BREAKTHROUGH AGENDA

THE BREAKTHROUGH AGENDA REPORT 2023

Accelerating Sector Transitions Through Stronger International Collaboration

IEA

IRENA
International Renewable Energy Agency

UN Climate Change High-Level Champions
in collaboration with:

Marrakech Partnership | Global Climate Action

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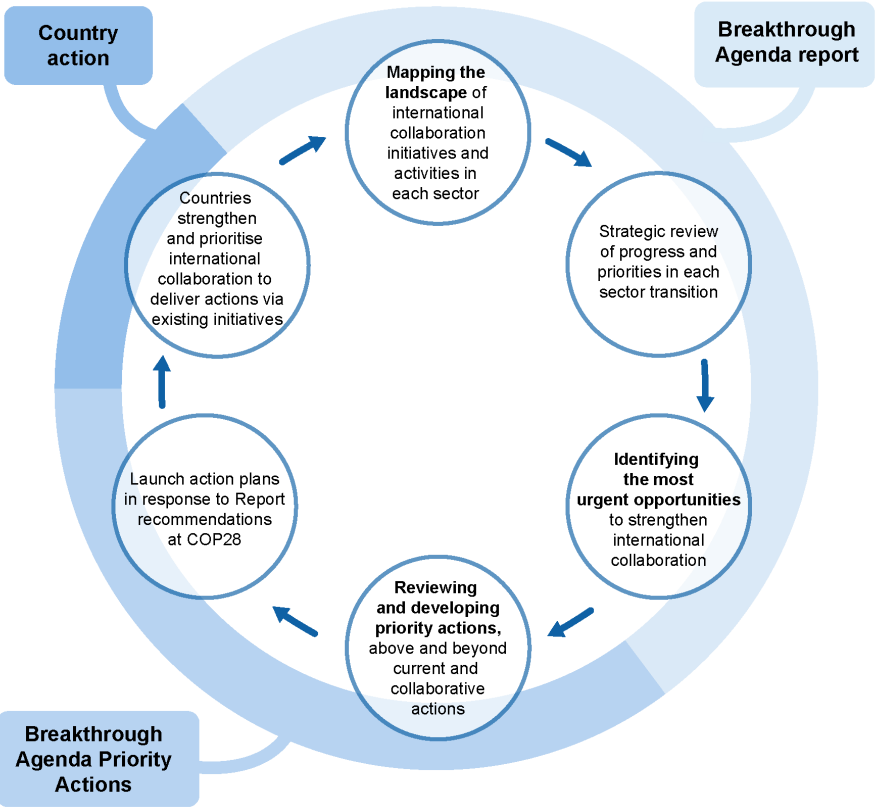
ABOUT THIS REPORT

The Breakthrough Agenda was launched by 45 world leaders at COP 26 and is a commitment to work together this decade to accelerate innovation and deployment of clean technologies, making them accessible and affordable for all this decade. To kick-start this Agenda, countries endorsed Breakthrough goals to make clean technologies and sustainable practices more affordable, accessible and attractive than their alternatives by 2030 in the power, road transport, steel, hydrogen and agriculture sectors. This report also covers the buildings and cement sectors, where new breakthroughs are being considered.

The Breakthrough Agenda establishes an annual cycle to track developments towards these goals, identify where further co-ordinated international action is urgently needed to accelerate progress and then galvanise public and private international action behind these specific priorities in order to make these transitions quicker, cheaper and easier for all.



To initiate this cycle, world leaders tasked the IEA, IRENA and the UN Climate Change High Level Champions to develop an annual Breakthrough Agenda report to provide an independent evidence base and expert recommendations for where stronger international collaboration is needed.

This document, the 2023 Breakthrough Agenda Report, is the second of these annual reports. For sectors addressed in 2022, it provides an assessment of progress against the recommendations made last year, updating recommendations for what more needs to be done. For sectors added in 2023, namely buildings and cement, it provides an assessment of each Breakthrough goal, a pathway of co-ordinated international actions through to 2030, and a set of specific recommendations on the most urgent and high-impact opportunities to strengthen international collaboration.

Breakthrough Agenda Signatories:

As of August 2023 the Breakthrough Agenda signatories are: Australia, Austria, Azerbaijan, Belgium, Cabo Verde, Cambodia, Canada, Chile, China, Denmark, Egypt, European Union, Finland, France, Germany, Guinea-Bissau, the Holy See, India, Ireland, Israel, Italy, Japan, Kenya, Latvia, Lithuania, Luxembourg, Malta, Mauritania, Morocco, Namibia, Netherlands, New Zealand, Nigeria, North Macedonia, Norway, Panama, Portugal, Republic of Korea, Senegal, Serbia, Slovakia, Slovenia, Spain, Sweden, Türkiye, United Arab Emirates, United Kingdom, United States.

FOREWORD

Over the past year, we have seen an acceleration in the global low-carbon transition, with progress often happening faster than most realise. This includes record deployment of solar PV, electric cars and heat pumps, which are all important solutions as countries transition to net zero emissions.

However, it is also clear that the transition is still not going fast enough – and is occurring at very different speeds across regions and sectors. For example, the record deployment of renewables and the incredibly rapid growth in sales of electric vehicles that took place in 2022 were both heavily concentrated in China, Europe and the United States. Stronger international collaboration is urgently needed to accelerate the pace of a just transition, ensuring that clean technologies and sustainable solutions are accessible to all.

This *Breakthrough Agenda Report 2023,* the second in an annual series, assesses progress on international collaboration in seven major emitting sectors. This includes the five sectors covered in last year's report – power, hydrogen, road transport, steel and agriculture – as well as buildings and cement. Should countries agree to work together towards breakthrough goals in these new sectors, as is now being considered, the Breakthrough Agenda will cover 60% of global greenhouse gas emissions.

