pursuing global social justice.

FIGURE 1.12 **GDP PER CAPITA AT PURCHASING POWER PARITY BY REGION (1990–2020)**



Source: Authors' elaboration based on World Bank. 2022. DataBank | World Development Indicators. In: *World Bank*. Washington, DC. Cited 4 June 2022. https://databank.worldbank.org/source/world-development-indicators

Cross-country interdependencies (Driver 3). Cross-country interdependencies abound within agrifood systems. The global economy, and the global agrifood system within it, are interlinked through trade, finance and migrations, as well as through global commons, such as the atmosphere, oceans, or shared land, and also immaterial ties, such as traditions, common knowledge, global security and peace. Within this context, global governance, the national institutional set-up and contractual power relationships matter to determine the performances, sustainability and resilience of agrifood systems. Issues arising from the cross-country interlinkages, such as the commodity-dependency of many countries that jeopardizes their resiliency; the possibility to repurpose agricultural subsidies to achieve more sustainable and resilient agrifood systems, or the issue of illicit financial flows that drain resources from LICs, could be neglected or energetically addressed. Decisions taken in one direction or another could contribute to increasing or jeopardizing the overall sustainability and resilience of agrifood systems.

Big data (Driver 4). Managing big data is the process of gathering, storing, analysing and extracting knowledge from high-volume and complex data, often by means of artificial intelligence (AI) and algorithms, including machine learning. Big data, along with its data-driven analysis, seems to be successful in many domains, but it started being applied to agrifood systems only relatively recently, particularly in the context of precision agriculture, smart farming and digital farming. With the multiplication of data and of the means of collecting them, users will increasingly want to protect the ownership and privacy of their data. While policy and regulations that govern personal data are becoming more frequent, there are currently few, if any, legal or regulatory frameworks aimed specifically at agriculture and food data that clarify who can create value from data, including those generated by the "Internet of Things" (IoT) sensors bound together with devices of all sorts, and under which conditions. As big data and related data analytics are potential game changers, the changes will be for the good or the bad of smallholders and the overall sustainability of agrifood systems, depending on whether effective institutions and governance mechanisms at national and global level will be able to set the rules of the game to ensure positive outcomes.

Geopolitical instability and increasing impacts of conflicts (Driver 5). Increasing instability and conflicts, including resource- and energy-based ones, form a major driver of food insecurity and malnutrition. In recent years, the world has witnessed a decline in global cooperation and security. There have been multiple internationalized wars – civil wars with involvement of external parties and ongoing large-scale humanitarian crises, rising nationalism, transnational terror

organizations, cyber-attacks, sustained levels of violence in nominally "post-conflict" countries and a drastic increase in the number of non-state violent agents. Extractive activities tend to be concentrated in rural areas, particularly affecting Indigenous Peoples' territories, where the majority of the remaining natural resources and biodiversity are concentrated. This has been a recurrent reason for socioeconomic and – territorial conflicts generating displacement and violence. Military expenditure has been increasing in HICs and in many LMICs since the turn of the century, after a global slowdown in the aftermath of the end of the "cold war". This report also demonstrates that conflicts, or protracted crises, affect the outcomes of agrifood systems: in countries where conflicts or protracted crises are ongoing, the prevalence of undernourishment is two to three times higher than in LMICs, on average. At the same time conflicts are also be trimmed within agrifood systems: food price surges often act as catalysts for other grievances such as unemployment, low incomes, unpaid salaries, political marginalization and lack of access to basic services.

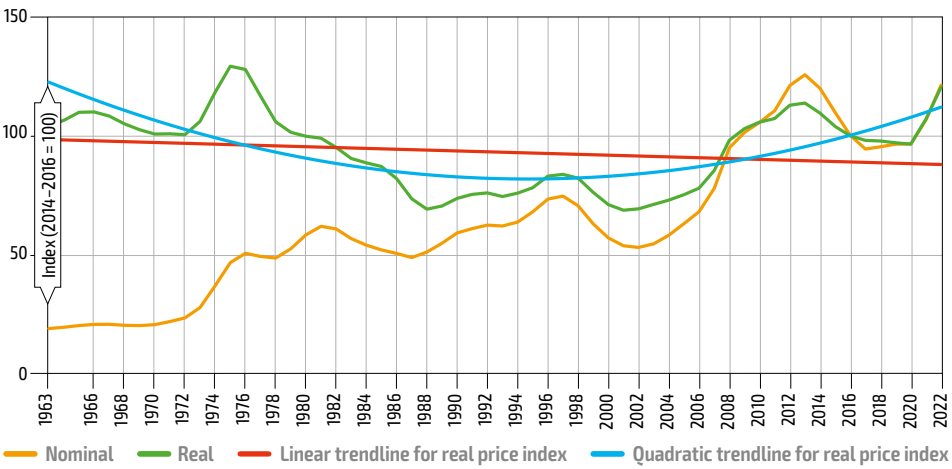
Risks and uncertainties (Driver 6). Despite the growing mass of knowledge and experience accumulated and technologies developed by humanity, the world remains full of risks and uncertainties. In fact, uncertainty may have become the zeitgeist of a period marked by a human health crisis which exacerbates unfolding global emergencies associated with climate change, biodiversity loss, pollution, conflicts and the resulting increase of world food insecurity. There are clear signals that uncertainty is growing. The cumulative impact of multiple risks and interconnected crises has turned into a major source of insecurity and uncertainty, and it may create conditions where cascading, cumulative and synergetic impacts have the potential to generate a snowball effect and lead to a tipping point, beyond which the world would enter unknown territory and massive global emergency. However, as knowledge on key issues and their underlying processes improve, there is hope that their future evolution should be less prone to uncertainties, and that risks and impacts could be more precisely assessed, monitored, managed and prevented.

Poverty and inequality (Drivers 7 and 8). The decreasing poverty and inequality trends have been reversed because of the COVID-19 pandemic, demonstrating the fragility of past achievements. Although the 2030 Agenda for Sustainable Development is grounded on the principle of "Leave no one behind", in many instances, specific groups within societies, such as the elderly, children and youth, women, migrants and Indigenous Peoples, still confront high risks of discrimination and marginalization that can place them in situations of vulnerability, inadequate access to entitlements and economic poverty. Several traits of agrifood systems perpetuate poverty

and inequalities: land distribution and access, low incomes resulting from low food price policies and exclusion of small producers from agrifood value chains. Moreover, smallholder farmers lack the means to cope with natural resources degradation and climate change. In the case of SSA, significantly higher poverty levels than in other regions are probably a consequence of the slow structural transformation of the economy, characterized by a stable share of agriculture in GDP and a relatively slow development of manufacturing and services that do not generate sufficient decent employment and income opportunities. Poverty is also associated with deforestation and degradation of forests, and unsustainable management of marginal land. Whether strategies to reduce the striking inequalities between HICs and LMICs and to address within-country inequalities will be adopted or not, the world could move towards a future characterized by more inequality, or better distributed income and wealth.

Food prices (Driver 9). Analyses conducted in this report show clear signs that food prices are on the rise at all levels. At the global bulk markets level, as illustrated by the FAO Food Price Index, agricultural prices in real terms (that is, compared to the prices of manufactured goods) have been increasing since the turn of the century, after four decades of declining or stagnant trends (see Figure 1.41).

