Growing Better:

Ten Critical Transitions to Transform Food and Land Use

The Global Consultation Report
of the Food and Land Use Coalition

September 2019

The **Food and Land Use** Coalition

Table of Contents

Foreword 4

Acknowledgements 6

Executive summary 9

Chapter 1: Introduction 22

Chapter 2: The Case for Action 34

- 2.1 Key facts 35
- 2.2 Risks to food security 37
- 2.3 Hidden costs and risks 37
- 2.4 Inefficiencies in food and land use systems 47
- 2.5 Inefficiencies in financing food and land use systems 51
- 2.6 Conclusions 55

Chapter 3: Ten Critical Transitions to Transform Food and Land Use 60

- Critical Transition 1. Promoting Healthy Diets 63
- Critical Transition 2. Scaling Productive and Regenerative Agriculture 78
- Critical Transition 3. Protecting and Restoring Nature 89
- Critical Transition 4. Securing a Healthy and Productive Ocean 112
- Critical Transition 5. Investing in Diversified Sources of Protein 120
- Critical Transition 6. Reducing Food Loss and Waste 128
- Critical Transition 7. Building Local Loops and Linkages 138
- Critical Transition 8. Harnessing the Digital Revolution 148
- Critical Transition 9. Delivering Stronger Rural Livelihoods 154
- Critical Transition 10. Improving Gender Equality and Accelerating the Demographic Transition 164
- The Need for Comprehensive, Integrated National Reform Agendas 166

Chapter 4: A Better Food and Land Use Future 176

- 4.1 Summary of outcomes of the transformation programme 177
- 4.2 Detailing the Outcomes of the Better Futures Scenario 181
- 4.3 Financing the Food and Land Use Transformation 194

Chapter 5. From Theory to Action 210

1. Actions for Governments 211
2. Actions for Business and Farmers 214
6. Actions for Investors and Financial Institutions 215
7. Actions for Civil Society 216
8. Actions for Participants in Multilateral Processes and Multi-Stakeholder Partnerships 217

Annex A:

- FOLU partners, supporters and Ambassadors 221
- FOLU country platforms 224

References 229

Growing Better:

Ten Critical Transitions to Transform Food and Land Use

FOLU Core Partners

AGRA Growing Africa's Agriculture · EAT · gain Global Alliance for Improved Nutrition · International Institute for Applied Systems Analysis IIASA www.iiasa.ac.at · Sustainable Development Solutions Network A GLOBAL INITIATIVE FOR THE UNITED NATIONS · SYSTEMIQ · wbcsd · World Resources Institute

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Cover image:
Villagers of the Sagai forest villages in the Narmada district of Gujarat, India, where land rights have been reinstated to the community members, enabling them to make a better living by restoring and protecting the land and forests they depend on.

The Global Consultation Report
of the Food and Land Use Coalition

September 2019

The **Food and Land Use** Coalition

Foreword

Transforming the world's food and land use systems is necessary to achieve the targets for climate and sustainable development set out in the 2015 Sustainable Development Goals and the Paris Agreement on climate change. The Food and Land Use Coalition (FOLU) was launched in 2017 to catalyse and speed up this transformation.

The term "food and land use systems" covers every factor in the ways land is used and food is produced, stored, packed, processed, traded, distributed, marketed, consumed and disposed of. It embraces the social, political, economic and environmental systems that influence and are influenced by those activities. Food from aquatic systems, marine and freshwater, is also included in the definition because fish (wild and farmed) accounts for a significant share of the protein in human diets and this share will potentially increase.[i] The report also covers agriculture for non-food purposes, such as bioenergy, fibres for textiles and plantation forestry products, as these already compete with food for fertile land and the competition could intensify in the future.[ii]

To achieve its purpose, FOLU develops knowledge, tools and partnership platforms to help those involved in economic and political decision-making to identify and pursue pathways to sustainable food and land use systems. We demonstrate that applying systems thinking to these tasks can foster productive, prosperous rural economies, protect and value natural resources and ecosystems, and provide nutritious, affordable food to a growing global population.

FOLU's work divides between (i) making the strategic case for rapid change, (ii) supporting countries with their food and land use planning, policy and market redesign, (iii) empowering diverse change leaders across public, private and civil society sectors, (iv) developing evidence-based transformation pathways and (v) accelerating shifts throughout the private sector.

FOLU values independent, science-based thought leadership and policy recommendations and engages diverse stakeholders in their development. We believe business has a critical role to play in achieving the outcomes for climate, biodiversity, public health and prosperous livelihoods that the world needs. The World Business Council for Sustainable Development, a FOLU core partner, convenes business leaders to support them in this role. FOLU acknowledges the invaluable contribution of Unilever, Yara International and the Business and Sustainable Development Commission in nurturing our initial development.

For more information, please visit our website at **www.foodandlandusecoalition.org**

[i] FOLU recognises the importance of the ocean as an essential source of protein and many other critical ecosystem services. We address the role of the ocean in the critical transition 4 on "Securing a healthy and productive ocean" and will look to strengthen our work on this critical aspect of the overall food and land use agenda over the coming years.

[ii] See Box 25 in critical transtion 3 on Protecting and Restoring Nature in Chapter 3 of the full online report.

The FOLU community continues to grow and evolve.

It currently comprises the following elements:

Core Partners: organisations responsible for the Coalition's global-level initiatives and engagement.

These include:

- Alliance for a Green Revolution in Africa (AGRA)
- EAT
- Global Alliance for Improved Nutrition (GAIN)
- International Institute for Applied Systems Analysis (IIASA)
- Sustainable Development Solutions Network (SDSN)
- SYSTEMIQ
- World Business Council for Sustainable Development (WBCSD)
- World Resources Institute (WRI)

FOLU Country Platforms: stakeholder networks that support the development and implementation of food and land use transformation strategies at the national level, including through the FABLE Consortium which currently comprises independent research teams from 18 countries, including the European Union (see Box 39 in Chapter 3 of the full online report).[iii]

Ambassadors: professionals who serve in an individual capacity, drawing on their expertise to support FOLU's objectives.

Supporters: donors and philanthropic organisations providing financial support to our work.

These include:

- The Gordon and Betty Moore Foundation
- The MAVA Foundation
- Norway's International Climate and Forest Initiative (NICFI)
- The UK Department for International Development (DFID)

[iii] These independent research teams do not necessarily reflect the views of their respective governments.

The final report and its content are the sole responsibility of the Food and Land Use Coalition as represented by the undersigned:

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International Food Policy Research Institute (IFPRI)
Alliance for a Green Revolution in Africa
Consultative Group on International Agricultural Research (CGIAR) centres
Food and Agriculture Organization of the United Nations (FAO)
Sustainable Food Trust
University of California, Davis
University of Leuven
Wageningen University
World Farmers Organisation
World Vegetable Center

Environment:

Bioversity International
CGIAR Research Program on Water, Land and Ecosystems
Columbia University
Conservation International
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Partners in Public Health
Tufts University
The World Health Organization (WHO)
UNICEF

Left: Ma Jinzhong joined the farm in 2013 and is now overseeing the greenhouses at the Pear Garden Farm in Beijing, China. He reflects on how farming approaches are going back to traditional ways: "We used cow manure before, and we use it now. I am going back to how I worked in the beginning."
Right: Balaynesh Kasa with three of her children. She farms hops at a watershed restoration and homestead development in Bahir Dar, the Amhara Region of Ethiopia. This provides her with enough income to support her family and send her four children to school.

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Executive summary

"You may delay, but time will not."

Benjamin Franklin

The world faces a remarkable opportunity to transform food and land use systems over the next ten years. This report lays out the scientific evidence and economic case that demonstrate that, by 2030, food and land use systems can help bring climate change under control, safeguard biological diversity, ensure healthier diets for all, drastically improve food security and create more inclusive rural economies. And they can do that while reaping a societal return that is more than 15 times the related investment cost (estimated at less than 0.5 percent of global GDP) and creating new business opportunities worth up to $4.5 trillion a year by 2030.[1] Delivering such a transformation will be challenging but will ensure that food and land use systems play their part in delivering the Sustainable Development Goals (SDGs) and the Paris Agreement targets on climate change.

Leaving these systems to continue on current trends, by contrast, means sleepwalking into a scenario wherein climate change, sea-level rise and extreme-weather events increasingly threaten human life, biodiversity and natural resources are depleted, people increasingly suffer life-threatening, diet-induced diseases, food security is compromised, and socioeconomic development is seriously impaired. Such a pathway would place the SDGs and the Paris Agreement targets out of reach and within a few decades threaten our collective security.