This report is a joint product of the International Energy Agency (IEA), the International Renewable Energy Agency (IRENA) and the UN Climate Change High-Level Champions. Each organisation has brought its own expertise to assess progress in international collaboration, and to deliver clear recommendations for the actions that governments and non-state actors need to take together. It also draws on global expertise generously shared by governments, businesses and civil society organisations active in each of the sectors covered.

Overall, the report finds only modest progress in strengthening international collaboration in these sectors. There have been some examples of good progress, which can provide a blueprint for other sectors and initiatives. These include collaboration on standards and definitions for near-zero emission green steel and low-carbon hydrogen, the trade of used internal combustion engine vehicles, and rising commitments to invest in research and development in several sectors.

There remains significant scope for stronger international collaboration in all sectors. This requires greater commitment and participation from all involved. The priorities include governments and businesses sending stronger, collective demand signals for sustainable products (such as low-carbon hydrogen, steel and cement); a continued improvement in the coordination, scale, and effectiveness of financial and technical assistance provided to developing countries; stronger, more sustained public-private collaboration on research and innovation across several sectors; and targeted collaboration on trade.

We hope that the recommendations in this report provide a practical, detailed roadmap for stronger international collaboration. We look forward to continuing to support governments, businesses and civil society organisations in their efforts to implement the recommendations of this report, as we work together to make the transition to clean technologies and sustainable solutions faster, easier and more affordable for all. We need to incorporate the full range of environmental, social, economic and governance dimensions and to address transitional challenges, especially in developing countries. The acceleration in the global low-carbon transition must be connected with inclusive development pathways through ensuring linkages with and contribution to the 2030 Agenda for Sustainable Development.

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CHAPTER 8. AGRICULTURE

STATE OF THE TRANSITION

The Breakthrough objective for the food and agriculture sector, as adopted by signatory countries at COP 26, is that climate-resilient, sustainable agriculture must be the most attractive and widely adopted option for farmers everywhere by 2030.

Agriculture accounts for around one-third of all GHG emissions globally when food production, transport, processing, retailing, and loss and waste along the entire value chain are considered. Almost half of the world's population lives in households reliant on agrifood systems for livelihoods. The agrifood sector is particularly vulnerable to climate change, with losses and damages occurring throughout the value chain due to extreme weather events like high temperatures, droughts and floods. Small-scale farmers in the Global South are especially at risk, and current efforts to adapt to climate change fall short of what is needed. Further, without sustained reductions in emissions in this sector, international climate goals cannot be met.

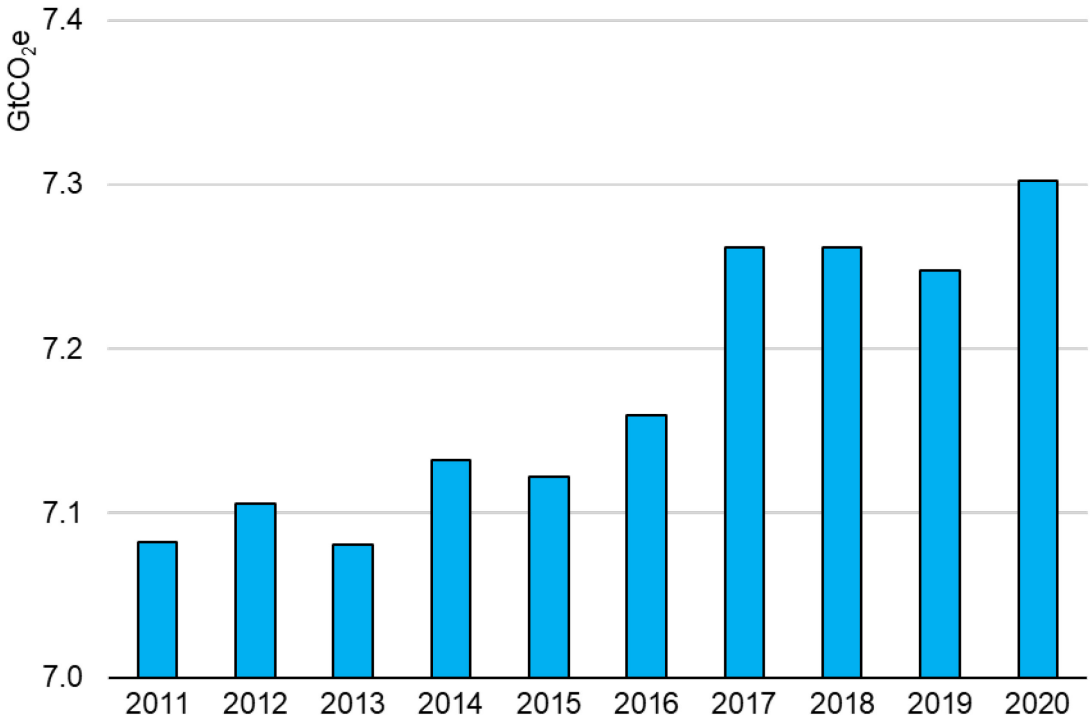
The agrifood sector requires transformative changes (or breakthroughs) within a just transition framework. It needs to reduce emissions and ensure food and nutrition security without endangering the livelihoods of smallholder producers or damaging natural resources. The sector's inherent diversity makes technologies and approaches for reducing GHG emissions and building long-term climate resilience very context-specific. This then requires careful analysis of trade-offs and synergies across various dimensions, in order to choose technologies that minimise trade-offs and maximise synergies. Innovations in practices, technologies,[1] policies and financing across various sub-sectors and components of the agricultural value chain are needed.

In last year's report, we proposed four principles to measure progress against the agriculture breakthrough objective. These were: 1) agricultural productivity and incomes must sustainably increase; 2) GHG emissions from the sector must decline; 3) soil, water, and natural ecosystems should be safeguarded; and 4) the sector as a whole – including the 80% of the world's poor who live in rural areas and work mainly in farming – must adapt and build resilience to climate change.