FIGURE 1.41 FAO NOMINAL AND REAL FOOD PRICE INDICES (1963–2022)



Notes: The FAO nominal food price index is calculated as the average of the price indices for five commodity groups weighted with the average export shares of each of the groups over 2014–2016. The FAO real food price index is calculated by deflating the nominal price index with the World Bank manufactures unit value index (MUV). Real price index, linear trend equation $y = 441 - 0.174x$ ($R^2 = 0.04$); real price index, second order polynomial $y = 1.58 * 10^5 - 158x + 0.0397x^2$ ($R^2 = 0.49$). Data for each year are calculated using a three-year right-aligned moving average.

Source: Authors' elaboration based on FAO. 2022. World Food Situation | FAO Food Price Index. In: *FAO*. Rome. Cited 18 May 2022. www.fao.org/worldfoodsituation/foodpricesindex/en

Ongoing degradation of natural resources, the impacts of climate change on yields, pests and diseases, and the impacts of pollutants on pollinators and changing policies, all contribute to create uncertainty and tensions that might push food prices further up. Prices would plausibly further increase if externalities were accounted for and internalized to reorient food systems towards greater sustainability, or if bioeconomy agricultural commodities are increasingly used to produce non-food goods, or if prices of energy continue to rise. At the farm level, prices are strongly influenced by incentives and subsidies, aimed at keeping consumer prices low and advantaging national products. This also creates unduly negative externalities, including GHG emissions, although the trends in HICs may be changing. At the consumer level, food prices have followed an upward direction, albeit more limited than bulk and producer prices. If, specifically in HICs, the signs currently indicating some movement by consumers towards less resource-intensive dietary patterns with better nutritional and environmental outcomes are confirmed, and if this movement accelerates, it would considerably diminish the pressure on agricultural demand, although some food items could be more labour-intensive, and thus more expensive particularly in HICs, where agricultural wages are comparable to those in the rest of the economy.

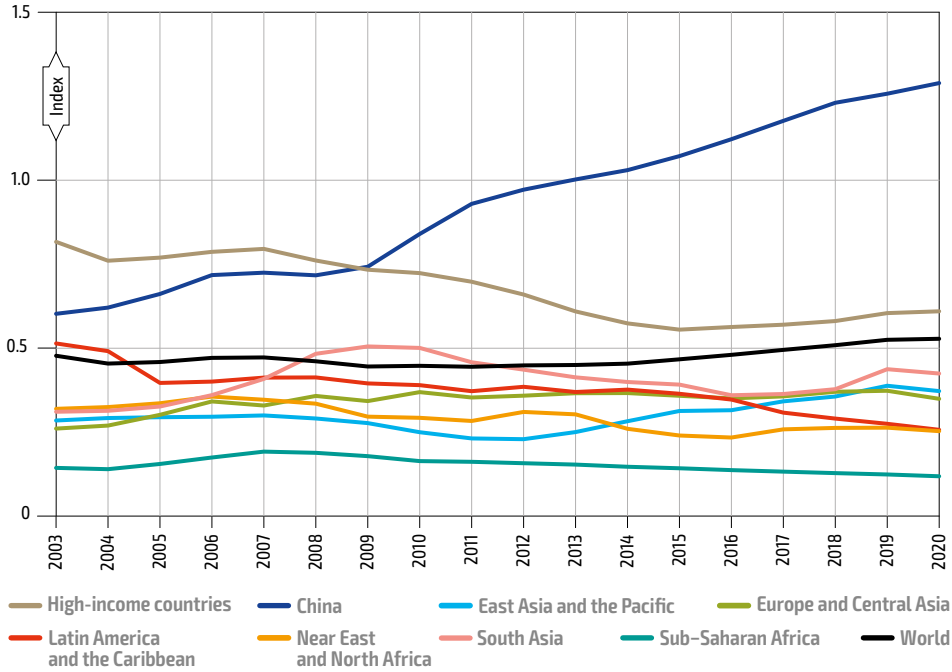
Innovation and science (Driver 10). There is a need to innovate to help transform dysfunctional agrifood systems, as the current model generates a series of ills that are compromising prospects for the future. Anthropogenic GHG emissions responsible for climate change, loss of biodiversity, degradation of land and water and resources, and food waste are some of the negative impacts of how agrifood systems have been managed so far. Science and innovation are fast advancing fields whose promise is immense, but there are also risks, as rapid developments can outpace the ability of societies to adapt, and existing socioeconomic inequalities and adverse environmental effects can be exacerbated. Eighty percent of global investment in research and development (including, but not limited to, the agricultural sector) is concentrated in ten countries. If past trends continue unaltered, large middle-income countries will likely play a greater role in innovation and science, aside from HICs, that dominate the field; whereas LICs, particularly in SSA, risk to be marginalized and remain "technology takers". This applies to science, technology, engineering and mathematics research in general, but also for research specifically related to agrifood systems. Biotechnologies as well digitalization and geoengineering have an important potential but face strong resistance based on the need to improve knowledge concerning possibly unknown side effects. Agroecological and other alternative, environment-friendly approaches also address social inequalities, as do some supply chain innovations. In this endeavour,

consideration of traditional knowledge and the transformative potential of Indigenous food and knowledge systems may help. In the field of policy, innovations such as citizens' conventions or assemblies made up by members drawn by lot, or legal actions aimed at curving government policies, are becoming more numerous, but their impact has yet to be felt. A major issue in the near future will be how and in which institutional framework are technologies and innovations to be governed, who will benefit from them and what will guide their regulation. In particular, how will the relative weight given to productivity, sustainability and inclusiveness be determined. In fact, the outcomes of the technologies and innovations listed in this chapter depend on the extent to which they address the needs of small-scale producers, whether civil rights are enforced, and an effective legal system ensures the respect of contracts as well as the protection of ownership (including Intellectual Property Rights), and that society operates on the basis of transparent rules.

Investment in agrifood systems (Driver 11). Investment plays a central role in transforming agrifood systems. It has been growing and engaging new private actors such as pension funds, specialized investment funds, endowment funds and impact investors, in addition to pre-existing private corporations, traders and public organizations. Hybrid mechanisms, such as blended finance, that strategically utilize public funds to attract private investment are increasingly important. However, considerable disparities across countries exist. For instance, per capita investment in HICs, which, together with China, total more than half of the overall investment, is five times larger than in SSA. Foreign direct investment is low in agrifood systems, relative to other sectors, and mostly linked to exports. In contrast, self-financing remains the largest source of investment for farmers, who often rely on informal providers such as credit cooperatives and village savings associations, particularly in LMICs. Evidence also suggests that the lack of domestic investments in downstream segments of value chains does not permit capturing value addition, creating jobs and benefitting from their economy-wide multiplier effects. If past trends continue unaltered, private investment will continue to be the main source of funding. However, smallholders, with little or no capacity to save, may become increasingly marginalized. More than ever, public action and investment are critical to provide indispensable public goods and ensure both inclusivity and sustainability of private investment. Unfortunately, if China is excluded, the proportion of public resources allocated to agriculture is globally much less than the sector's weight in the economy and decreasing in most regions (see **Figure 1.50**).

Capital and information intensity of production (Driver 12). "Capital deepening", that is, the increase of capital per unit of labour, occurred

FIGURE 1.50 **ORIENTATION INDEX OF GOVERNMENT EXPENDITURE IN AGRICULTURE BY REGION (2003–2020)**



Notes: "Agriculture" includes forestry and fisheries. "Government" refers to general government, including all the government levels in each country, when data is available. The Agricultural orientation index of government expenditure in agriculture (GEA) is calculated as: GEA/government expenditure (economy-wide) divided by value added in agriculture/GDP (share of agricultural expenditure divided by the share of value added).