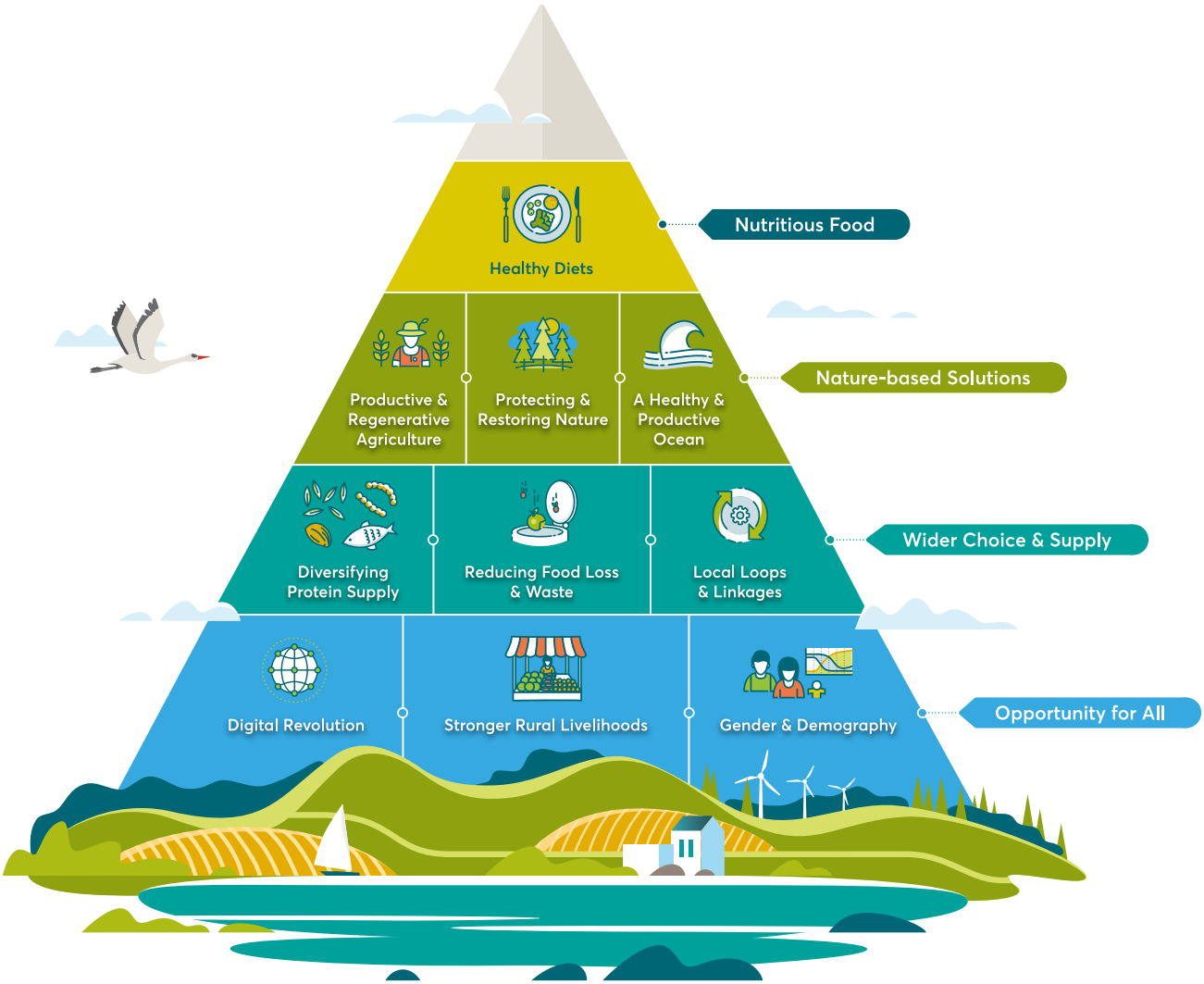
Transformation of food and land use systems thus needs to become an urgent priority globally – for leaders in the public and private sectors, and for civil society, multilateral institutions, the research community, consumers and citizens.

To support such leadership, this report from the Food and Land Use Coalition (FOLU) proposes a reform agenda. This agenda is centred around ten critical transitions that would enable food and land use systems to provide food security and healthy diets for a global population of over nine billion by 2050, while also tackling our core climate, biodiversity, health and poverty challenges (Exhibit 1). The specifics of the reform programme will inevitably vary from one country to the next, and from one community to the next. But all countries and communities could benefit from taking a holistic approach to the transformation of food and land use systems, combining the massive opportunities that are becoming available in respect of "nutritious food", "nature-based solutions", "wider choice and supply" and "opportunity for all" agendas.

Conceiving of the programme as a pyramid, the transition at the apex is toward diets that are conducive to good human and planetary health. This is because the consumption patterns of more than nine billion people – what they choose to eat and how they make (or are influenced to make) those choices – are the critical factors shaping how food and land use systems evolve. Empowering consumers to make better-informed decisions that are healthier for them and for the planet ignites the whole reform agenda.

At the second level, the power of nature-based solutions is mobilised to create more productive, regenerative techniques of food production, new approaches to protecting forests and other critical ecosystems, and new ways to manage the ocean in order to protect ocean life and increase ocean protein production. All nature-based solutions have common features. They require effective legal mechanisms to protect natural capital. They require producers – farmers, fishermen and indigenous communities – to be paid transparently and fairly for the ecosystem services they provide. And they show that it is possible simultaneously to strengthen food security, tackle climate change and protect biodiversity. No trade-off is necessary.

Growing Better: Ten Critical Transitions to Transform Food and Land Use



Economic Prize

$5.7 trillion economic prize by 2030 and $10.5 by 2050 based on avoided hidden costs

Investment Requirements

$300-$350 billion required each year for the transformation of food and land use systems to 2030

Business Opportunity

$4.5 trillion annual opportunity for businesses associated with the ten critical transitions by 2030

Cross Cutting Reforms to Transform Food and Land Use

Government: Establish targets; break down governmental silos; put a price on carbon; land use planning; repurpose agricultural support and public procurement; massively increase R&D and target it on healthy, natural solutions.

Business & Farmers: Organise pre-competitively to support government reform agendas and set internal standards for specific sectors; establish true cost accounting for food and land use.

Investors & Financial Institutions: Build on the Task Force on Climate-related Financial Disclosures to cover nature; develop a set of financing principles for food and land use; develop innovative finance instruments, including blended finance, to manage risks and leverage opportunities.

Participants in multilateral processes and multi-stakeholder partnerships: Raise ambition in the United Nations Framework Convention on Climate Change 2020 stock-take and ensure an ambitious outcome in the 2020 Convention on Biological Diversity in Kunming, China.

Civil Society: Drive information campaigns for food and land use reform and direct campaigns against serial offenders (public and private).

FINANCIALS KEY

Economic prize by 2030 | Annual additional investment requirements to 2030 | Business opportunity by 2030

Ten Critical Transitions		Essential Actions	Financials (by 2030)
 Healthy Diets	Global diets need to converge towards local variations of the "human and planetary health diet" – a predominantly plant-based diet which includes more protective foods (fruits, vegetables and whole grains), a diverse protein supply, and reduced consumption of sugar, salt and highly processed foods. As a result, consumers will enjoy a broader range of high-quality, nutritious and affordable foods.	**Government:** Establish and promote planetary and human health dietary standards through repurposed agricultural subsidies, targeted public food procurement, taxes and regulations on unhealthy food **Business:** Redesign product portfolios based on the human and planetary health diet	$1.28 trillion $30 billion $2 trillion
 Productive & Regenerative Agriculture	Agricultural systems that are both productive and regenerative will combine traditional techniques, such as crop rotation, controlled livestock grazing systems and agroforestry, with advanced precision farming technologies which support more judicious use of inputs including land, water and synthetic and bio-based fertilisers and pesticides.	**Government & Business:** Scale up payments for ecosystem services (soil carbon/health and agrobiodiversity) plus improve extension services (training and access to technology, seeds, etc.) **Business & Investors:** Shift procurement from buying commodities to investing in sustainable supply chains; deploy innovative finance to reach currently underfinanced parts of supply chains	$1.17 trillion $35-40 billion $530 billion
 Protecting & Restoring Nature	Nature must be protected and restored. This requires an end to the conversion of forests and other natural ecosystems and massive investment in restoration at scale; approximately 300 million hectares of tropical forests need to be put into restoration by 2030.	**Government:** Put in place and enforce a moratorium on the conversion of natural ecosystems, and give legal rights and recognition to the territories of indigenous peoples **Government:** Scale REDD+ to $50 billion per year by 2030 if results delivered and establish a Global Alliance Against Environmental Crime **Business:** Establish transparent and deforestation-free supply chains and demand the same of suppliers	$895 billion $45-65 billion $200 billion
 A Healthy & Productive Ocean	Sustainable fishing and aquaculture can deliver increased supply of ocean proteins, reducing demand for land and supporting healthier, and more diverse diets. This is only possible if essential habitats - estuaries, wetlands, mangrove forests and coral reefs – are protected and restored and if nutrient and plastic pollution are curbed.	**Government:** Protect breeding grounds, end both illegal fishing and overfishing, and provide title/ access rights to artisanal fishers **Government & Investors:** Develop new approaches and business models for insurance against catastrophic events affecting fisheries (storms, warming events, reef collapse) and for compensating poor fishermen for the cost of fish stock recovery	$350 billion $10 billion $345 billion
 Diversifying Protein Supply	Rapid development of diversified sources of protein would complement the global transition to healthy diets. Diversification of human protein supply falls into four main categories: aquatic, plant-based, insect-based and laboratory-cultured. These last three sources alone could account for up to 10 percent of the global protein market by 2030 and are expected to scale rapidly.	**Government:** Use public procurement to secure long-term offtake for alternative protein sources **Government:** Increase R&D spending in alternative proteins (especially those with large benefits for lower-income consumers) and ensure that the resulting intellectual property remains in the public domain	$240 billion $15-25 billion $240 billion
 Reducing Food Loss & Waste	Approximately one third of food produced is lost or wasted. To produce this food that is never eaten by people requires an agricultural area almost the size of the United States. Reducing food loss and waste by just 25 percent would therefore lead to significant benefits relating to environmental, health, inclusion and food security.	**Government:** Regulate and incentivise companies to report on and reduce food loss and waste **Investors:** Finance income-sensitive, climate-smart storage technologies	$455 billion $30 billion $255 billion
 Local Loops & Linkages	With 80 percent of food projected to be consumed in cities by 2050, what urban dwellers choose to eat and how their needs are supplied will largely shape food and land use systems. This transition sets out the opportunity to strengthen and scale efficient and sustainable local food economies in towns and cities.	**Investors:** Invest in emerging technologies and innovations which will close the food system loop **Government:** City governments to foster local circular food economy through targeted public procurement and zoning	$240 billion $10 billion $215 billion
 Harnessing the Digital Revolution	Digitisation of food and land use systems is occurring through gene-editing techniques, precision farming, and logistics and digital marketing tools, enabling producers and consumers to make better, more informed choices, and to connect to the value chain rapidly and efficiently.	**Government:** Open access to public sector data (e.g. on national land registries, fisheries, agriculture, soil health etc.) and regulate and incentivise the private sector to provide open source data where appropriate **Civil Society:** Create, maintain and communicate results from real-time platforms for transparency, as is currently done through Global Forest Watch	$540 billion $15 billion $240 billion
 Stronger Rural Livelihoods	Underlying all ten critical transitions is a vision of rural areas transformed into places of hope and opportunity, where thriving communities can adapt to new challenges, protect and regenerate natural capital and invest in a better future. Ensuring a just transition.	**All:** Establish public-private-philanthropic partnerships to train a new generation of young farmer entrepreneurs over the next decade **All:** Scale up rural roads and digital investments to drive productivity, end rural isolation, and, in particular, initiate a global campaign for renewable electricity access for all **Government:** Safety nets for individuals and stranded communities to ensure a just transition	$300 billion $95-110 billion $440 billion
 Gender & Demography	Women can be enormously powerful in shaping food and land use systems, thanks to their central role in agriculture and in decisions concerning nutrition, health and family planning. Making sure women have equal access to resources, such as land, labour, water, credit and other services, should be central to policies concerning the ten critical transitions, including by accelerating the demographic transition to a replacement rate of fertility in all countries.	**All:** Invest in maternal and child health and nutrition as well as education for women and girls **All:** Ensure access to reproductive health services and products	$195 billion $15 billion n/a

The third level of the pyramid is made up of transitions that expand consumer choice and supply, especially of resource-intensive, healthy foods such as proteins. Accelerating the diversification of protein supplies, reducing food loss and waste, and creating more local supply chains, together with tighter resource looping, are all ways to diversify supply, reduce environmental pressures and expand consumer access to affordable, healthy food. All need different forms of public-private partnership and behaviour change, often at a local level, if they are to lend themselves to being scaled up fast.