Unfortunately, very little progress has been achieved in the last 5 years across these dimensions. Global crop yields and metrics for livestock have shown no change over the last years of available data. GHG emissions from agriculture (at farm gate) also show virtually no movement towards the 2030 goal of declining to 5.70 Gt CO_2 equivalent (CO_2-eq), remaining at around 7.25 Gt CO_2-eq from 2016 to 2020 (Figure 8.1).

[1] The term technological areas (or technologies) and approaches is used throughout this chapter to describe different types of innovations i.e. in practices, technologies, strategies, approaches, policies, financing, etc.

Figure 8.1. Agriculture related emissions (at farm gate), 2011-2020



Note: Farm gate emissions include emissions from crop residues and their burning; rice cultivation; enteric fermentation; manure management, including manure left on pastures and manure applied to soils; synthetic fertilisers; and energy use in agriculture.

Source: FAO (2023), FAOSTAT (database), (accessed Sept 2023).

Gains and losses in global cropland have roughly balanced out, but this small net change masks that agricultural expansion continues to drive deforestation globally and particularly in the tropics.[2] Agricultural land expansion globally will have to stop if the global targets for 2030 to end deforestation and to halt the loss of natural vegetation important for biodiversity are to be met. According to the Food and Agriculture Organisation (FAO), agricultural water use efficiency (value of output per m^3 of water used) increased by 12.5 % between 2015 and 2019. FAO also reports, however, that water stress is rising in "critically affected" regions in the Global South. In sum, the most recent year of data collection reveals a fairly uniform lack of progress across the metrics selected in last year's report. While it is true that meaningful observations on agricultural sector trends require longer time horizons, the most recent year's lack of desired movement is consistent with the previous 5 years of slow progress in this sector.

[2] From 2015 to 2022, for example, deforestation occurred across a total of 48 Mha globally, with over 70% of these permanent losses being due to large-scale commodity production (which includes mining, and oil and gas extraction) (Hansen et al., 2013; Curtis et al., 2018; Turubanova, S. et al., 2018; Tyukavina, A. et al., 2022).

In this report we propose modifying the four principles to emphasise the importance of a just transition in this sector in the face of ongoing climate change, while also emphasising the context-specificity of agricultural solutions, as follows:

- Agricultural productivity and incomes in low- and middle-income countries (LMICs) must increase sustainably, in order to achieve food and nutrition security and healthy and sustainable diets for all.
- The sector must reduce GHG emissions, and depending on technologies and approaches and geographies, these can be reductions in emissions intensity, or absolute emissions reductions, or both, with the ultimate aim of reducing absolute emissions.
- Soil, water, biodiversity and natural ecosystems must be safeguarded across all geographies, including through a focus on healthy ecosystems.
- The sector must adapt and build resilience to climate change, including through approaches that promote inclusion and social safety nets for the poor and vulnerable smallholder producers in the Global South.

SEVEN PROMISING TECHNOLOGY AREAS AND APPROACHES CRITICAL TO THE TRANSITION

In last year's report we identified seven technological areas and approaches critical to accelerating the transition in the agriculture sector. These include: reducing emissions from fertilisers; alternative proteins; reducing food loss and waste; crop and livestock breeding; reducing methane emissions from livestock; agroecological and other sustainable approaches; and digital agriculture and climate services.

In this year's report, we consider how international collaboration can accelerate development and deployment of solutions in each of these seven areas.

In each area, many national (and local) actions will be required, as well as international collaboration. Figure 8.2 shows the four (updated) principles, which are the desired outcomes of the agricultural breakthrough; the five pathways, which are ways in which these desired outcomes can be achieved; and the seven technological areas and approaches on which concrete actions need to be taken in order to achieve the desired outcomes. These seven technological areas and approaches are by no means comprehensive, and we also identify a few other technological areas and approaches for inclusion in future reports. Our updated recommendations are based on the priorities emerging from a detailed science-based analysis of the seven technological areas and approaches in an underlying report by the CGIAR titled "Achieving agricultural breakthroughs: A deep dive into seven technological areas and approaches", henceforward called the CGIAR report.

Figure 8.2. Principles and pathways for achieving breakthrough in the agriculture sector

Note: ASF= animal source foods; HIC = High income countries; NUE= nitrogen use efficiency.

This also provides an Illustrative example of how seven technological areas and approaches map onto different pathways for achieving the breakthrough objectives while adhering to the four breakthrough principles. This figure is not meant to be a comprehensive mapping of all seven technological areas and approaches across all five pathways, as objectives for many or most of them can be achieved through multiple pathways. The seven technological areas and approaches covered in this chapter are in boxes with solid lines and are underlined and italicised. New technologies and approaches suggested for inclusion in future reports are in boxes with dotted lines.

Sources: IEA analysis based on data from IEA, IRENA and UN Climate Change High-Level Champions (2022), Breakthrough Agenda Report 2022.

In last year's report, we called for increased levels of climate finance directed at agriculture; a long-term process to share learning on policy reforms; a strategic dialogue on international trade in relation to the agriculture transition; development of agreed standards for monitoring the state of natural resources on which agriculture depends; and higher investment in agricultural RD&D. Metrics to track year-on-year action on these broad recommendations are high level at best, but our latest analysis supports the view that these five broad areas continue to represent the priorities for international collaboration in the sector.

In this chapter we respond to a request from countries under the Agriculture Breakthrough for deeper analysis of the seven technology areas, and increasingly specific recommendations on international collaboration. In each section below, we make a brief assessment of progress against last year's recommendation, followed by new and targeted recommendations for 2023.