Sources: Authors' elaboration. Government expenditure based on FAO. 2022. SDG indicators in: *FAOSTAT*. Rome. Cited 30 June 2022. www.fao.org/faostat/en/#data/SDGB and selected unpublished background data to such dataset.

in the last decades both in HICs and middle-income countries, leading to labour productivity growth. However, without considering LICs, the labour productivity gap between these countries is still huge and barely converging. This partially explains the vast wage differentials that exist between similar jobs in different countries. In contrast, since the 1950s capital productivity was stagnant in HICs and fell in middle-income countries, thus the gap was closed in the 1990s. This not only signals an essentially "labour-saving" technological change, but has further implications for the wage differential between the two groups of countries. Investors demand higher profits rates in middle-income countries because they are riskier. In the past, higher profit rates in those countries were granted by higher capital productivity. Today they can only be granted by comparatively lower wages. This also

explains the important wage gaps that exist. New technologies automate jobs that had until now been irreplaceable. Depending on where (in which groups of countries) they will be predominantly applied, the wage gaps could increase (if applied predominantly in HICs) or, conversely, decrease. In addition, the new technologies influence both the value-added sharing between labour (workers) and capital (owners), but, depending on their ownership (whether domestic or foreign), as well as the value-added sharing between domestic and foreign agents.

With the development of automated and digital technologies, low-skilled routine jobs are being replaced by high-skilled jobs. With information and communication technology, there will be gainers and losers, as literate farmers stand to gain, while others may have to move to other sectors, in search of still existing low-skilled, low-wage jobs. On the natural resource side, those technologies are expected to reduce resource use per unit of output, including land, water and agrochemicals. But resource savings can be offset if the output increases. Therefore, protecting natural resources for a sustainable future cannot be left to productivity growth alone. In this context, the concept of "information intensity" of production still requires to be clearly defined. What is clear is that rapidly falling costs of robust sensors may cause data gathering through digital technologies to become widespread, even in LICs. The concern is that the data collected there will typically be stored on platforms (very often foreign) that control the technology and use data to further control processes and/or sell processed information to their customers for other uses. Overall, if not properly governed, technological change, through the foreign ownership of capital and the foreign (or at least off-farm) ownership of data, can shift patterns of ownership and control over production and resources.

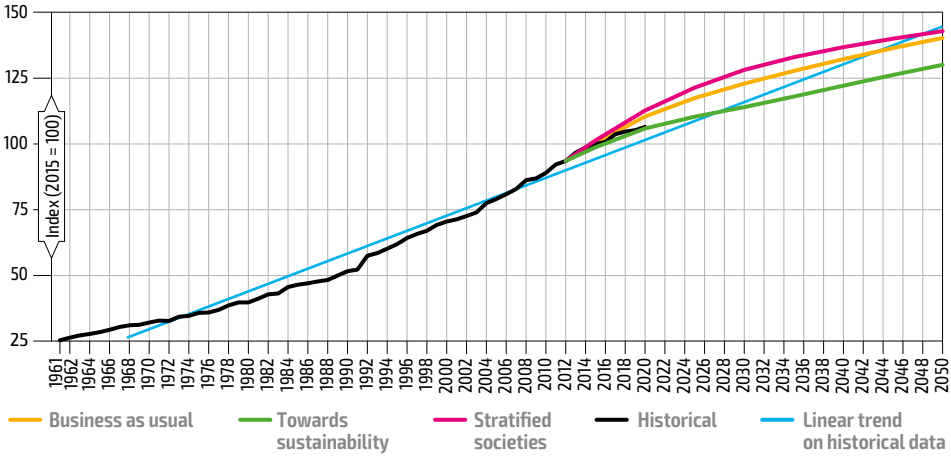
Market concentration of food, and agricultural inputs and outputs (Driver 13). Recent history of the food and agriculture sector has been characterized by concentration. Large corporations have emerged at every level of the food systems, from agricultural inputs provision to food retail. In agriculture proper, farm size has grown in HICs, while in LMICs, a mass of nearly 600 million increasingly fragmented smallholders coexists with mega-farms. The spectacular growth of international trade in agricultural commodities has led to new forms of organization. Global value chains structure the world food economy and have become major suppliers of food and agricultural products around the planet, governed by powerful lead firms that define private production and processing standards to meet consumers' requirements. With the advent of supermarkets, during the twentieth century, and now of digital platforms whose role in food has been accelerated by the COVID-19 pandemic, new forms of economic power are being concentrated in a handful of

corporations that cut across interlinked markets. Innovations such as zero-price markets, multi-sided platforms, attention markets and big data analysis create new opportunities for concentrating economic power and accumulating wealth. If past trends continue, further concentration in food systems may be expected, with uncertain impacts on hundreds of millions of smallholders whose odds of being excluded and pushed towards urban areas throughout the world, particularly in LMICs, may increase. If the "consume local" movement that was boosted during the COVID-19 pandemic, gains further strength at the global level, an alliance of consumers and producers able to take the lead in piloting the food systems through a transition towards greater sustainability could contribute to changing the rules of the game.

Consumption and nutrition patterns (Driver 14). With the acceleration of dietary transitions in many LMICs towards higher consumption of resource-intensive foods and Western-style diets, three major interrelated challenges lie ahead for the coming decades: malnutrition in all its forms (undernutrition, micronutrient deficiencies, overweight and obesity), resurging undernourishment and the current unsustainability of agrifood systems. The exacerbated consumption of food of animal origin, particularly in HICs, may reduce the efficiency of food systems, because of low energy and protein conversion rates from feed to food, thus generating high GHG emissions and undue pressure on natural resources. Dietary patterns with better nutritional and environmental outcomes are possible and have a transformative potential for agrifood systems on a scale not achievable with supply-side technological changes only, by contributing to limit the required increases of agricultural output in the next decades (see scenario "towards sustainability" in **Figure A** of **Box 1.41**). There are signs that highly educated and well-off consumers in urban areas have started to adopt alternative behaviours, swayed by influencers, activists or consumer movements and associations. However, consolidating these changes requires guidance (e.g. nudges, food labelling, information and education) and incentives from public authorities. In fact, a majority of vulnerable consumers with limited information and reduced purchasing power may be left out of this movement if they are not provided support. However, on the one hand, it is particularly important not to neglect major structural, power and political challenges that compromise scaling-up these changes. On the other hand, if past trends in food consumption continue, the risk is high that the impact of agrifood systems on climate change and natural resource degradation will further increase.

Scarcity and degradation of natural resources (Driver 15). A review of the causes and impacts of natural resource scarcity and degradation, and of the relations between natural resources and agrifood systems,

FIGURE A BOX 1.41 **GLOBAL AGRICULTURAL GROSS PRODUCTION VALUE: HISTORICAL (1960–2020) AND PROJECTED (2012–2050)**



Notes: Linear trend on historical data: y=-2.83 +1.45x; R2 = 0.98. Historical gross production value (index 2014–2016=100) is plotted using a three-year right-aligned moving average. The historical gross production value index is calculated on the basis of the gross production value in constant USD of 2014-2016. Projections by scenario are calculated as annual variations of projections by scenarios with respect to the base year (2012), as reported in FAO. 2018. *The future of food and agriculture – Alternative pathways to 2050*. Rome.