Finally, the pyramid's foundation puts opportunity for all at the heart of the transformation. The transitions at this level will ensure that digitisation empowers people rather than concentrates data, that investment is made in the talent, infrastructure and social systems needed for a rural renaissance, and that women are supported in making choices that are better for themselves, their families and communities.

Why the hurry? Why not wait?

The need for urgent change is not obvious. On the surface, food and land use systems have been doing well in recent decades. Despite a growing global population, more and more people enjoy affordable, safe and plentiful food. But dig deeper, and the end-to-end system losses are well over 50 percent as a result of poorly allocated land and water resources, slow diffusion of best farming practice beyond large farms, under-investment in rural infrastructure and human capital, and food loss and waste amounting to one-third of primary production.[2] Food and land use systems also generate "hidden" environmental, health and poverty costs estimated at almost $12 trillion a year, a number larger than the value of the system's world output measured at market prices (Exhibit 2).[3]

- **Environmental costs.** Current food and land use systems cause up to 30 percent of total greenhouse gas emissions driving climate change and are the leading cause of the continuing conversion of the world's tropical forests,[iv] grasslands, wetlands and other remaining natural habitats – and thus the main culprit of the ongoing "sixth extinction[v]" of biodiversity.[4]

- **Health costs.** In addition to the direct impact of agricultural pollution on public health, food systems generate widespread malnutrition. More than 820 million people, most of them in sub-Saharan Africa and South Asia, still regularly go hungry.[5] At the same time, some 680 million adults are obese.[6] On current trends, half of the world's population will suffer from malnutrition and related health effects by 2030, placing a heavy financial and operational burden on health services and reducing productive potential.[7]

- **Socio-economic costs.** These perpetuate poverty and inequality. Two-thirds of the 740 million people living in extreme poverty (on less than $1.90 a day purchasing power parity (PPP) 2011) are agricultural workers and their dependents.[vi] Where smallholders participate in markets that are becoming structurally more concentrated, they often receive minimal returns: coffee farmers earn around one percent of the retail value of a cup of coffee sold on high streets across the world.[8] Underinvested, inequitable food and land use systems consign many to lives of constant insecurity.

The future looks grim unless these costs are tackled now. Modelling carried out for this report shows that leaving food and land use systems on their current trajectory would put the SDGs and the Paris Agreement targets beyond reach. Catastrophes previously considered "tail end" risks[vii], such as concurrent crop failures in several of the world's main food-producing regions, would become increasingly likely, causing untold human misery.

[iv] Forests function as carbon sinks by removing carbon dioxide from the atmosphere during photosynthesis. Atmospheric carbon dioxide is fixed into the plant's chlorophyll and the carbon is integrated to complex organic molecules which are then used by the whole plant. When forests are cleared, for example through burning, they release the carbon within the plant into the atmosphere, becoming a source of carbon dioxide.

[v] For more information on the "sixth extinction", see Ceballos, G., Ehrlich, P. and Dirzo, R. 2017. 'Population losses and the sixth mass extinction'.

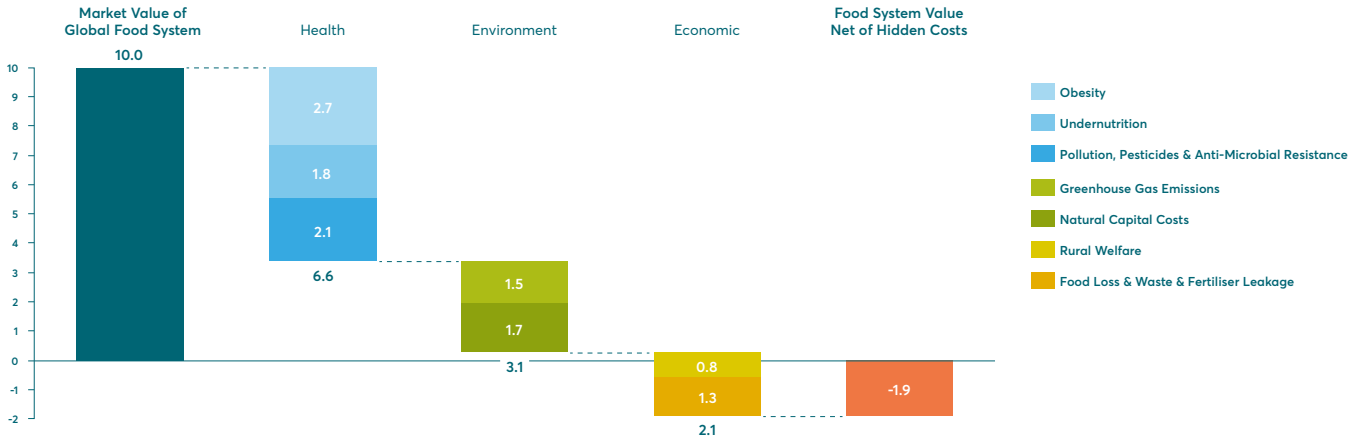
[vi] This report adopts the World Bank's $5.50 per day poverty line for upper-middle income countries as the measure of poverty. Since the majority of the world's poor now live in lower-middle and upper-middle income countries, this more accurately reflects current levels of global poverty. World Bank data indicates that 40 percent of the world's working poor, as defined by this measure, are employed directly in the agricultural sector. This report therefore assumes that approximately 40 percent of people in rural poverty are directly reliant on food and land use systems. We note that this is a conservative estimate, as many service and manufacturing jobs are also related to food and land use systems, especially in rural areas.

[vii] Tail risk is defined here as the risk (or probability) of the occurrence of rare events.

EXHIBIT 2

The hidden costs of global food and land use systems sum to $12 trillion, compared to a market value of the global food system of $10 trillion

Trillions USD, 2018 prices



A great deal for the planet

The economic and social benefits offered by this programme would yield exceptional returns on investment. Total economic gains to society could reach an estimated $5.7 trillion a year by 2030 and $10.5 trillion a year by 2050 versus the Current Trends scenario.[9] The transitions also open up business opportunities – from tackling food loss to creating the new value chains needed for regenerative agriculture and the shift to healthy diets – worth an estimated $4.5 trillion a year by 2030.[10] Some entrepreneurs and progressive corporates are already leading the charge to capitalise on these opportunities, but a strategic reframing that today's hidden costs are tomorrow's new markets still needs to go mainstream.

Taking a more granular perspective, the ten critical transitions could drive a turnaround of food and land use systems.

They could deliver:

- **Better environment.** Benefits to be achieved include becoming net carbon-neutral, contributing up to one-third of the mitigation needed for the 1.5-degrees Celsius climate pathway recommended by scientists and the Paris Agreement, halting biodiversity loss, restoring ocean fish stocks and bringing about an 80 percent reduction in air pollution caused by food and land use systems.

- **Better health.** Through a global convergence on the planetary and human health diet and producing enough nutritious food – including a diversified mix of proteins to fulfil everyone's needs – eliminate under-nutrition (in aggregate, recognising that there will still be extreme poverty-driven pockets) and halve the disease burden associated with the consumption of too many calories and unhealthy foods.

- **Inclusive development.** The critical transitions could boost income growth for the bottom 20 percent of the rural population, increase yields of low-productivity smallholders, create over 120 million extra decent rural jobs, and contribute to a more secure future for indigenous peoples and other local communities across the world.

- **Food security.** The transitions could increase food security significantly by helping to stabilise or even lower real food prices, supplying enough food of the right quality and quantity and improving access for the poorest and most vulnerable.

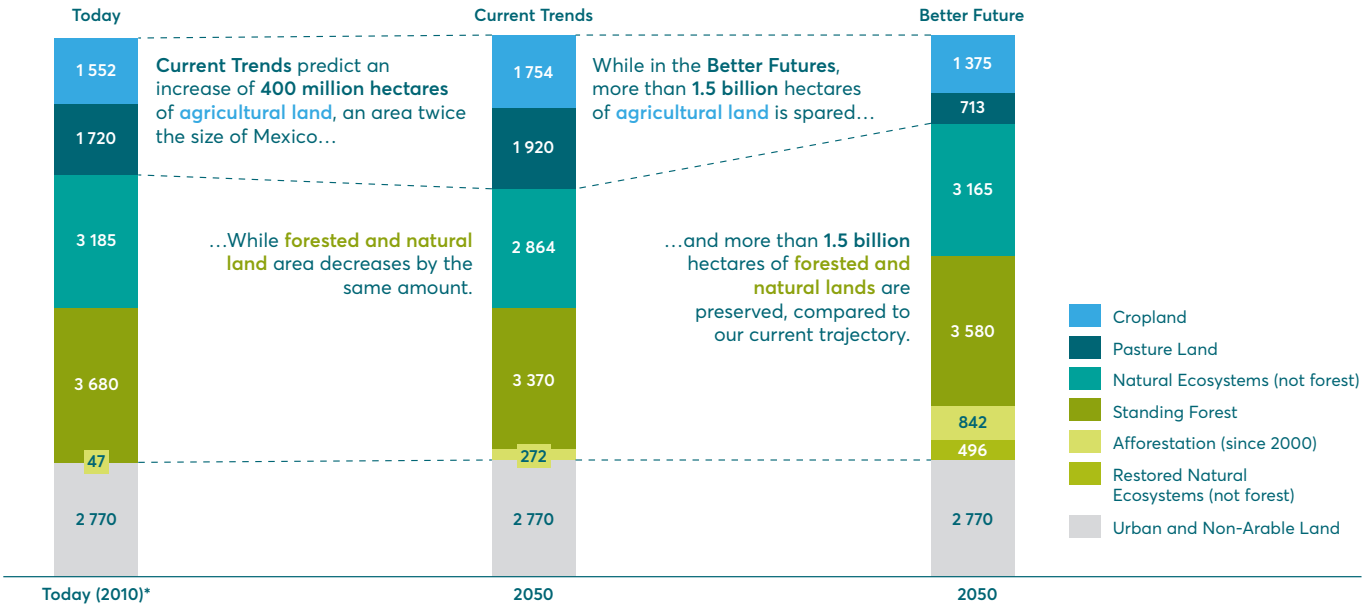
The explanation for the – somewhat counterintuitive – downward rather than upward pressure on food prices is a combination of the dietary shift towards less resource-intensive foods, combined with ongoing increases in agricultural productivity and reductions in food loss and waste.