INCREASED INTERNATIONAL CLIMATE FINANCE SHOULD BE DIRECTED TO UNLOCKING THE POTENTIAL OF AGRICULTURAL TECHNOLOGIES AND APPROACHES WITH PROVEN EFFECTIVENESS

OVERVIEW

Last year, we recommended that the level of international climate finance directed at agriculture should be greatly increased, in line with its importance to global emissions, adaptation and resilience and food security. We also recommended that governments, multilateral development banks (MDBs) and private sector investors should work together to make finance and assistance available to small- to medium-sized enterprises (SMEs) and smallholder farmers in developing countries on a far larger scale than has been achieved so far.

WHAT PROGRESS HAS BEEN MADE?

We assess that minimal progress has been made against the recommendation we made last year.

Total (international) climate-related development finance (from bilateral, multilateral and private philanthropic sources) to agriculture, forestry and fisheries dropped in 2020/21 versus the previous year[3], with 2021 levels at the lowest seen since 2016. The gap between needed investment and actual flows is large and growing. At an annual average of USD 28.5 billion, agrifood systems receive just 4.3% of total global climate finance tracked

[3] Last year's Breakthrough Agenda Report reported on data for 2019/20.

at the project level (domestic and international combined) and the Climate Policy Initiative (CPI) estimates that seven times as much is needed to meet even the lowest estimates of climate investment needed by the sector.

Some progress has been made in laying the analytical groundwork – to be presented by international organisations around COP 28 – for the recommended increase in climate finance for agrifood systems. International organisations and initiatives across public and private sector actors are producing, for example, a detailed analysis of OECD-Development Assistance Committee (DAC) financial flows and investment gaps in agriculture and food systems (Food and Agriculture for Sustainable Transformation Initiative (FAST)); an analysis of public and private current climate finance flows to agriculture, forestry and other land use (AFOLU) and associated recommendations for private and public actors (Climate Shot Investor Coalition and CPI); and a roadmap to help investors in the sector align their portfolios with the Paris Agreement aim of limiting global warming to 1.5 °C (FAO and the FAIRR Initiative). While these analyses are important, it is vital that a substantial increase in climate finance follows. The UNFCCC report on the second biennial communication, released in the early half of 2023, states that many governments remain committed to maintaining or increasing their current levels of climate finance. The most recent updates on the levels of climate finance that have been disbursed, however, are expected to be released around COP 28 this year. They will show to what extent progress has been made globally and from all sources.

WHAT MORE NEEDS TO BE DONE?

This year's recommendation supplements the headline call for more finance by focusing on specific financing gaps that need to be closed to support the rapid deployment of solutions that have been proven to be effective, while reducing emissions and/or enabling adaptation.[4] We suggest the following areas as priorities for international climate finance in the agriculture sector, based on their significance for global emissions and the availability of scalable solutions:

- **Agroecology:** Incremental climate finance should be added to ongoing streams of development finance in order to support greater integration of agroecological and other sustainable approaches in farming and food systems (i.e. that increase ecological functioning and enhance carbon storage and sequestration, while also strengthening resilience to shocks[5]). Such approaches reduce GHG emissions, improve food security and achieve environmental outcomes. This incremental finance should be accompanied by robust economic and financial viability analysis for the specific context of projects and programmes. A review of evidence on biodiversity restoration,

[4] Technologies and solutions can be organised by technology readiness levels (TRLs), ranging from an idea all the way to full commercialisation, under all uncontrolled conditions. This recommendation targets innovations for which there is scientific evidence of effectiveness. Those that are more less developed can be found across all technology areas in the CGIAR report. Other innovations may already have reached niche markets (e.g. some newer alternative proteins), and the support they need is highlighted in other recommendations below.
[5] For more information, see section 7 the CGIAR Report.

mitigation and adaptation co-benefits, food security, and improved livelihoods, as well as on the pattern of productivity gains, losses and sustained recovery is provided in section 7 of the CGIAR report. International partners should also co-ordinate around instruments that target financial support to offset any temporary losses (if needed) to producers who are making the transition to agroecology and other sustainable approaches. This will be particularly important for small-scale producers, as will developing links to markets for agroecological and other sustainable products, backed by robust risk analysis and publicly supported risk instruments.

- **Reduction of food loss and waste** can be mainstreamed into all investments in food systems, including those supported by international development assistance. Proven technologies to reduce loss and waste along the value chain include reducing food losses at the production and postharvest stage, particularly in the LMICs where such losses are high, and reducing food waste at the consumer level, particularly in HIC contexts where such waste tends to be high.[6] At the global level, halving food loss and waste can potentially remove 25% of GHG emissions from the food system.
- **Reducing methane emissions from livestock**: Proven methane-reducing technologies in the livestock sector include methane inhibitors such as 3-nitrooxypropanol (3-NOP), tanniferous forages as feed additives, concentrate feeds, and anaerobic digesters (ADs) that break down manure. In Africa, over 100 000 such ADs are currently operational on farms, while China and India combined have over 40 million. International financial assistance can help to rapidly increase the use of all these technologies, by making them more affordable. In addition, for LMICs, simply increasing financing for the mainstreaming of climate smart livestock approaches that improve livestock productivity will have a significant impact not just on emissions but also on livelihoods.[7]
- **Reducing emissions from fertilisers:** Technologies that reduce emissions from fertilisers while maintaining positive productivity include slow-release fertiliser, chemical and biological inhibitors and coated fertilisers; precision nutrient management such as sensor-based fertiliser management, and use of decision support systems for fertiliser recommendations. The production of alternative fertiliser has not yet achieved significant scale, meaning that economic viability versus conventional fertiliser is likely to remain an issue until increased uptake drives costs down.[8] The same type of early-stage public finance that has supported demonstration projects, or technical assistance for policy reforms for alternative energy technologies, could be used to support the market development and deployment of alternative fertilisers.
- **Crop and livestock breeding**: Successful crop and livestock breeding outcomes, i.e. technologies that raise both the productivity and climate resilience of crops and

[6] See section 4 of the CGIAR report for reviews of these technologies.
[7] See section 6 in the CGIAR Report.
[8] See also section 2 in the CGIAR report.

livestock, have been robustly tested. Countries and MDBs providing international development assistance, co-ordinating internationally with leading research and breeding organisations, can target funding to enable crop and livestock breeders and scientists in developing countries to access new high-precision breeding equipment and capacity, and can support the diffusion of successful approaches. In the context of livestock breeding, animal health and welfare should be given utmost importance. Any unintended consequences and trade-offs for animal welfare and health should be mitigated to prevent reduction in animal fitness resulting from selection for high productivity traits.[9]

Across the seven technology areas, the lack of capacity and know-how regarding improved technologies will slow adoption. It will be important to support capacity building and technical assistance to developing country governments in each of these areas.