Sources: Authors' elaboration. Historical gross production value based on FAO. 2022. Value of Agricultural Production In: *FAOSTAT*. Rome. Cited 29 June 2022. www.fao.org/faostat/en/#data/QV; projections are based on FAO. 2018. *The future of food and agriculture – Alternative pathways to 2050*. Rome. www.fao.org/3/I8429EN/i8429en.pdf

illustrates the systemic interlinkages between agrifood systems and natural resources. Agrifood systems are highly dependent on natural resources and natural resources are strongly affected by activities conducted within agrifood systems, as agrifood systems are one of the major reasons of degradation of natural resources. Biodiversity is following an irrevocable and continuing decline of genetic and species diversity, and this trend may be accelerating, with the risk of precipitating a sixth mass extinction. Causes include land-use change, agricultural practices, overexploitation of resources, climate change, pollution and invasive species. Consequences include disruption in ecosystems services, affecting vital processes such as those provided to plants by soil biodiversity or pollinators. Deforestation, resulting from expansion of agriculture, endangers forests along with the goods and services they offer, while depletion of marine resources by unsustainable fishing threatens future production. If past trends continue at the current rate in the future, scarcity and degradation of natural resources will create an untenable situation as agrifood systems greatly depend on them. This would drive the world along a path incompatible with achieving the Sustainable Development Goals and securing the emergence of agrifood systems that are sustainable from

economic, social and environmental perspectives. To come up with more sustainable and resilient agrifood systems, understanding the key values of Indigenous Peoples' food and knowledge systems – such as the respect for all forms of life (biocentrism); the circularity of biological processes, including food generation, consumption and disposal; and the management of natural resources at community level – may shed further light on the complex mutual relationships between agrifood systems and natural resources. Achieving the Sustainable Development Goals would require serious changes in the way food is being produced and processed, in the diets adopted by consumers, and in the incentives and guidance provided by policies to all actors operating within agrifood systems.

Epidemics and degradation of ecosystems (Driver 16). The remarkable growth of agriculture, mostly through intensification, land use change, monoculture and reliance on a reduced number of species, and within species and of varieties, deforestation, the encroachment into wild areas and forests and climate change as well as massive global rapid travel and trade, are deeply transforming the planet's ecosystems and their internal processes. These changes trigger imbalances, some of which feed back into agriculture and human health, such as the multiplication of crop and animal pests and diseases or emerging zoonotic infectious diseases, antimicrobial resistance, foodborne diseases and pesticide poisoning, with their cohort of victims and their imprint on the global economy. Intensive livestock systems with high-density populations of low genetic diversity, exposure of livestock to wildlife, ineffective management and biosecurity measures, as well as insufficient vaccination, are responsible for the spreading of animal diseases. The inappropriate use of drugs in animal production is aggravating antimicrobial resistance, while unsafe food and water are responsible for hundreds of millions of foodborne disease cases. The scale and intensification of agriculture, as well as the lack of prompt intervention in cases of outbreaks, are major causes of plant pests and diseases. At the same time, massive application of pesticides impacts on human health and biodiversity. Unless the determinants that are deeply transforming the planet's ecosystems and their internal processes are tackled, it is most probable that the consequences of this transformation on plant, animal, human and environmental health will worsen. Addressing these causes will imply modifying significantly the way agrifood systems operate (e.g. production technologies, spatial expansion of agriculture, speed of movements of goods and people and consumption) as well as implementing preventive and mitigation strategies, including ecological interventions, using a One Health approach, and integrating One Health Intelligence across sectors, and including early warning and risk assessments.

Climate change (Driver 17). The interaction between food systems and the climate is a major driver of change. Food systems play a key role in the dynamic of anthropogenic GHG emissions causing climate change, as they may emit or absorb variable volumes of GHG, depending on the way they are managed. On the other hand, climate change affects food systems, forcing adaptation in the manner food is produced, processed and consumed, and impacting both producers and consumers. Food systems generate around one-third of all anthropogenic GHG emissions. Over the last two decades, growing emissions in agriculture and in post-harvest activities are only partly compensated by reduced land-use-related emissions. Within agriculture, livestock and, to a lesser extent, fires and cultivation of soils rich in organic matter such as peatland, are the major sources of GHG emissions. Meanwhile, climate change is accelerating, and its impacts are being felt on food systems, affecting quantity, quality and accessibility of food. Higher temperatures and extreme weather events are two main elements through which food systems are impacted. The consequences of climate change (lower crop yields, lower quality of biomass produced by rangeland and pastures, alteration of forests and ecosystems dynamics, higher presence of crop and animal pests and diseases, reduced nutritional quality of food, loss of aquatic systems' production capacity and large-scale redistribution of marine fish resources) threaten to erode, and even reverse, the gains made in the combat against hunger and malnutrition. Moreover, food quality under higher temperatures could turn into a major nutritional issue in the future. Future development of post-harvest activities and increased livestock production would add to the GHG emissions already emitted by agrifood food systems, while limitation in agricultural expansion and related deforestation would help reduce them. Adaptation of food systems to higher temperatures and extreme weather events will likely become an important domain for research, as future trends indicate that climate change will continue its course in the coming few decades, until the urgently needed mitigation measures, produce their effects.

Sustainable ocean economies (Driver 18). The concept of "sustainable ocean economies", also referred to as "Blue economy" regards the implementation of Green Economy principles to aquatic environments in order to achieve greater sustainability in both traditional and emerging water-related activities.[3] Fisheries, and particularly aquaculture, have been growing at a very fast rate over the last three decades and have become a major source of high-quality animal protein, polyunsaturated fatty acids and

[3] This document uses the World Bank definition of "Blue economy" intended as "the sustainable use of ocean resources for economic growth, improved livelihoods, and jobs while preserving the health of ocean ecosystem".

micronutrients provided that the quality of the fish produced is preserved, rather than just maximizing profits. Aquaculture is now the main provider of fish products and it supplies animal proteins, while emitting lower amounts of GHG per kilogramme of output than terrestrial animals, especially ruminants. However, the increasing level of marine litter, particularly plastic, impacts negatively fisheries production and quality of its outputs that run a greater risk of being contaminated. Furthermore, aquaculture makes extensive use of antimicrobials and pollutes waters, thus creating potential hazards for human health and negative impacts on biodiversity. If past trends persist, fisheries – and particularly aquaculture – will continue to grow, but, unless more sustainable practices are adopted in capture fisheries, marine fish stocks will probably decrease and their exploitation will require more fuel and generate more GHG emissions. The practical application of the "Blue economy" approach is constrained by weak national capacities, dubious "Blue economy" interventions with deleterious consequences, and insufficient involvement of fishers and fish workers in decision-making. This includes a lack of information to make accurate trade-off decisions when prioritizing one aquatic-based sector over another. If there is no general agreement on, and application of, the principles defining "Blue economy" – and if governance of aquatic activities is not more inclusive of fishers, fish farmers and fish workers – the implementation of the "Blue economy" concept could favour aquatic activities other than fisheries (e.g. tourism, maritime transport, water desalinization and bio-prospecting) and benefit large economic operators rather than fisher and fish farmer communities.

2 ALTERNATIVE SCENARIOS FOR THE FUTURE OF AGRIFOOD SYSTEMS

Concurring factors combine to generate multiple future risks and challenges for agrifood systems and their expected performances. The interplay of the drivers presented in Chapter 1, possible changes in individual and collective behaviour, materialization of natural events, risks and uncertainties, and the influence of public strategies and policies, may lead to radically divergent futures, where the fundamental questions on sustainability of agrifood systems are met with diverse answers. Without any pretention to "defog" the medium- and long-term future per se – which is not predictable as such, given the uncertainty affecting all the drivers of agrifood systems – but just to clarify how the current and immediate future behaviour of public and private decision-makers could influence the medium- and long-term future, this part of the report explores four alternative scenarios and their possible implications for the future of agrifood systems.