Several of these results are made possible by the freeing of more than 1.5 billion hectares of land that would otherwise be used for farming and livestock grazing in 2050 – owing largely to the same factors driving down food prices. This land could be restored to nature, creating potential not only to protect all remaining forests and other natural ecosystems, but also to enable more sustainable, secure food production by helping to stabilise climate conditions. Instead of repeating the developed-country cycle of massive destruction of natural capital, followed by partial regeneration, developing countries could deploy their land in ways that would be better for farmers, for indigenous communities, for nature and for the climate. With the right policies, transition support and investments in place, these objectives would not be in conflict, but would positively reinforce one another. But the change will not happen without real support, financing and leadership.

EXHIBIT 3

In the Better Futures scenario, 1.2 billion hectares of land which is currently used for agriculture will be freed up for restoration of natural ecosystems by 2050. Conversely, in the Current Trends scenario, a further 400 million hectares of natural ecosystem will be converted for agriculture

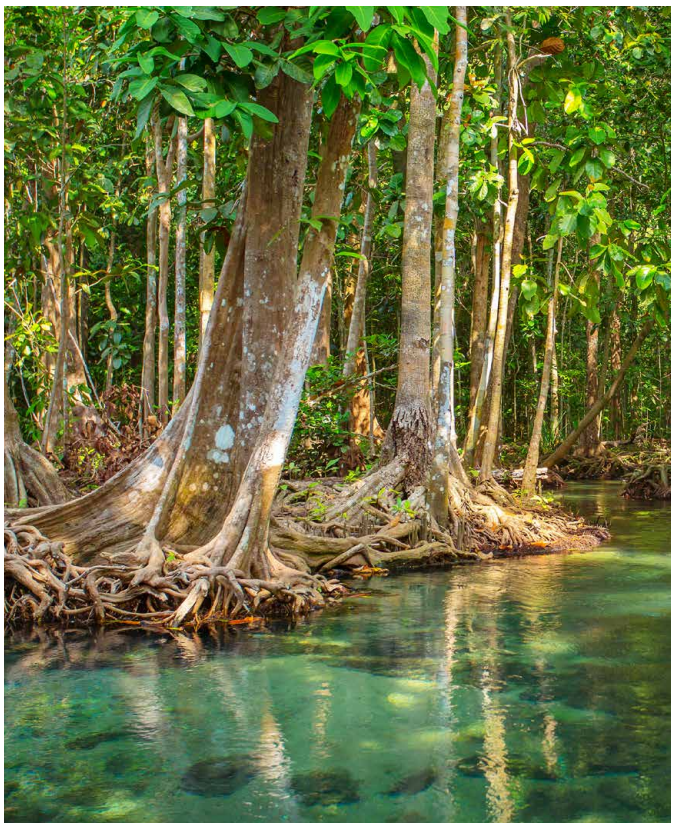
Total Surface Land Use: million hectares



*** Baseline data forecast from 2000**
Source: IIASA GLOBIOM 2019

Note: According to IIASA estimates, parts of the permanent pastures, as defined in the IPCC 2019 Special Report on Climate Change and Land report, are pastures without significant contribution to total livestock production and thus, are included in the land use classification 'Natural Ecosystems Land'. The 'Pasture' land use classification includes only grassland utilised for agricultural production.

The investment required is modest compared with the gains. New investment of between $300 billion and $350 billion a year is all that is needed to capture the $5.7 trillion annual prize by 2030, a return ratio of more than 15:1.[11] Public and private capital will need to be reallocated across food and land use systems. This will be a challenge, and financial innovation, including large-scale deployment of blended capital, will be needed to de-risk and scale new food and land use systems assets. But based on these numbers, scaling the ten critical transitions for a better food and land use future would be a great deal for society and for the natural world on which society depends.



What needs to happen to drive the change with speed and scale?

Implementing these transitions will not be easy. Each faces barriers, whether related to policy, regulation, finance, innovation or behaviour. The current system is fragmented, with vested interests defending their turf. However, practical examples of all ten critical transitions are already up and running across the world, driven by policy, business, farming, community and social entrepreneurs. These entrepreneurs are creating waves of change, many arising from local communities. What they have begun has the same potential to surge as the renewable energy movement, with disruptive technologies – from precision farming to agro-genomics, digital traceability systems and large-scale platforms for alternative protein and algae production – ushering in a fourth agricultural revolution. But there is no time to lose. Unless food and land use systems are turned around in the next ten years, the compounding risks of their current trajectory will be unmanageable.

What would it look like if leaders in public, private and civil society sectors were to make food and land use systems an urgent priority, grasping the scale of the opportunity as well as the risks of inaction? What would it mean if they were to push this transformation to the top of their short-term priority list rather than allowing the tyranny of the urgent to crowd out the essential?

Right: A farmer tends to plants in a greenhouse at the Shared Harvest farm, a 66 acre community-shared organic farm in the Tongzhou and Shunyi Districts of Beijing, China.

First, **governments** – ideally working with key stakeholders – would develop national food and land use pathways rooted in science, and consistent with the SDGs and Paris Agreement targets, and a comprehensive reform agenda creating numerous win-win opportunities. These pathways would then be translated into consistent policy signals to the market and society at large:

- On **healthy diets**, governments would issue strong, clear health guidelines; use public procurement to scale the market for healthy food; and deploy fiscal instruments to reward producers of healthy food (making it more affordable for everyone, but especially lower-income households) and penalise producers of unhealthy food.

- On **nature-based solutions**, governments would shift public support for agriculture and fisheries, currently running at over $700 billion a year with only around 15 percent targeted at public goods[viii], towards paying farmers and fishers to produce the right food in climate- and nature-friendly ways.[12] Pricing carbon and water use properly and fairly would be a game-changer. Governments would also institute regimes to protect and pay for nature, especially tropical rainforests, and grant secure tenure and the means to defend it to the indigenous communities whose wisdom is critical to their stewardship. Policies that add to competition for land – such as subsidy regimes driving agricultural expansion, or biofuels mandates directly or indirectly driving deforestation or other ecosystem conversion – would be phased out.

- On **wider choice and supply**, governments would increase, perhaps double, public research and development (R&D), with strong open source principles, over the next decade, to accelerate the scale-up of regenerative agriculture, promote value creation based on natural solutions, and help mitigate climate-related impacts on agricultural production. They would act to cut food loss and waste, requiring greater transparency from larger companies, and level the playing field to stimulate a flowering of local, smaller suppliers.

- On **opportunities for all**, governments would take a lead in putting key public data into the public domain, helping civil society to monitor large players and hold them to account. In parallel, they would increase public investment in rural infrastructure (roads, broadband, solar power) and in rural education and training by $100 billion to $150 billion a year, with funding support for low-income countries from the international community.

[viii] The amount of subsidies aimed at "public goods" is captured by the Organisation for Economic Co-operation and Development (OECD) definition of General Services Support Estimates, that is "public financing of services that create enabling conditions for the agricultural sector."[13]

This report recommends a massive global push to drive solar energy electrification throughout low- and medium-income rural economies. The gains for the environment, agriculture, food value chains and off-farm employment would be substantial.

Second, **business leaders** would get behind the transformation programme, voice strong public support for government reform agendas, and work with government and civil society to accelerate the transitions. Chief Executive Officers (CEOs) and company boards would recognise the risks of a business-as-usual strategy and commit their companies to science-based targets in line with the SDGs and the Paris Agreement. They would put in place easily monitored plans for reshaping their supply chains, product development, and marketing strategies in line with healthier diets and nature-based solutions, expanding choice and inclusion. And they would develop and scale new coalitions across the ten critical transitions, working with government, academia and civil society.

BOX 1

The role of farmers in food and land use systems

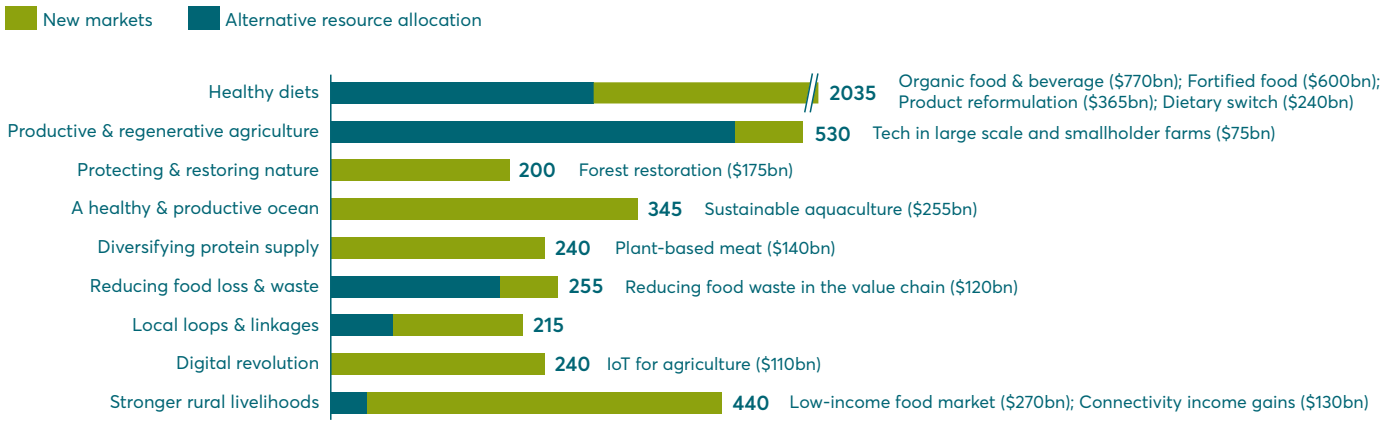
Farmers are the original food and land use systems entrepreneurs. They are CEOs of the most critical set of businesses in these systems. Today, however, farmers everywhere face ever more pressure and risks: from growing weather uncertainty as a result of climate change, increasingly stringent customer demands, shifting and complex public policies and support regimes, and new banking terms and conditions. This, indeed, is mainly why this report puts such emphasis on changing the rules of the game, and on shaping the game so that farmers are paid fairly to produce the right food in the right way. This includes allocating risk (market, weather, production) in ways that do not leave farmers carrying most of the risk while getting the least of the returns; protecting their tenure and giving them confidence to make longer-term investments; and improving opportunities for women and younger farmers while respecting their experience in land stewardship and food production. Farmers are natural entrepreneurs – and will play a critical role in any successful transformation of food and land use systems.