RECOMMENDATION A1 HAS BEEN UPDATED AS FOLLOWS:

Increased climate finance should be directed to supporting the deployment of agricultural technologies and approaches for which science has generated evidence on effectiveness, including agroecology, reducing food loss and wate, reducing livestock methane emissions, reducing emissions from fertilisers, and crop and livestock breeding

PROMOTE INTERNATIONAL SHARING OF KNOWLEDGE ON POLICY AND IMPLEMENTATION TO FACILITATE FASTER UPTAKE OF PROVEN TECHNOLOGIES

OVERVIEW

Last year we recommended that governments, research institutions, international organisations and the private sector should commit to a long-term process to test, develop evidence, and share learning on approaches to redirecting policies and support for agriculture towards sustainability and climate resilience. we specified that this should involve all the world's largest agricultural producer countries, whose policies heavily influence global markets, as well as countries representing a diverse range of environmental and economic conditions.

[9] See section 5 in the CGIAR report.

WHAT PROGRESS HAS BEEN MADE?

We assess that modest progress has been made against the recommendation we made last year.

The Policy Dialogue on Transition to Sustainable Agriculture, co-convened by the United Kingdom and the World Bank, was launched in January 2021 and provides an on-going active – primarily intergovernmental – platform for peer-to-peer experience-sharing, knowledge exchange and building collective ambition for policy reform. The 26 countries participating in this initiative comprise LMIC and HIC nations from across multiple regions, but so far include only 2 of the world's top 10 agricultural producers.

There have been ongoing efforts towards developing complementary international dialogue for a wider set of participants, such as the Just Rural Transition initiative that brings together producers, civil society, the private sector and others. While not yet a long-term process, there have been further episodic initiatives, such as the Africa Agriculture Policy Leadership Dialogue in 2023, that have convened similar discussions with a wider set of actors from the private sector, international organisations and research communities. Other international efforts include the policy side events held at the UN Food System Summit Stocktake in 2023.

WHAT MORE NEEDS TO BE DONE?

To meet international climate goals, rapid knowledge-sharing on best practices in policy and implementation is urgently needed. This will help avoid "reinventing the wheel" in regions that are at an earlier stage in their transition. We identify key areas where international knowledge sharing is critical to support a "just rural transition" to sustainable food systems, focusing on those technology areas for which an absence of strong international knowledge networks or a dearth of shared policy experience are key obstacles to the uptake of innovation and the spread of new solutions.

While there has been an increase in attention and intention around platforms for international collaboration on sharing best-practice policies and approaches, equally important will be the identification of a priority, science-based agenda for these platforms; the participation of countries that together make up the majority of relevant global markets; the provision of high-quality evidence and analysis to inform discussions; and the long-term funding and political commitment to enable exchanges to be sustained over time.

We judge that leveraging, strengthening and – where necessary – creating international knowledge networks closely linked to national-level agencies will be important for more widespread implementation of solutions in the following areas:

- **Alternative proteins**: There is a need to develop knowledge exchange platforms on the regulatory frameworks and policies to promote the use of newer alternative proteins.[10]
- **Reducing food loss and waste:** The FAO, World Resources Institute (WRI), One Planet, and Meeting of Agricultural Chief Scientists-G20 Collaboration Initiative, among others, with the support of CGIAR, can provide co-ordinated and increased technical assistance and data to existing multi-stakeholder platforms currently promoting dialogues among researchers, industry, governments and civil society on the needs and means to reduce food loss and waste.[11] Countries can also share best practice in conducting consumer awareness campaigns to reduce food loss and waste, supported by international partnerships such as One Planet's Sustainable Food Systems (SFS) Programme and FAO's SAVE FOOD: Global Initiative on Food Loss and Waste Reduction.
- **Reducing methane emissions from livestock:** National government ministries and industry leaders should engage substantively in sharing knowledge, with the support of key international research initiatives and organisations[12], to further scale up innovative technical solutions for reducing methane emissions and/or climate-smart livestock production practices that also improve livestock productivity and livelihoods – particularly for smallholder producers in LMICs.[13]
- **Digital services:** Digital services in agriculture can help farmers and small agricultural businesses to rapidly gain the skills and knowledge they need to adapt to and mitigate climate change while improving food production sustainably in several ways. Greater support for regional associations that raise awareness, inter-country co-operation, and knowledge sharing that is aimed at ensuring poor people, women and youth have good access to mobile internet and cellular services should be provided. This can be supported through sharing international experience on public-private partnership investments for affordable digital agriculture and climate services, and through more funding to these regional associations.[14]
- **Repurposing agricultural support and subsidy policies** from existing distortionary agricultural support that encourages pollution and environmental degradation towards more climate friendly incentive regimes. The need to repurpose existing agricultural policies and subsidies to support more sustainable practices is a common theme that runs through all seven technology areas. Current support to agriculture, provided through public policies and expenditures, is sizeable. Of the overall annual support by a group of 79 countries, estimated at USD 638 billion, about 70% (or USD 431 billion)