Forward-looking exercises based on scenarios for alternative futures examine some key elements that contribute to shaping up and qualifying the respective narratives. The narratives of this report, which are set as retrospective storylines, are built by considering, *inter alia*:

- the internal consistency of narratives and the causal linkages that tie together the various drivers of agrifood systems and their outcomes (see **Figure 1.1**);
- "weak signals" of possible futures, that is, events or existing phenomena actually observed in the current reality that may reveal important features of possible medium- to long-term futures;
- medium-term achievements and "end-states" of different futures, cast in the outcome "space" of the aspirational "four betters" of the Organization (see **Figure 2.3**);[4]
- pathways to follow to reach medium-term achievements and long-term states (see **Figure 2.2**);
- "priority triggers" of development and related strategic policy options that can shift the future from one scenario to the other (see Chapter 3); and

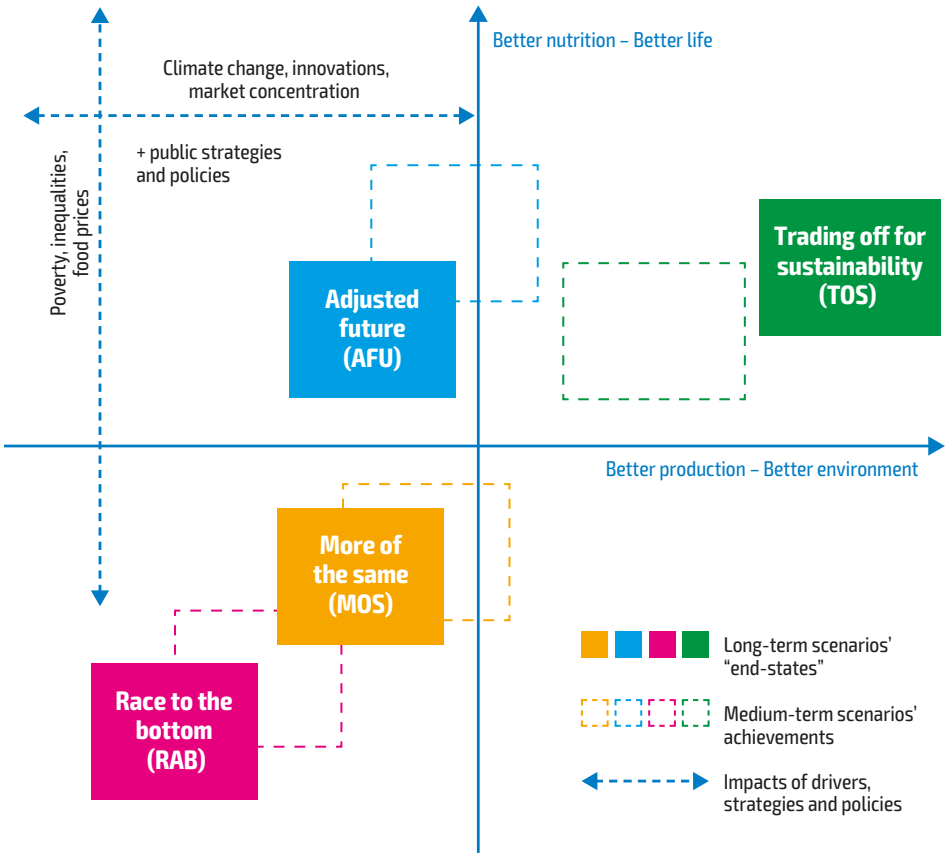
[4] The "four betters" are defined in FAO *Strategic Framework 2022–31*: (i) better production: ensure sustainable consumption and production patterns, through efficient and inclusive food and agriculture supply chains at local, regional and global level, ensuring resilient and sustainable agrifood systems in a changing climate and environment; (ii) better nutrition: end hunger, achieve food security and improved nutrition in all its forms, including promoting nutritious food and increasing access to healthy diets; (iii) better environment: protect, restore and promote sustainable use of terrestrial and marine ecosystems and combat climate change (reduce, reuse, recycle and residual management) through more efficient, inclusive, resilient and sustainable agrifood systems; and (iv) better life: promote inclusive economic growth by reducing inequalities (urban/rural areas, rich/poor countries and men/women).

- selected trade-offs among different objectives, to be addressed along development patterns by reconciling conflicting objectives and composing diverging interests through appropriate strategies and policies.

The summary narratives of the four scenarios, assumed to be paradigmatic of a multitude of possible futures are described in Table 2.3.[5]

[5] More detailed narratives are provided in the full report.

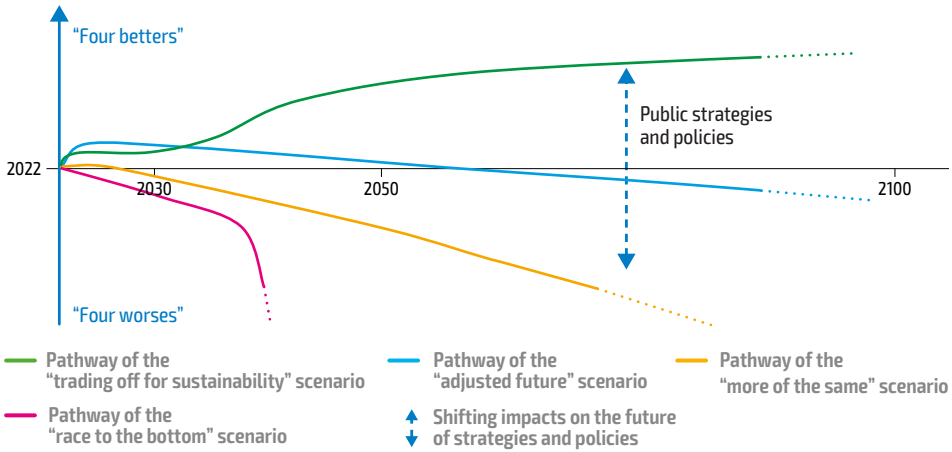
FIGURE 2.3 **MEDIUM-TERM ACHIEVEMENTS AND FUTURE "END-STATES" OF ALTERNATIVE SCENARIOS IN THE SPACE OF THE OUTCOMES**



Notes: The "four betters" are paired to allow for visualization under some assumptions. Better nutrition is assumed to be a dimension of better life and to be positively correlated with it if the other dimensions are kept constant. Better production is assumed to be an important contributor to better environment and to be positively correlated with it if other factors affecting the environmental quality are kept constant. Note that the "end-states" of the scenarios in the space of the "four betters" are placed for illustrative purposes, just to portray the relative position of each scenario with respect to the others.

Source: Authors' elaboration.

FIGURE 2.2 ALTERNATIVE FUTURE PATHWAYS



Source: Authors' elaboration.