For many companies in food and land use industries, whether growers, traders, processors, retailers or caterers, these changes will be huge. Their current business models are typically based on traditional scale economies, with product formulations designed for cost, convenience and shelf life. Traceability between producer and end-consumer is limited or even non-existent. There are huge opportunities – up to $4.5 trillion a year by 2030 – for those companies that can translate today's hidden costs into tomorrow's new markets and purpose-driven strategies.[14] But seizing them is likely to require new business models that emphasise value over volume-based economics, which in turn might require a generational shift in mindsets and leadership.

EXHIBIT 4

There is an annual business opportunity of $4.5 trillion associated with the ten critical transitions in 2030

USD billions (2018 prices), 2030 estimates, examples of opportunities >$100bn



Source: SYSTEMIQ, Blended Finance Taskforce, 2019 (see online techincal annex for methodology)

Third, **private investors** would demonstrate how, with public counterparts, they could by 2023 drive up to $100 billion a year into the relevant asset classes and instruments needed to transform food and land use systems globally. Together with regulators, they would pilot the extension of the guidelines issued by the Task Force on Climate-related Financial Disclosures (TCFD) into food and land use systems, covering physical, transition, health and social risks. And they would establish a set of core financing principles, along the lines of the Equator Principles or Principles for Responsible Investment, that would guide their capital allocation into better food and land use systems and away from high-risk companies.

Fourth, **the UN Secretary-General, leaders in UN agencies, presidents and shareholders of multilateral development banks and the International Monetary Fund (IMF)** would align their institutions' investment, advisory and normative activities on food and land use systems to support and inspire governments' reform agendas, adapting organisational strategies and mobilising resources to reflect the scale and urgency of the challenge. Their governing bodies would provide unequivocal and well-aligned direction across the different entities in the multilateral system to maximise efficiency and effectiveness, in keeping with the ongoing reform processes led by the UN Secretary-General. The banks, together with bilateral donors, would set ambitious targets to increase their investments, including the use of first-loss instruments and guarantees, to support the $300 billion to $350 billion investment requirements. And the IMF would include more explicit consideration of climate and food and land use systems risk in its Article IV surveillance activities.[ix]

Fifth, **civil society** would shape social change movements, support the government and private sector and hold all parties to account. The philanthropic community could have an outsized impact if it tripled its funding for food and land use and directed it to the ten critical transitions, taking the risk to get behind new coalitions and social entrepreneurs.

Finally, the next one to two years will provide opportunities to set a new direction and pursue unprecedented global collaboration, via meetings of the G7 and G20, the UN General Assembly Climate Action Summit, the UN conventions on climate change, biological diversity, and combatting desertification, the World Bank and International Monetary Fund Annual Meetings, the Global Nutrition Summit, the UN High Level Meeting on Universal Health Coverage, the World Health Assembly and the Sustainable and Inclusive Food Systems Summit.

[ix] When a country joins the IMF, it agrees to subject its economic and financial policies to the scrutiny of the international community as part of the IMF's Article IV surveillance activities. This regular monitoring is intended to identify weaknesses that are causing or could lead to financial or economic instability.

Left: Farmer Usha Rani from the Agripally village in the Krishna district of Andhra Pradesh, India, utilising Zero-Budget Natural Farming (ZBNF) practices.

For governments, a particular opportunity exists to embed food and land use reforms in ambitious Nationally Determined Contribution submissions under the UN Convention on Climate Change, and in similar commitments – the format of which will hopefully be determined at the biodiversity conference in Kunming in October 2020 – under the UN Convention on Biological Diversity. The latter occasion also provides an unmatched opportunity for broad global agreement on an ambitious new deal for nature, and for countries to come together on some key priorities like protection of remaining natural ecosystems, deforestation-free supply chains and global action against environmental crime.

There is no silver bullet for transforming food and land use systems, just as there is none for solving climate change or eliminating poverty. There is no universal blueprint that is right for every country. Rather, change will look different from one country to the next, and from one food and land use system to the next. But the complexity of transforming food and land use systems is a strength. It provides scope for building winning political coalitions behind broad transformation agendas. And it means that the process of transformation is dispersed, making it more open and accessible and, therefore, likely to engage millions of citizens and entrepreneurs.

Together, humanity faces an opportunity to design food and land use systems that protect our environment, improve our health, increase social justice and strengthen food security. We have one to two years in which to turn them in the right direction, and a decade thereafter to transform them. There are already many courageous change agents working – often at significant professional and personal risk – to advance transformation. This consultation report is fundamentally for them: to support their efforts, to accelerate the process of creative discovery, debate and learning, and to help us all shift our food and land use systems on to pathways that lead to hitting the SDGs and Paris Agreement targets on climate change. There is no time to lose.

Farmer picking tomatoes in a greenhouse at Shared Harvest farm, an organic farm promoting the Community Shared Agriculture model. Established in May 2012, Shared Harvest has grown rapidly and now possesses 66 acres based in Tongzhou and Shunyi Districts in Beijing, China.

Chapter 1: Introduction

"All the flowers of all the tomorrows are in the seeds of today."

Chinese Proverb

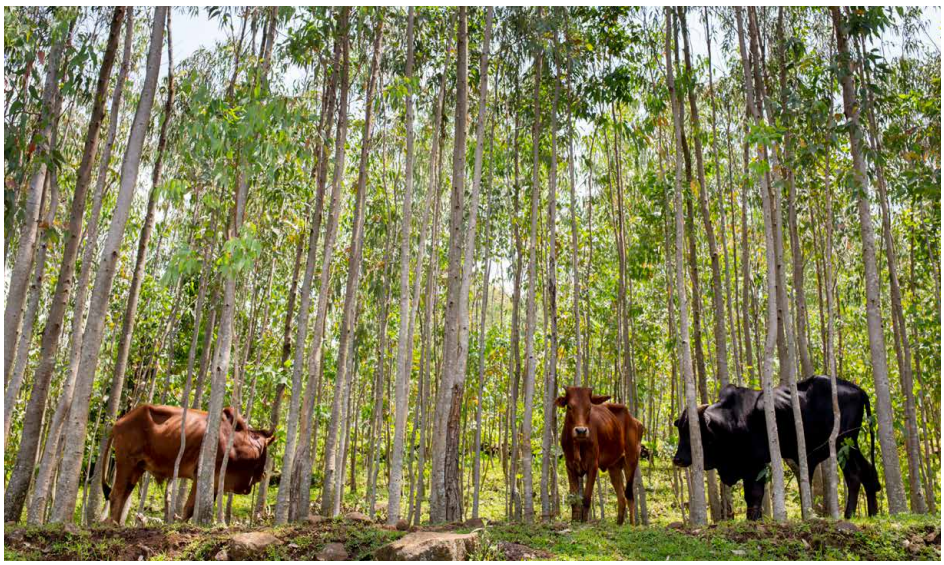
Land suitable for producing food is a scarce natural resource and vital to human civilisation. Today, growing demand for productive land is eroding the natural ecosystems that are essential not only to human life but also to all life on Earth. Decisions on how human societies use land, what food and other products we grow, and what we do to protect and restore natural ecosystems are thus fundamental to human development and our planet's future. Arguably, they are as fundamental as the future of our energy systems.

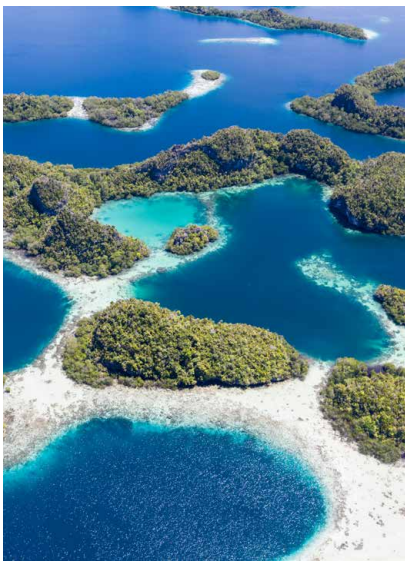
BOX 2

Defining "food and land use systems"

The term "food and land use systems" covers every factor in the ways land is used and food is produced, stored, packed, processed, traded, distributed, marketed, consumed and disposed of. It embraces the social, political, economic and environmental systems that influence and are influenced by those activities. Food from aquatic systems, marine and freshwater, is also included in our definition because fish (wild and farmed) accounts for a significant share of the protein in human diets and this share will potentially increase. The report also covers agriculture for non-food purposes, such as bioenergy, fibres for textiles and plantation forestry products, as these already compete with food for fertile land and the competition could intensify in the future.[i]

[i] See Box 25 on bioenergy, and critical transition 3 on Protecting & Restoring Nature.





Left: A farm in the Amhara region of northern Ethiopia incorporates tree-planting where cattle graze as part of a wider effort to restore the watershed there.

This report from the Food and Land Use Coalition (FOLU) presents a framework of reforms that can transform food and land use systems worldwide so that they nourish both humanity and the planet. This route to transformation offers astonishingly good value. Measured by impact per dollar spent, it offers outsized benefits in terms of the environment, health and inclusive livelihoods for all, with more equality, less poverty and more opportunities. Crucially, it shows that achieving food security for a global population of over nine billion is possible at the same time as protecting the environment, improving public health and promoting inclusion. In contrast, the consequences of not acting are appalling. On current trends, food and land use systems are driving widespread environmental harm, with devastating consequences for human welfare and civilisation. Delaying this transformation will put all the Sustainable Development Goals (SDGs) out of reach and mean that solving climate change impossible.

The implication of recent reports from the Intergovernmental Panel on Climate Change (IPCC) is that limiting global warming to as close to 1.5-degrees Celsius as possible is essential to avoid the risk of runaway climate change and to minimise the consequences of unavoidable climate change.[1] Following the precautionary principle, the modelling underpinning this report therefore takes the need for the world to get on to a 1.5-degrees Celsius pathway as an ongoing assumption. Success depends on fundamental changes not only in food and land use systems but also in other key systems, notably energy. None of these systems are advancing fast enough today. Implementing the report's framework of reforms can get the world's food and land use systems on the right track fast. However, success in transforming food and land use systems depends on other sectors stepping up the pace of change with the same degree of urgency (and vice versa).

Many actors in food and land systems are today striving – at professional and often personal risk – to advance the kind of reforms recommended in the report. A key aim is to support them in their quests. This includes helping to inform all those involved in political and economic decision-making in government, business, the financial sector, civil society and the international community about the importance, functioning and performance of today's food and land use systems. The framework of reforms described in the report would collectively shift these systems on to pathways that would enable them to contribute to realising the SDGs and Paris Agreement targets on climate change.