[10] See section 3.6 of the CGIAR report.
[11] See section 4.6 of the CGIAR report.
[12] Key international research institutes in this field include the Global Research Alliance on Agricultural Greenhouse Gases (GRA), CGIAR, the Global Methane Hub, and the WRI.
[13] See section 6.6 of the CGIAR report.
[14] See section 8.6 of the CGIAR report.

is directly targeted at producers.[15] Of this direct producer support, about 86% is through measures that the OECD refers to as "potentially most distorting"—including both market price distortions as a result of policies, and explicit subsidies as fiscal expenditures. The remaining 14% is in the form of decoupled transfers, which are less distorting. The distortive effects of many of these subsidies – including their role in raising GHG emissions – is well understood, as is the need, therefore, to repurpose them. Countries should participate in initiatives designed to share knowledge on reorienting agricultural policy support, such as the Policy Dialogue on Transition to Sustainable Agriculture.[16] They should work together through such initiatives to formulate indicative pathways for policy action, including repurposing agricultural subsidies towards incentives and support for capacity-building and uptake of sustainable agriculture practices and technologies highlighted in Recommendation 1. These technologies include low-emission fertilisers, food loss and waste reduction across entire value chains, investments for the appropriate implementation of agroecological and other sustainable approaches, proven methane-reducing technologies and climate-smart practices in livestock, and incentives towards greater international collaboration on crop and livestock breeding.

Further to the work on repurposing of subsidies, there is a dearth of shared policy experience on key areas such as agroecology and digital services. Specifically, key international organisations such as the United National Environment Programme (UNEP), FAO, The Nature Conservancy, Biovision, Agroecological Coalition and the Transformative Partnership Platform (TPP)[17] should document and disseminate policy experience and regulatory best practice to strengthen policy and institutional frameworks needed for uptake of agroecological and other sustainable approaches, which can be then taken up by governments. Governments should ensure that these, and other robust evidence bases underpin the platform agendas in which they participate. Similarly, the Global Coalition for Data and Digital Food Systems Innovation should work with the FAO[18] to create evidence to inform policy coherence and demonstrate the need for affordable digital services that are gender-aware and inclusive in agriculture. Governments should actively engage with these research outputs in their digital services investments.

[15] The remainder going to expenditures on public goods and services such as R&D, support to consumers, and small share explicitly targeted at promoting sustainable practices, such as land set-aside programmes.
[16] In addition to the Policy Dialogue on Transition to Sustainable Agriculture, international organisations engaged actively in policy and investment dialogues should bring the international best practice policy experience to the implementation of these recommendations (see Table 9.1 in the CGIAR Report for full list of possible partners who could implement recommendations).
[17] See section 7.6 of the CGIAR Report.
[18] See section 8.6 of the CGIAR Report.

RECOMMENDATION A2 HAS BEEN UPDATED AS FOLLOWS:

Governments, research institutions, international organisations and the private sector should commit to a long-term process to test, develop evidence and share learning on policy and implementation. This should prioritise the redirecting of subsidies to support agriculture to move towards sustainability and climate resilience, and the facilitation of faster uptake of proven technologies in the sector.

DEVELOP COMMON METRICS AND INDICATORS TO TRACK THE ADOPTION OF SUSTAINABLE AGRICULTURE SOLUTIONS

OVERVIEW

Last year we recommended that countries and international organisations should develop internationally agreed standards for monitoring and reporting on the state of natural resources on which agriculture depends, including soil carbon content and health, and pollinator health, as well as on the geographical extent of agriculture. We reported that there was a lack of regularly updated internationally comparable data on the extent of agricultural land, soil carbon, and biodiversity and pollinator health. We noted that such metrics are essential to support an understanding of the extent to which agricultural practices intended to be sustainable actually are sustainable, and that international measurement standards would help support high-quality knowledge sharing on policy effectiveness and enable international trade to play a positive role in supporting the transition.

WHAT PROGRESS HAS BEEN MADE?

We assess that minimal progress has been made against the recommendation we made last year.

While some international discussions on these issues continue to take place, there are still no agreed common metrics for tracking these indicators. For instance, there are regional agreements across subsets of countries on soil health (e.g. within the European Union), but despite the plethora of available soil health monitoring frameworks and indicators, there is no consensus on their use globally.

WHAT MORE NEEDS TO BE DONE?

There remains a need for countries and international organisations to develop internationally agreed standards for monitoring and reporting on the state of natural

resources on which agriculture depends. These include soil carbon content and health, pollinator health, and the geographical extent of agriculture.

In addition, we find that there is a need for internationally agreed metrics to track the adoption of some of the key sustainable agriculture solutions identified in this report. This could help inform the targeting of international assistance, and support the adoption of co-ordinated policy measures, as well as facilitate trade (see Recommendation A5). The technology areas and approaches that are not accurately tracked at present – and therefore for which it is not possible to assess progress – include reducing livestock emissions, reducing food loss and waste, increasing equitable access to digital agriculture and climate services, increasing impact evidence for the integration of agroecology and other sustainable approaches, and documenting environmental and health outcomes for new alternative proteins. To fill these gaps, countries and international organisations should work together on the following priorities:

- Reaching international agreement on metrics, measurement and reporting methodologies for livestock enteric methane emissions. This would permit the development of targets and baselines for such reductions.[19]
- Based on existing protocols, reaching agreement on the common adoption of globally consistent measurements for tracking food loss and waste. This would provide accurate data for tracking hot spots for food loss and waste – globally, nationally and locally – and to inform national and international development investment decisions in support of greater mainstreaming of measures to reduce food loss and waste. Detailed annual estimates should include data on nutrient losses along the food supply chain to inform food security interventions.[20]
- Agreeing internationally on metrics for examining the performance of agroecology and other sustainable approaches (including climate smart agriculture and regenerative agriculture) to provide decision makers and would-be investors with accurate data.[21]
- Developing common metrics and indicators to monitor progress in connecting to smallholder producers through digital services will inform technical support for governments and private sector start-ups and help ensure equitable digital agriculture and climate services for all.[22]

[19] See section 4.6 in the CGIAR report.
[20] See section 4.6 in the CGIAR report.
[21] See sections 7.3 and 7.6 in the CGIAR report.
[22] See section 8.6 in the CGIAR report.