TABLE 2.3 SUMMARY OF ALTERNATIVE LONG-TERM RETROSPECTIVE NARRATIVES FOR AGRIFOOD SYSTEMS

SCENARIOS	NARRATIVES
More of the same (MOS) Muddling through in reaction to events and crises while doing just enough to avoid systemic collapses, led to degradation of agrifood systems sustainability and to poor living conditions for a large number of people, thus increasing the long-run likelihood of systemic failures.	Ineffective development strategies and policies, economic imbalances across and within countries and skewed international trade, including persisting commodity dependency of many LICs, resulted in national and geopolitical grievances, deteriorating social and humanitarian outcomes, and a continuous environmental neglect throughout the 2020s and beyond. Agrifood systems kept struggling to satisfy an increased food demand as a result of the persistence of conventional agricultural practices that eroded the natural resources base. Dramatic crop yield improvements that materialized during the second half of the twentieth century turned out to be unsustainable in the long run. On the demand side, diets had been only marginally rebalanced to limit reliance on resource-intensive food, rich in animal products. Short-termism and the belief that it was possible to solve issues without questioning the prevailing development paradigm based on fossil energy and power concentration, drove most decisions in the majority of countries and at the global level. Key social and environmental trade-offs were left unaddressed, with no progress made on poverty and hunger eradication.

SCENARIOS	NARRATIVES
	Global corporations continued to prioritize shareholder profit as their primary bottom-line indicator and their fiscal elusion kept jeopardizing public budgets and actions. "Public-private partnerships" (PPPs), quite fashionable in the 2020s, could have had some potential for transformation, but were mostly ill-conceived and not monitored, so they mostly ended up becoming "green-washing or social-washing" devices. As a consequence, the 2030 Agenda and the "four betters" were substantially not achieved by 2030, and the few temporary successes were disproportionately distributed. During the subsequent decades, issues related to climate change, including weather extremes, economic downturns, conflicts and mass migrations, did not allow for any further progress, but rather, led to further degradation and high risks of systemic failures.
Adjusted future (AFU) Some moves towards sustainable agrifood systems were triggered in an attempt to achieve Agenda 2030 goals. Some improvements in terms of well-being were obtained, but the lack of overall sustainability and systemic resilience hampered their maintenance in the long run.	Efforts towards adjusting some drawbacks of the development paradigm prevailing in the 2020s ensured some successes in terms of access to basic services, food security and nutrition. Some civil society movements temporarily succeeded in pushing governments to engage in multilateral agreements aimed at addressing issues that required global governance, such as mass migrations and blatant inequalities across and within countries. Some governments, in a quite timid last-minute attempt to meet selected SDG targets, tried to tackle the most urgent economic, social and environmental trade-offs and adopted fiscal policies to fund social protection measures, as well as modest GHG emissions measures and trade regulations. Agrifood and socioeconomic and environmental systems at large could have benefited from such interventions. However, piecemeal approaches, conflicts of interest among public decision-makers subject to the pressure of private lobbies, did not allow for the achievement of more resource-efficient food production or for a substantial internalization of environmental externalities, or the implementation of disincentives for consumption of resource-intensive food. PPPs contributed in some instances to progress towards SDGs, but in several others, they revealed themselves to be only "green-washing or social-washing" devices, as was spotted by a few civil society movements, while systemic governance weaknesses persisted at all levels. Therefore, although some well-being-related SDG targets and "betters" had been achieved in the aftermath of 2030, agrifood and socioeconomic and environmental systems at large failed to transform and ensure maintenance of these achievements in the subsequent decades.

SCENARIOS	NARRATIVES
Race to the bottom (RAB) Gravely ill-incentivized decisions led the world to the worst version of itself after the collapse of substantial parts of socioeconomic, environmental and agrifood systems with costly and almost irreversible consequences for a very large number of people and ecosystems.	Societies had been progressively structured in separate layers where self-protected elite classes, i.e. groups of wealthy individuals with transnational interests, held a strong decisional power and largely influenced sovereign governments. To preserve their interests, various means, differently blend-ed depending on the institutional set-up of the different geostrategic blocks, had to be increasingly used in order to manipulate and control people, in-cluding ideological propaganda, the myth of good versus evil, the creation of external enemies, more traditional "command-control-punishment" instru-ments associated with pervasive social media restrictions and remote sur-veillance. Both agrifood technologies and consumer preferences had been increasingly shaped to satisfy the needs of business oligarchs. They not only disregarded natural resource conservation and climate change, but also maximized their surplus extraction from domestic and international agri-food value chains by ignoring diversification and resilience. In this context, PPPs became an element of deceptive narratives about development and played a mere "green-washing or social-washing" temporary function. In addition, the lack of social cohesion, citizens' limited awareness, the increas-ing dependency of most sovereign countries on oligarchies had left ungov-erned global issues, such as climate change, pandemics, energy transition, big data generation and control, international capital flows and migrations. A series of consecutive economic crises, exacerbated inequalities and wide-spread poverty worldwide, and fuelled instability, civil wars and interna-tional conflicts. Ineffective or lacking multilateral cooperation at all levels along with diverging interests of leaders of geostrategic blocks engendered conflicts at a global scale, leading to the collapse of substantial parts of socio-economic, environmental and agrifood systems. Famine, forced mass dis-placements, degradation of natural resources, loss of biodiversity and eco-systems' functions, and emergence of new pandemics, as well as nuclear and bacteriological contamination, were just signs of a world in complete disar-ray. By 2030, most SDG targets and the "four betters" were far from being achieved and by 2050, they had become a remote dream.

SCENARIOS	NARRATIVES
Trading off for sustainability (TOS) Awareness, education, social commitment, responsibility and participation triggered new power relationships and shifted the development paradigm in most countries. Short-term GDP growth and immediate final consumption were traded off for inclusiveness, resilience and sustainability of agrifood, socioeconomic and environmental systems.	New power relations, systems and actors emerged during the second half of the 2020s, thanks to civil society movements that progressively increased individual awareness and social commitment towards sustainable development at large. Distributed and participatory power and governance models gradually took over and complemented, or partially replaced, other power relationships based either on "command-control-punishment" mechanisms – typical of autocratic governments – or on the enormous influence of big transnational companies able to steer formally democratic sovereign governments. At world level, this brought about the reshaping of the institutional structures created in the aftermath of the Second World War and of the global development paradigm that ensued and prevailed in the last part of the twentieth century and during the first decades of the current century, based on narrowly defined GDP growth. As a result, multi-stakeholder national and global governance systems became much more effective in conducting global transformative processes. Thanks to these forces, before 2030, governments implemented strictly targeted social protection policies that significantly improved the quality of life of most vulnerable layers of societies. The immediate well-being of all the other citizens was traded off for longer term investments in sustainable production processes, energy transition, GHG reduction, and natural resource conservation and restoration. All this paid back before 2050, also thanks to some well-designed and closely monitored PPPs. Agrifood systems largely contributed to the overall socioeconomic and environmental transformation. Small and commercial farms and multinational corporations progressively adopted more sustainable technologies for food production, integrated multi-output energy and agrifood processing and generated remunerated environmental services. Concurrently, consumers, starting from those in HICs, shifted away from excessive consumption of energy- and natural resource-intensive animal products also because of increased food prices that fully reflected the "true costs of food", including social and environmental ones. Paradoxes, disparities, uncertainties and challenges had not disappeared, but they played out differently because well-educated citizens had developed critical thinking, had become much less prone to manipulation, more aware of trade-offs that emerged in development processes, and readier to engage in addressing and solving them. Although, by 2030, the "four betters" had not yet materialized fully, solid bases had been built that led to their full achievement and maintenance in the subsequent decades.

Source: Authors' elaboration.