This is a "consultation report" in the fundamental sense of the word. It is based on technical and philosophical assumptions that can legitimately be challenged, which is why it spells out those assumptions explicitly. No approach to food and land use systems transformation will ever be "complete". The report aims to trigger action, but also to inspire dialogue and debate across the world, helping to support a shared journey of learning, creativity and societal change.

The report is structured as follows:

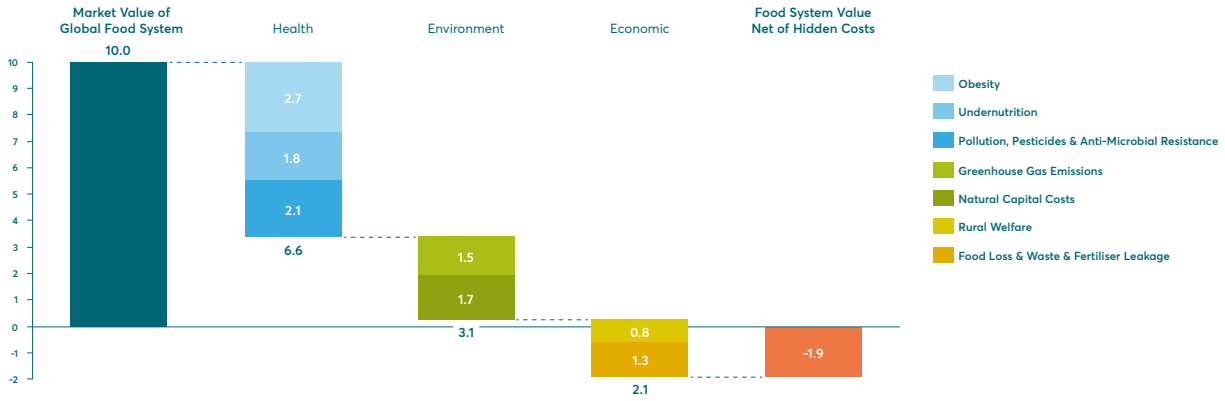
Chapter 2: The Case for Action details the salient features of today's food and land use systems. It charts their success over the past few decades in increasing the production of affordable food, and acknowledges the notable areas of excellence found in agricultural production. It goes on to demonstrate that, despite these advances, food and land use systems globally are on average inefficient in their use of resources and carry large but mostly hidden costs to the environment, health and inclusive development (Exhibit 5). These inefficiencies and costs increasingly undermine food security. They also contribute to growing climate-related volatility affecting harvests and food prices. For instance, the likelihood of simultaneous production shocks affecting more than ten percent of production in the top four maize-exporting countries, which account for 87 percent of global maize exports, rises from close to zero at present, to seven percent under a 2-degrees Celsius warming scenario and to a staggering 86 percent under a 4-degrees Celsius warming scenario.[2] These alarming trends are evident across the world, but particularly in sub-Saharan Africa and South Asia, where their potential impact threatens vast human suffering as well as ecological breakdown.

Urgent changes to food and land use systems are therefore essential.

EXHIBIT 5

The hidden costs of global food and land use systems sum to $12 trillion, compared to a market value of the global food system of $10 trillion

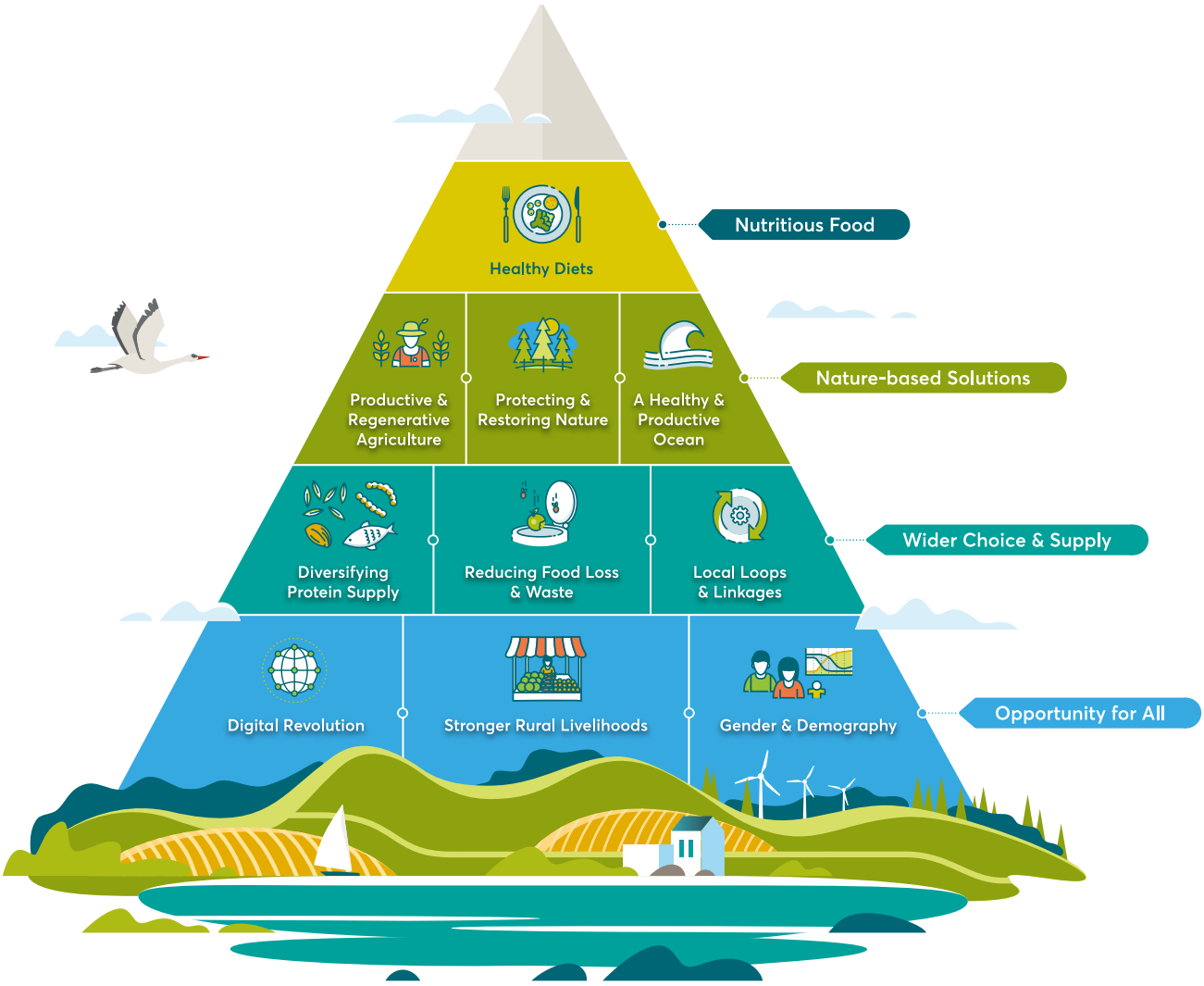
Trillions USD, 2018 prices



Source: SYSTEMIQ, Food and Land Use Coalition, 2019 (see online technical annex for methodology)

Chapter 3: Ten Critical Transitions to Transform Food and Land Use Systems details a comprehensive transformation agenda comprising ten critical transitions that together could move food and land use systems off the negative trajectory described in Chapter 2 and on to a sustainable pathway. If implemented widely, these transitions would lead to positive and genuinely sustainable outcomes for the environment, human health and inclusion. All ten critical transitions need to scale together because each depends upon and reinforces the others. All of them require action from national governments, business, the financial sector, civil society, including academia, and the international community.

Growing Better: Ten Critical Transitions to Transform Food and Land Use



Chapter 4: A Better Food and Land Use Future details the modelling and related analysis completed for this report. Two main scenarios were constructed. The Current Trends scenario demonstrates the negative effects of food and land use systems continuing on their current trajectory, putting the SDGs and Paris Agreement goals on climate change out of reach. The Better Futures scenario demonstrates that a much better pathway is still open to us, provided the comprehensive transformation agenda described in Chapter 3 is implemented. The critical transitions outlined in Chapter 3 and the modelling outlined in Chapter 4 are closely linked.

Since the modelling methodology and the main outcomes of the modelling underpin the narrative of this report, both are described in Box 3 below.

BOX 3

Modelling Current Trends and Better Futures

The main modelling for this report has been produced by the International Institute of Applied Systems Analysis' (IIASA) Global Biosphere Management Model (GLOBIOM), informed by in-depth analytical work on specific sectoral issues. The model provides a link between agricultural production choices and their impact on the planet. Complementary modelling was done by the University of Washington on diets and health; in addition, we ran scenarios on income and employment using the World Bank Shockwave model. A more detailed exposition on the modelling can be found in the technical annex (Annex B) of the full online report.

The aim of the modelling is to offer broad insights into developments under two different scenarios.

The baseline scenario, "Current Trends", was designed to deliver a picture of a future grounded in historical trends. This future would see considerable progress and innovation (for example with regards to agricultural productivity) within the framework of the current system. Current Trends mainly relies on the standardised set of assumptions that has informed the analysis of the Intergovernmental Panel on Climate Change's 5th Assessment Report (IPCC AR5), coupled with the matching set of climate assumptions.[ii] Under this scenario the world gets nowhere close to meeting the Sustainable Development Goals or the Paris Agreement targets.

The reform scenario, "Better Futures", is based on ten assumptions of fundamental change, derived from the ten critical transitions. Strong (but not perfect) implementation of the ten critical transitions would be the key to achieving the outcomes described in this report.[iii]

The key assumptions are:

1. **Aggregate average agricultural productivity** continues to increase following historic trends at a rate of 0.9 percent a year under Current Trends. The Better Futures scenario assumes an additional 12 percent increase in productivity by 2050 due to technological advancements, i.e., an annual rate of increase of 1.1 percent overall. This reflects renewed efforts in R&D and technological diffusion, and large investments in infrastructure, which would help raise yield and reduce the yield gap between more productive and less productive producers.