RECOMMENDATION A3 HAS BEEN UPDATED AS FOLLOWS:

Governments, international organisations and research institutes should develop common metrics and indicators to track the adoption of key sustainable agriculture solutions and to monitor the state of natural resources on which agriculture depends.

INCREASE SUPPORT TO FOOD SYSTEM RESEARCH, DEVELOPMENT AND DEMONSTRATION TO SUPPORT UPTAKE AND SCALING OF PROMISING TECHNOLOGIES AND APPROACHES

OVERVIEW

Last year we recommended that governments and companies should work together to deliver higher levels of investment in agricultural research, development, and demonstration (RD&D), to be maintained over the course of this decade. The scale and diversity of collaborative international RD&D initiatives and programmes should also be increased. Priority should be given to innovations that can reduce food waste, limit emissions from livestock and fertilisers, improve alternative proteins, develop climate-resilient crops and livestock, and protect soil and water resources.

WHAT PROGRESS HAS BEEN MADE?

We assess that modest progress has been made against the recommendation we made last year.

Last year we reported that the level of funding for agricultural research had fallen in recent years, especially from high income countries. We noted that this was weakening collaborative international efforts, with an example being that spending through the CGIAR on agricultural R&D in 2019 was 30% below its inflation-adjusted level in 2014. Since then, there has been an 11% nominal increase in funding to the CGIAR, but this can only be loosely indicative of the level of support for collaborative international efforts, which are a subset of overall food system RD&D. Unfortunately, detailed annual breakdowns on the sources and uses of all relevant RD&D investment globally are not found to be easily accessible on a year-on-year basis.

This year, however, has seen an uptick in dollar commitments through the Agriculture Innovation Mission for Climate (AIM4C), a key global forum for collaboration between governments and other partners to mobilise greater investment in climate-smart agriculture R&D. AIM4C government members raised their commitments this year to just over

USD 10 billion for the 2021-2025 period across 5 priority areas. The Innovation Sprints undertaken to date map to most of the technological innovation areas identified by the Breakthrough Report, with the notable exception of food loss and waste. While this initiative is welcome and well aligned with the priority technological areas independently identified by this report, both more funding and research projects are needed to fill the priority gaps remaining (see below).

WHAT MORE NEEDS TO BE DONE?

Investment in RD&D and the adoption of climate relevant technologies and approaches for use in low- and middle-income countries (LMICs) has an estimated potential of reducing agriculture, forest and land use emissions by some 40-50%. This finding covers both the increased uptake of innovation and the continued importance of discovery science in identifying the transformation solutions of the future.

Last year we identified a set of technology areas as having RD&D gaps that needed to be filled to "accelerate the development and eventual cost-effective deployment of technologies and solutions" to reduce emissions and improve resilience. Here we highlight a number of specific RD&D gaps within each of these technology areas (see the CGIAR report for full details) and recommend how they may be overcome:

- **Reducing methane emissions from livestock:** Further studies are needed to assess the specific on-farm mitigation potential and impacts of different methane emission reducing strategies and technologies in the livestock sector in diverse regions and farming systems. In addition, investing in RD&D to identify cost-effective methods for Measurement, Reporting, and Verification (MRV) of emissions reductions in the livestock sector could lead to greater carbon market opportunities, including for small producers.[23]
- **Alternative proteins:** Research investments with a long-term goal of making alternative proteins a reliable and affordable option are needed in high- and middle-income countries (HMICs), to replace high levels of animal-source food intake, and in LMIC contexts with high levels of malnutrition, to reduce child malnutrition with high-quality protein sources.[24]
- **Digital services:** Increased RD&D to advance uptake of digital agriculture and climate services should focus on: 1) the design of contextually appropriate digital agriculture and climate services; 2) identification of successful strategies for scaling up services and reaching poor smallholder farmers; and 3) assessment of the impacts of scaling up digital agriculture and climate services.[25]
- **Crop breeding:** Strengthen existing international initiatives for crop breeding to complement the development of new crop varieties, with a focus on new RD&D needs

[23] See section 6.6 in the CGIAR report.
[24] See section 3.6 in the CGIAR report.
[25] See section 8.6 in the CGIAR report.

such as development of these varieties through participatory protocols that engage a community or group of farmers in crop breeding for climate resilience. Organisations such as the CGIAR, FAO, International Union for the Protection of New Varieties of Plants (UPOV) and the Codex Alimentarius Commission set up by the World Health Organization (WHO) and FAO[26] can play an important role in this regard. These processes are needed to ensure that the benefits of accelerated genetic innovations and increased deployment of new technologies are shared equitably with smallholder farmers and the broader scientific community.

When aiming to promote the uptake of innovations believed to be technologically ready, governments should undertake a robust economic and financial analysis (EFA) for their specific context and application. Development partners such as the FAO or World Bank should host a database of these context-specific EFA variables and outcomes and organise them by region, country and agroclimatic conditions, among other things. Governments should systematically share their EFA data with such an international database to allow faster and better-informed uptake of ready technologies in areas, regions or countries with similar conditions.

> RECOMMENDATION A4 HAS BEEN UPDATED AS FOLLOWS:
>
> Governments, research organisations and companies should work together to deliver higher levels of investment in agricultural research, development and demonstration, to be maintained over the course of this decade. Priority should be given to innovations that can reduce methane emissions from livestock, make alternative proteins a reliable and affordable option, increase the resilience of crops, and advance uptake of digital services by farmers.