3 CHALLENGES, TRIGGERS AND STRATEGIC POLICY OPTIONS

To shift agrifood systems towards sustainability and resilience, several "triggers of change" are available that can be taken advantage of. These are areas of development that, because of their transformative potential, deserve particular attention, institutional boosts, and skills and organizational suitability in order to accelerate transformative processes. Key priority triggers identified by FAO's CSFE, and later incorporated in FAO *Strategic Framework 2022–31*, comprise:

- institutions and governance
- consumer awareness
- income and wealth distribution
- innovative technologies and approaches.

Considered as effective starting points, or accelerators of transformative processes, these triggers are expected to mutually interact and influence important drivers of agrifood systems and, through them, spread impacts throughout all agrifood, socioeconomic and environmental systems to achieve desired outcomes (see **Figure 1.1**).

Triggers for transformation are all expected to mutually interact and have systemic impacts on agrifood systems and on the context within which they develop. Whether they will be activated or disabled, the modalities of their utilization and the extent of their effectiveness will definitely influence the future that could develop according to a "more of the same" type of scenario, or move away towards alternative futures.[6] **Table 3.1** portrays how the various triggers could be activated or deactivated to determine the four scenarios presented in this report.

[6] Some "triggers" identified bear direct linkages with key drivers highlighted here, such as the trigger "Income and wealth distribution" through which inequalities are expected to be addressed. Other triggers, such as "Institutions and governance" are more systemic in nature and may trigger first round impacts on different sets of drivers.

TABLE 3.1 TRIGGERS AND SCENARIOS

Scenarios / Triggers	MORE OF THE SAME (MOS)	ADJUSTED FUTURE (AFU)	RACE TO THE BOTTOM (RAB)	TRADING OFF FOR SUSTAINABILITY (TOS)
Institutions and governance	Public institutions will progressively lose the power to orient and regulate economies and societies because of the emergence of private entities allegedly supplying public goods. Some civil society movements will question this drift with no success, given the limited space left to independent media and other communication channels. In fact, media and data platforms will progressively become concentrated in the hands of a few private entities tied to economic powers. Thus, the governance of global goods, such as peace, climate, health, oceans, etc. will progressively weaken to the detriment of sustainable agrifood systems.	When the failure of Agenda 2030 becomes evident, multilateral institutions will manage to act on a limited number of social targets. Some countries, pressured by collective action, will address the political economy challenge to reach compromises among citizens, parliaments and private lobbies, and will manage to address some trade-offs and reinforce regulations to reduce GHG emissions, improve food safety, control chemicals' use and safeguard biodiversity. In other countries, conflicts of interest between public decision-makers and private lobbies, big agrifood companies and small-scale farmers, will prevent substantial changes from taking place. Lack of global coordination, power asymmetries and systemic governance weaknesses will hamper results at national and global scales.	Governments, steered by elites acting under the influence of few powerful actors, will increasingly become more authoritarian. Private sector companies will be closely allied with governments, as they will create rules that favour said companies. Governance of global issues will progressively weaken to favour economic interests of the elites over environmental and social ones, while few attempts of civil society movements to oppose this system will fail. International organizations will be diverted from their original goals through underfunding, thus forcing them to embrace dubious public-private global partnerships and fictitious "global alliances", that progressively will replace them. Thus, global commons will drastically degrade with dramatic consequences.	The mobilization of real and representative civil society and other organizations will lead to the emergence of more effective participatory and novel, multilevel governance models resulting in a balanced power distribution across the state, civil society organizations, the United Nations, academia, trade unions, farmers organizations and private corporations. To address global challenges, the world will reverse the piecemeal governance of the early decades of the century to adopt a more integrated approach by strengthening transparency and through the provision of public goods at global, regional and national levels. Although setting and enforcing global agreements on GHG emissions and sustainable agriculture standards will be difficult, owing to the implied costs of adopting new technologies, some success will be achieved, with long-run positive impacts on agrifood systems.

Scenarios / Triggers	MORE OF THE SAME (MOS)	ADJUSTED FUTURE (AFU)	RACE TO THE BOTTOM (RAB)	TRADING OFF FOR SUSTAINABILITY (TOS)
Consumer awareness	Consumers will be induced by advertising campaigns to consume foods alleged to be healthy and sustainable. However, limited verifiable information will prevent consumers' associations from acting as effective counterparts. Regulations for increasing transparency will be biased thanks to lobbying. Despite some awareness, low-price, highly processed foods with poor nutritional value will be massively consumed because of limited incomes of many people.	Governments, to accommodate an increasing request of transparency on the quality, and social and environmental sustainability of food from the public and consumers' associations, will reinforce measures regarding labelling and traceability. Consumers' associations will attempt to induce behavioural changes. However, food transnationals, claiming excessive costs, will manage to water down such initiatives. The lack of global coordination favoured the avoidance of norms, thus limiting overall results.	Consumer awareness about the quality and sustainability of foods will progressively shrink, owing to the progressive reduction of public goods such as education and freedom of expression. Consumers' associations will be purposely weakened, including through legal prosecution, as they will tell uncomfortable truths regarding the quality of food and the sustainability of food production. Thus, the removal of citizens' power will fully deactivate a key trigger of transformation.	Consumer awareness will increase, thanks to a combination of coordinated public policies, including education and critical thinking in schools, and behavioural changes generated by consumers' associations. Through an organized movement at global, national and local levels, citizen consumers will gain power to become an active party in the transformation of agrifood systems. Despite initial attempts to disqualify the consumers' movements favouring sustainable production, transnationals will realize that collaboration with consumers will actually pay off.
Income and wealth distribution	Improving income and wealth distribution would be a must, given the food price increases caused by the tightening natural resources and the billions of people that cannot afford healthy diets. Unfortunately, income and wealth distribution will worsen, given the diminished fiscal space that will	Faint-hearted taxes on profits of transnationals in information and communication technology and "big oil", and to some extent on fiscal dumping, will be imposed. These will bring mixed results, owing to diverging interests of various countries. However, both in LMICs and HICs, some fiscal space will be created	Fiscal competition, and fear of losing investment capital and associated jobs, will continue to discourage governments from billing the richer classes. In this context, rent-seeking from transnationals, including in agrifood systems, will be exacerbated. Very weak institutions at all levels will allow power accumulation	Although in a context of limited economic growth because of the transition from fossil fuels to renewables, and in a context where investment in new sustainable technologies was favoured compared to household consumption, some achievements to reduce hunger will materialize thanks to social protection policies strictly targeting the neediest social groups.