2. **By 2050, food loss and waste could be reduced by 25 percent.**[iv]

3. **Negligible conversion of forests and other natural ecosystems from 2020 onwards is possible.**

   This assumption is based on what exogenous climate modelling finds necessary to limit global warming to 1.5-degrees Celsius. It thus describes the necessary level of ambition. This report recognises that ending deforestation next year is unrealistic under any assumptions. However, the essential point to take away from the modelling is that the reform agenda to halt deforestation needs to be put in place without delay. The reform agenda described in this report aims to achieve the desired result as soon as possible, realistically between 2025 and 2030 (this has a knock-on effect for biodiversity, as well, where the model has recovery starting in 2020, yet realistically that would happen gradually between 2025 and 2030, as deforestation is gradually halted).

4. **Systematic measures to increase energy efficiency globally** can achieve a reduction in energy demand by 40 percent relative to current demand – this would help the planet stay within a 1.5-degrees Celsius pathway without deployment of bioenergy with carbon capture and storage technologies (BECCS).[v]

[ii] Our Current Trends scenario is defined by the Shared Socio-Economic Pathway 2[3] and by the climate assumptions of the Representative Concentration Pathway 6.0.[4]

[iii] A number of the key institutional features introduced in the critical transitions, such as structural changes that would lead to shorter supply chains, could not be modelled with the tools available. Their impacts are, therefore, described in more qualitative terms. These challenges were particularly strong when constructing socio-economic scenarios, given the limited number of variables that could be used to depict changes to livelihoods.

[iv] Note that the Sustainable Development Goal target is to reduce per capita global food waste at the retail and consumer levels by 50 percent, and to achieve a reduction in food losses along production and supply chains, including post-harvest losses by 2030. Recent analysis, however, demonstrates that achieving this goal is only achievable with breakthrough technologies and behavioural change. To avoid unrealistic assumptions, a 25 percent reduction has been modelled for this report.

[v] Grubler et al (2018) illustrates how such a low energy demand scenario is possible based on rapid social and institutional changes in how energy services are provided and consumed, in addition to technological innovation. Trends in this direction are already observable (e.g. digitalisation and device convergence reduce energy demand, with a smartphone providing a single integrated digital platform which potentially replaces over 15 different end-use devices).[5]

Though achievable, this is an ambitious assumption. For this reason, and because a number of other 1.5-degrees Celsius assumptions are also ambitious, an option is maintained to deforest, starting around 2040, some of the newly reforested land and use the biomass for BECCs, if such a solution becomes imperative to avoid runaway climate change and if further analysis demonstrates the relative merits of such an option relative to relevant alternatives.[17] Note that if the BECCS alternative is implemented, there will be significant negative consequences for biodiversity from 2040 onwards (see Box 25 on bioenergy in Chapter 3 in the full online report).

5. **Enough food will be produced in 2030 to deliver on the ambitions of SDG2** (to end hunger, achieve food security and improved nutrition and promote sustainable agriculture), making it possible to eliminate food insecurity by 2030.

6. **The world would converge towards "human and planetary health" diets by 2050** (see Chapter 3, critical transition 1 on healthy diets), with significant progress in that direction by 2030. This would include a global convergence in calorie intake and average level and composition of protein consumption.

7. **The ocean would deliver 40 percent more sustainable proteins over the next 30 years.** Note that the potential is far larger, as Chapter 3 demonstrates, but a number of uncertainties makes a conservative assumption more realistic.

8. **Significant investments in human capital, technology diffusion and the digital revolution** would support the emergence of a new generation of young rural entrepreneurs who can take advantage of the opportunities offered by the transformation of food and land use systems and create decent jobs in agriculture and in the processing of agricultural products.

9. **Increased investment in rural infrastructure (e.g. roads, clean electrification) and connectivity** would be the key to overall income growth, helping to drive off-farm value added and the creation of non-agricultural jobs.

10. **The combination of investments in rural assets and the design of new productive safety nets** increases the resilience of the rural population in the face of possible dislocations caused by the transformation of food and land use systems and increasingly likely weather shocks.

These assumptions were tested by conducting sensitivity analysis around variable specifications. The narrative accounts for key uncertainties – such as the potential negative impact of climate change and the potential positive impacts of technology – on agricultural yields. In sum, the assumptions provide a realistic basis for the Better Futures scenario, though, again, that scenario depends on the full implementation of the ten critical transitions laid out in this report.

The implication of recent reports from the IPCC is that limiting global warming to as close to 1.5-degrees Celsius as possible is essential to avoid the risk of runaway climate change and to minimise the consequences of unavoidable climate change. Following the precautionary principle, the modelling underpinning this report, therefore, takes the need for the world to get on to a 1.5-degrees Celsius pathway as an ongoing assumption. Success depends on fundamental changes not only in food and land use systems but also in other key systems, notably energy. None of these systems are advancing fast enough today. Implementing the report's framework of reforms can get the world's food and land use systems on the right track fast. However, success in transforming food and land use systems depends on other sectors stepping up the pace of change with the same degree of urgency (and vice versa).

The main outcomes of the modelling include:

1. **Higher productivity, reduced food loss and waste and dietary shifts** yields the opportunity to shift more than 1.5 billion hectares of land away from agriculture compared to the Current Trends scenario by 2050, meaning that:

   Greenhouse gas emissions are reduced in a way that is consistent with the 1.5-degrees Celsius pathway recommended by science. At a conservative estimate of the social cost of carbon, the differential in emissions between the Better Futures and Current Trends scenarios can be estimated at around $1.3 trillion annually, mainly achieved by protecting and restoring tropical forests.

   The Biodiversity Intactness Index (BII) in the Better Futures scenario decreases by 1 percent between 2010 and 2020, which represents around one third of the losses experienced over the past 40 years. It starts to recover after 2020, a sign of halting and reversal of biodiversity declines. In contrast, under the Current Trends scenario biodiversity continues a steady decline towards the "sixth extinction" at a speed similar to that of the last 40 years, reaching 3.2 percent loss in BII between 2010 and 2050.

BOX 3 - Continued

1. **As demand and production methods change**, the advantages of high intensity agriculture erode, reducing overuse of fertilisers and herbicides/pesticides.

   By 2030 sufficient food is produced to feed everybody on the planet nutritious diets, while protecting affordability. A number of actions, such as ongoing agricultural productivity gains, reductions in food loss and waste and shifts in diet towards less-resource intensive foods, contribute to making this food affordable and accessible to the full global population. This could yield dramatic gains in the battle against poverty.

   Shifting to healthier diets has the potential to more than halve by 2050 the number of people dying prematurely due to diet-related non-communicable diseases caused by high body mass index, from ten million to around five million.

2. **The economic gains to society from reducing the current "hidden costs" of food and land use systems** would sum up to $5.7 trillion annually by 2030 and $10.5 trillion annually by 2050. These numbers are almost certainly under-estimates, since they do not properly price in the benefits of reducing tail risks.

3. **Rural incomes grow twice as fast over those under the Current Trends scenario, and over 120 million more decent jobs are created in the countryside.**

4. **Financing the food and land use transformation agenda requires significant reallocation of capital** to new assets across food and land use systems, combined with an estimated annual $300 – $350 billion increase in total capital investment – less than 0.3 percent of global GDP during the period. We need to invest more wisely, reducing systemic inefficiencies and redeploying capital in line with a more honest account of risk-adjusted returns.

The scale and extent of these results are impressive. They may even seem over-optimistic. However, the modelling of the Better Futures scenario has incorporated a large degree of caution and flexibility. In particular, the assumptions are based on the scaling-up of existing technologies, while in many areas there are signs that entirely disruptive change is within reach.

Thus, while some aspects of the recommended transformation are likely to turn out less positively than modelled, others might be more positive, for example;

- Mariculture production of seafood is primarily constrained by the availability of feed in the form of fish meal and fish oil. If it were possible to remove this constraint by sourcing these proteins from molluscs, the productive potential of oceanic aquaculture would become almost unlimited. If such a technological breakthrough were achieved, consumption of poultry and pork could be replaced by consumption of farmed carnivorous fish such as salmon, and about 200 million hectares of cropland would be saved in the process.

- The model allows for significant reforestation over 800 million hectares, but the theoretical potential under the hypothesis of agricultural intensification is more than twice as large. Even if only half of the additional potential were leveraged, almost four additional $GtCO_2e$ would be removed from the atmosphere annually by 2050, for a value to society of $400 billion.

- Scientific consensus indicates that a range of five to 13 $GtCO_2e$ a year of additional sequestration from forests could be achieved, depending on tree species' growth differences and what happens to the timber afterwards. However, these differences cannot currently be captured by the model in its calculations.

- Assuming that the appropriate measures were put in place by governments to support such activity, re-wetting deforested peatlands could result in a two thirds reduction of ongoing emissions from deforested land from 2025 onwards, resulting in a net negative emissions from the pre-farmgate food and land use sector by 2050 (up to one $GtCO_2e$ per year). That seems, for now, a likely scenario, given the impressive progress the Government of Indonesia is currently making in this area.

- While modelling for this report assumes a 25 percent reduction in food loss and waste, the potential is clearly larger if sufficient capital, regulatory action and innovation is targeted at the problem, yielding the potential for additional economic gains and reductions in greenhouse gas emissions as well as in biodiversity and ecosystem loss.