INTERNATIONAL EFFORTS SHOULD WORK TOWARDS ENABLING THE PRIVATE SECTOR TO SCALE UP SOLUTIONS THROUGH GLOBAL MARKETS

OVERVIEW

In last year's report we recommended that governments should begin a strategic dialogue on how to ensure international trade facilitates, and does not obstruct, the transition to sustainable agriculture. International organisations can advise on options to ensure a level

[26] See section 5.6 in the CGIAR report.

playing field so that policy measures essential to drive the transition do not put a country's agricultural sector at a competitive disadvantage in international trade. Early priority should be given to agreeing sustainability standards for the agricultural commodities that contribute disproportionately to deforestation.

WHAT PROGRESS HAS BEEN MADE?

We assess that minimal progress has been made against the recommendation we made last year.

In 2023, the World Trade Organization (WTO) participated in the Agricultural Ministers' Conference at the 15th Global Forum for Food and Agriculture in Berlin, suggesting that the role of trade in the transition to sustainable agriculture is beginning to appear on the international agenda. We have not, however, comprehensively tracked progress against this recommendation and other positive initiatives may well be underway. There remains a need for countries to begin substantial, sustained discussions to ensure that international trade supports the transition to sustainable agriculture.

WHAT MORE NEEDS TO BE DONE?

The private sector investment that is needed for the transition requires the right enabling environment, with clarity and consistency on the "rules of the game". More than the level of tax or the cost of labour, firms rank the legal and regulatory environment high among the factors affecting their investment decisions. Given high levels of international trade in both agricultural inputs and agricultural produce, in many cases international agreements on standards and trade will be critical to creating the necessary regulatory environment and investor confidence. Further, robust consumer demand for internationally traded goods is the enduring incentive for private investment and the exit strategy for public subsides. The universal availability of information about more sustainable technologies and on their benefits and risks to consumers influences consumer demand, and the international community has much to contribute to resolving current information asymmetries.

In last year's report we highlighted the agricultural commodities that contribute disproportionately to deforestation as a subsector to be prioritised. Here we propose priorities relevant to the seven technology solution areas discussed in this chapter. We suggest the following priorities:

- **Alternative proteins:** Countries should work together through forums such as the Codex Alimentarius Commission informed by expert organisations such as the FAO, Good Food Institute (GFI), WRI and the CGIAR[27] to develop common standards, regulations, metrics, labelling norms, and methodologies for assessments of environmental, social, health and nutrition impacts and for ensuring overall food safety

[27] See section 3.6 in the CGIAR report.

of newer alternative proteins. Such standards will be important for consumer confidence and for informed choice around more climate-friendly proteins, particularly in HICs where current meat consumption is higher than global averages. The harmonisation of regulations internationally would facilitate trade in alternative proteins and reduce risks to the private sector.

- **Low-emission fertilisers:** Countries should work to agree harmonised standards and regulations to level the playing field with high-emission alternatives on regulatory costs. Countries could hold talks on this issue and use forums such as the Policy Dialogue on Transition to Sustainable Agriculture or the Global Research Alliance on Agricultural Greenhouse Gases (GRA) to discuss experience and regulatory proposals. Advice could be sought from expert bodies such as the International Nitrogen Management System and the International Nitrogen Initiative.[28]
- **Crop and livestock breeding** is critical to both adaptation and mitigation. Countries should work together to develop and implement Intellectual Property frameworks that clearly set out the rights and responsibilities of the private and public sectors and those of international breeding bodies and their local community partners. This is needed to ensure that poorer farmers have access to resilient and low-emission crop and livestock varieties. Expert partners that could support countries in such an endeavour could include, among others, CGIAR, FAO, UPOV and the Codex Alimentarius Commission.
- **Agroecology:** Countries should work towards the harmonisation of standards and terminology for the products of agroecological and other sustainable agricultural approaches. Clearer labelling and certification enables incentives in the form of premiums, raising the profitability of producing these goods, and resolving any confusion that could lead to cynicism among investors and consumers, constraining demand.[29] Without harmonisation on definitions and labelling, it may be more difficult to spread these approaches rapidly through global markets.

Across all breakthrough technologies for which the private sector is a key scaling actor, international dissemination of successful business models and experience with risk-sharing financial instruments can be effective in attracting greater private sector investment. International measures such as these provide a predictable operating environment for the private sector which reduces risk and can boost investment in technologies that will impact the different dimensions of agricultural breakthrough. They also support high quality evidence to inform consumer demand, further supporting market-driven alignment with climate goals.

[28] See section 2.6 in the CGIAR Report.
[29] See section 7.6 in the CGIAR report.

RECOMMENDATION A5 HAS BEEN UPDATED AS FOLLOWS:

Governments should begin strategic dialogues on how to ensure international trade facilitates, and does not obstruct, the transition to sustainable agriculture. In addition to addressing the agricultural commodities that contribute disproportionately to deforestation, early priority should be given to agreeing standards, labels and regulations for alternative proteins, low-emission fertilisers, and products of agroecological and other sustainable approaches, and to developing intellectual property frameworks that promote access to resilient and low-emission crop and livestock varieties. This should be complemented with international sharing of best practice on mobilising private investment and engaging consumers.

ISSUES NOT COVERED IN THIS CHAPTER

In this chapter we have focused on opportunities for international collaboration to accelerate the adoption of solutions in seven technology areas. While these are important priority areas, they are not comprehensive. Other technology and solution areas will also be important to the just transition to sustainable agriculture. These include emissions reduction from rice paddies, improved water management as a climate adaptation strategy with mitigation co-benefits, and the promotion of more healthy and sustainable diets. Wider concerns, including antimicrobial resistance and zoonotic diseases, and broader issues of inclusion and social justice, will also be relevant to the transition in the sector. We encourage governments and international organisations to continue to develop a stronger shared understanding of the opportunities and risks around the transition to sustainable agriculture, and of the priorities for international collaboration.