Scenarios / Triggers	MORE OF THE SAME (MOS)	ADJUSTED FUTURE (AFU)	RACE TO THE BOTTOM (RAB)	TRADING OFF FOR SUSTAINABILITY (TOS)
	entail the reduction of publicly funded social protection programmes along with the privatization of basic public goods such as education, health care services, and security. Additionally, the reduction of jobs, wages and trade unions' strength, owing to increasing capital and information intensity of production processes, will compound the dire situation.	to fund last-minute actions for SDG1 and 2, and to act against the mounting inequalities resulting from a jobless growth in some sectors, and a rampant gig economy elsewhere. Trade unions will regain strength to adjust to labour market asymmetry in negotiating power. Overall, poverty, hunger and food insecurity will decrease around 2030, but only temporarily.	and extraction of huge rents from agrifood value chains, while wages and job security will be sacrificed, also because of the non-existent trade unions. Owing to all that, income and wealth distribution will dramatically worsen. Dysfunctional agrifood systems will exhibit increasing food prices with disastrous consequences on poverty, food security and hunger.	In the long run, equitable taxation, aware trade unions, improved public services and well-designed social protection programmes as well as the development of novel, accessible and sustainable technologies will help reduce inequality, poverty and hunger in a sustainable manner.
Innovative technologies and approaches	Science will progress and support innovation, but investment will be concentrated in a few HICs. A fragmented and ever more competitive multipolar system will facilitate the acceptance of doubtful biotechnologies, owing to neglected precautionary principles and weak global regulations. Agroecological and other environment-friendly approaches will be developed only to a limited extent.	Science and innovation will contribute to eliminate the risk of a quite likely collapse. Although the emphasis put in the 2020s on digitalization will prove to be excessive, some applications, such as soil, crop and animal monitoring through remote sensing and other IoT applications, will prove to be very useful. However, to quickly ensure affordable healthy diets by increasing land and water productivity, LMICs will become the	Instead of facilitating the adoption of sustainable techniques, digitalization will be increasingly used to control value chains at all levels. Digital equipment will be increasingly provided almost for free to smallholders by a few transnationals controlling big data and AI systems to obtain strategic digital information. Private investment in agrifood systems will mainly originate from export-oriented transnationals in global value chains to take over smaller	After a period of uncertainty, digitalization, IoT and AI worked for people and sustainable development thanks to a new global governance of big data generation, use and ownership. This process, demanded by civil society, independent academia and some governments, will be fully supported and facilitated by the relevant United Nations bodies. The gains from technological innovation will not only prioritize previously neglected populations in LMICs, but also sustainable, resilient and integrated agrifood systems.

Scenarios / Triggers	MORE OF THE SAME (MOS)	ADJUSTED FUTURE (AFU)	RACE TO THE BOTTOM (RAB)	TRADING OFF FOR SUSTAINABILITY (TOS)
	AI and machine learning will facilitate agricultural robotics, and soil and crop monitoring. However, the few investors controlling these technologies will have no incentives to transfer or adapt them to multi-cropping or small-scale systems.	experimental field for strong genetic manipulations. However, insufficient testing and lack of knowledge of the systemic implications will prove most of them to be unsustainable and will give way to more controllable biotechnologies.	national businesses and make mass land acquisitions. Thus, in many instances, large numbers of farmers will become landless and jobless, and forced to urbanize or migrate abroad. The pioneering attempts to adopt integrated agroecological and agroforestry approaches will become remote dreams.	Thus, priority will be given to scientific research and development geared towards approaches that meet the needs of the great variety of agroecological and social conditions.

Source: Authors' elaboration.

Triggers of change need to be exploited through context-specific actions that require a clear evidence-based design, effective implementation, and constant monitoring of processes and outcomes. Selected strategic policy options to move agrifood systems towards sustainability – not only for the relatively short-term of Agenda 2030, but beyond it to 2050 and 2100 – emerged during the CSFE. This exercise also catalysed strategy and policy proposals already expressed in recent FAO flagship reports, documents from Regional Conferences and other corporate documents.

Selected strategy and policy options are proposed in the last part of the full report, with no pretence at being exhaustive. They are organized according to the main trigger of change they are likely to activate, notwithstanding the fact that trigger strategies and policies are intertwined in most practical contexts, and therefore a single strategic option may activate more than one trigger.[7]

[7] Most of these strategic policy options were identified during the CSFE and in the technical papers provided as background documents to this report by technical divisions. Others refer to recent corporate reports, FAO flagship publications and documents of Regional Conferences.

CONCLUDING REMARKS

Transformative processes will most certainly require long-term commitment, persistency and perseverance. Acceptance of long-termism by citizens and their governments is required, meaning transformative action needs to start now. Whether that will happen or not, will determine one of the possible futures of agrifood systems. The factors that influence the decisions of citizens and governments regarding the future of agrifood systems are multiple, including the urgency to satisfy immediate needs, ethical and cultural values, the social contexts within which decisions will be made, as well as current and future political, economic, social, cultural and military power structures. Stakeholders interested in transforming agrifood systems along sustainability and resilience patterns will have to increase their awareness, enlarge their agency space and "outsmart" political economy constraints that have thus far prevented the move towards the targets of Agenda 2030.

Sustainably nourishing close to 10 billion people by 2050, while preserving natural resources and increasing the resilience of agrifood systems to the inevitable shocks and "unknown unknowns" that will materialize along the way, is an unprecedented challenge. It requires addressing the trade-offs that have been highlighted in this report. All of them deserve further analyses through a holistic approach for guiding contextualized actions. However, for some of them, win-win solutions are not possible, as highlighted in the scenario "trading off for sustainability". For others, win-win solutions may not even be currently imaginable, given the boundaries of the planetary resources available. The readiness to give up something today, particularly by better-off citizens and more powerful actors, to the advantage of others and of future generations, might end up being the only option to ensure sustainable and resilient agrifood systems that positively contribute to intra- and intergenerational equity.

This corporate strategic foresight report forces one to strategically prepare for different outlooks, including those considered more pessimistic. It has been said: "I feel very optimistic about the future of pessimism."[8] This sentence could be interpreted in different ways. Of course, it could also support a pessimistic view of the future. Indeed, given that trends and human behaviour have not changed significantly despite many warnings, inconvenient truths, recommendations, Millennium Development Goals (MDGs) and SDGs, assuming that paths will not change for the better would be a fairly safe bet.

[8] Jean Rostand, French biologist and philosopher (1894–1977).

Most human beings desire improved lifestyles and well-being, more real income, a fulfilling income-generating occupation, a better house, a better mode of transportation, travel, to eat at the best restaurants, enjoy improved public services, top-quality health care facilities and education facilities, sophisticated services, and solid and durable infrastructures.

Understandably, most humans desire all of this at the lowest price possible. This is true for humans in both HICs and LMICs. These aspirations and lifestyles come at a cost as they require substantial resources, which are being exhausted at a fast pace. Even when confronted with this reality, most humans would not give up on pursuing their dreams and aspirations. Plus, there would be a fear of free-riding from others who would not comply with a potential pact. Therefore, most citizens and their governments might not activate triggers nor deal with tough trade-offs. Technological advancements eventually might not be capable of solving the problem.

Ultimately, a strategic foresight report has also to convey unfortunate, but plausible, scenarios such as a "more of the same" or even or worse. But, as highlighted in the foreword of this report, one could also recall, that "…my mind is pessimistic, but my will is optimistic. Whatever the situation, I imagine the worst that could happen in order to summon up all my reserves and will power to overcome every obstacle."[9]

The story of mankind should be one of gradually learning as much as possible from the past in order to avoid repeating crises, and to dare to imagine – and push for – an "impossible" improved future. Hopefully, this strategic foresight report is a contribution in this direction.

[9] Antonio Gramsci, Italian philosopher, political scientist and politician (1891–1937).

THE FUTURE OF FOOD AND AGRICULTURE DRIVERS AND TRIGGERS FOR TRANSFORMATION

This report aims at inspiring strategic thinking and actions to transform agrifood systems towards a sustainable, resilient and inclusive future. It builds on both previous reports in the same series as well as on a comprehensive corporate strategic foresight exercise that also nurtured the FAO *Strategic Framework 2022–31*. The report analyses major drivers of agrifood systems and explores how their trends could determine alternative futures of agrifood, socioeconomic and environmental systems. The fundamental message of this report is that it is still possible to push agrifood systems along a pattern of sustainability and resilience, if key "triggers" of transformation are properly activated. However, strategic policy options to activate them will have to "outsmart" vested interests, hidden agendas and conflicting objectives, and trade-off short-term unsustainable achievements for longer-term sustainability, resilience and inclusivity.

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