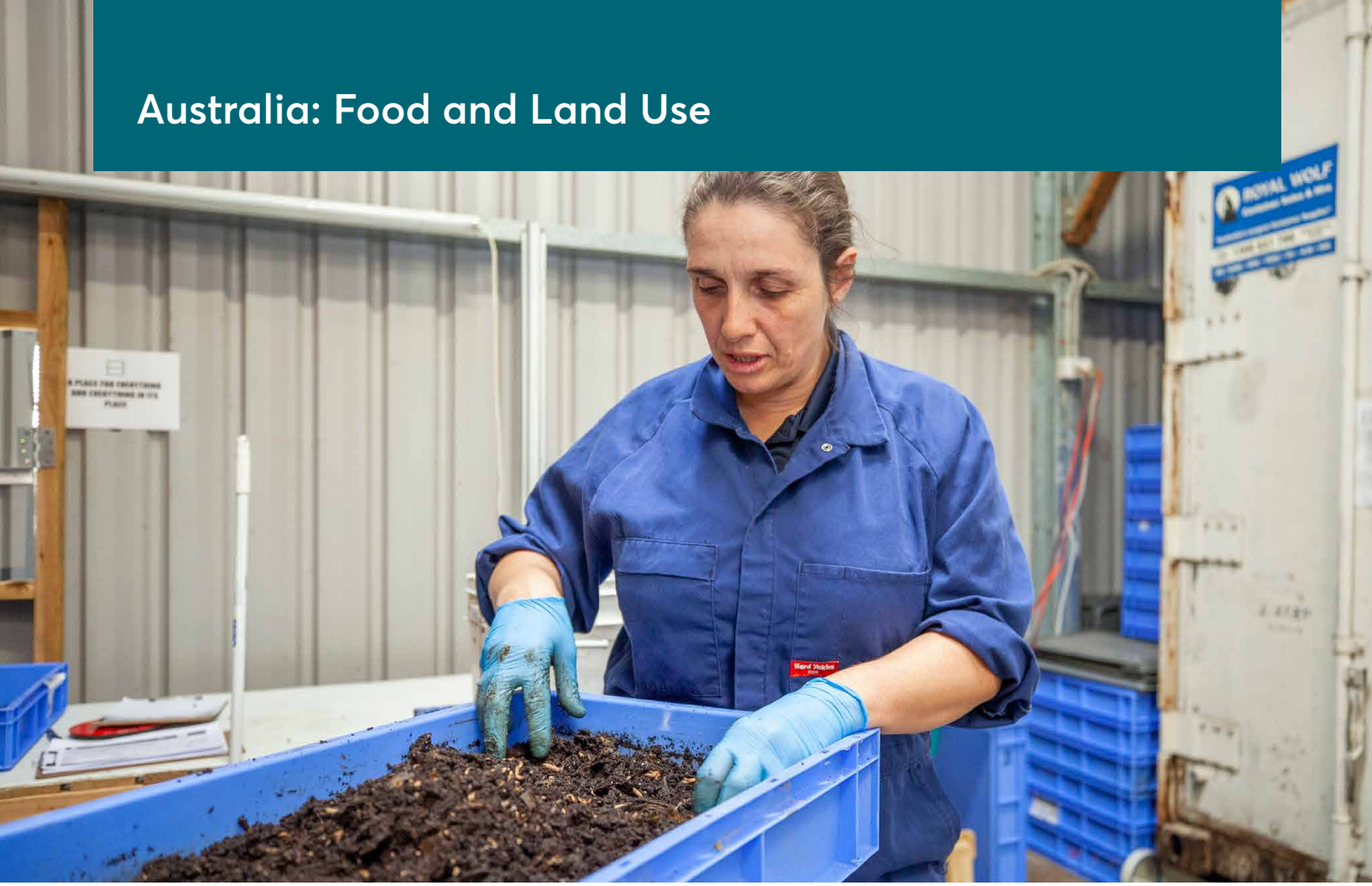
In other words, there is significant potential upside in the Better Futures scenario beyond the encouraging outcomes described above, if the ten critical transitions are fully implemented. As so often, the essential variable is political will.

Left: A family presents the brinjal (aubergine) which they produced at their house in the Sankli village in the Sagai forest in Gujarat, India.

Chapter 4 also explains the basis for estimating the net investments required for the transformation. Relative to the large societal benefits, the total costs of the ten critical transitions are modest. The transitions require significant reallocation of capital across food and land use systems, but the additional investment needed would be between $300 billion and $350 billion a year. In short, the benefits of the recommended transformation would disproportionally outweigh the costs.

Chapter 5: From Theory to Action outlines an action agenda for the next one to two years, to the end of 2020. This focuses on immediate actions that governments, business, finance, civil society (including academia and philanthropists) and international organisations can take to jumpstart a transformation unmatched in human history. The need for action now is hard to overstate. Science makes it clear the transformation must be completed in ten years.

Australia: Food and Land Use



Olympia Yarger, CEO of the organisation GoTerra in Canberra, Australia. GoTerra uses robotic technology to manage food waste using insects, as well as creating high protein insect meal and valuable, nutritious soil conditioner.

Context

Australia is the most arid continent, with a highly variable climate and diverse environment. Over the past century, its ambient temperature has increased by 1-degree Celsius, and is projected to rise by a further 0.4 to 2-degrees Celsius by 2030. Agricultural land is increasingly under strain from climatic impacts, compounded by a history of intensive agriculture in a fragile environment. Although farmers have made important advances in land management, soil health is under threat. Almost 50 percent of soils in key agricultural regions are acidified, while soil carbon levels are historically low and the risk of erosion has grown with greater frequency of drought, flood and loss of ground cover. These processes threaten productivity, reduce crop choice and constrain yields.

Agriculture contributed three percent of Australia's GDP in 2018, with agricultural exports worth $44.8 billion. As one of the world's largest exporters of beef, Australia has major impacts on other countries and industries. For instance, 1 million metric tonnes of soybean meal for animal feed was imported in 2018, a key commodity that is driving global deforestation. Australians also consumed three times the global average of meat per person a year, positioning the industry as central to both diet and economy.

Critical transitions

National government policy and analysis – including national research agency CSIRO's National Outlook 2019 – addresses all ten of the critical transitions set out in this report. Four of the key transitions include:

1

Healthy diets. The Collective for Action on Obesity has called for "concrete, comprehensive action and funding" to implement the National Obesity Strategy, as well as a "whole of society" response to tackling the "obesogenic environment". Successful pilot projects include the New South Wales government's Healthy Children's Initiative, which provides training and public education on healthy diets and exercise in schools and health centres across the state.

2

Productive and regenerative agriculture. Australia has produced pioneers of regenerative agriculture, particularly among graziers, although many practices remain hotly debated and outside the mainstream. Small-scale impact investors such as Odonata are demonstrating the power of blended finance models to support sustainable agriculture, including in Tiverton, Australia's first remnant-vegetation-only farm on volcanic plains grassland. Meat and Livestock Australia has set a 2030 carbon neutral target for the industry, with an R&D programme intended to deliver that goal. The Queensland State Government has committed to establish an AUS$500 million fund offering additional revenue for farmers adopting practices that reduce water consumption and run-off from nutrients, sediments and chemicals, especially in the Great Barrier Reef catchment. In recent years, attitudes to the environment among regional communities have begun to shift, supported by the grassroots efforts of the non-profit, farmer-led Farmers for Climate Action.

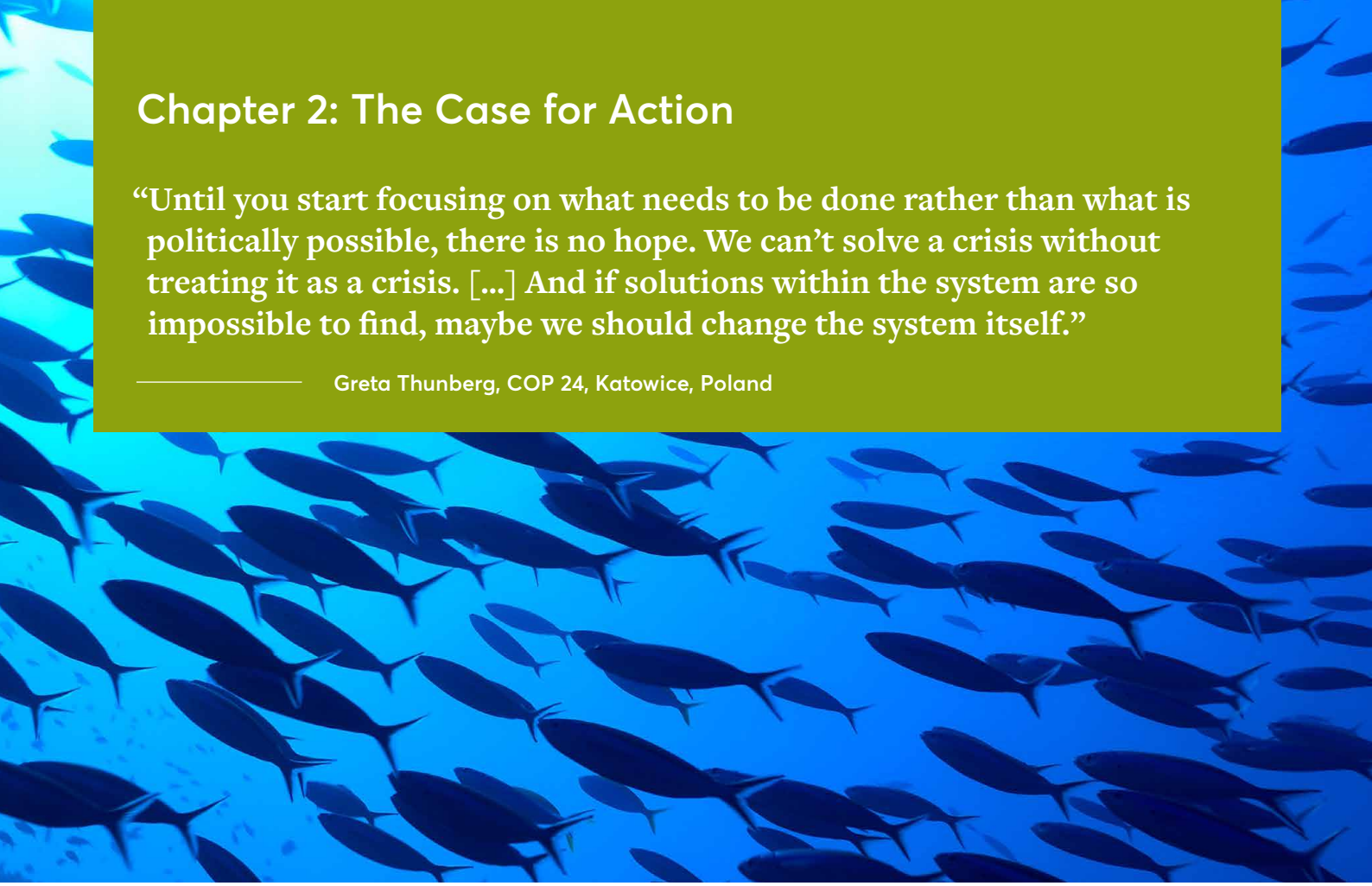
3

Protecting and restoring nature. Australia's diverse and valuable ecosystems – from perennial and hummock grasslands to temperate, old-growth forests and the Great Barrier Reef – are at risk from infrastructure development, agricultural run-off, invasive species, natural resource extraction and climate change. Efforts are being made to protect and restore these vital ecosystems, ranging from mangrove rehabilitation to forest protection and sustainable tourism around the Great Barrier Reef. Greening Australia's Reef Aid programme works with farmers, communities and indigenous leaders to prevent agricultural runoff, rebuild eroding gullies and restore vital coastal wetlands in the Great Barrier Reef catchment. The WA Forest Alliance continues its 30-year campaign to win permanent protection for native forests in the south-west of Western Australia, while Greening Australia is working to create the country's biggest carbon sink and establish one million hectares of habit in the Great Southern Landscapes.

4

Food loss and waste. Australia has a national strategy to halve food loss and waste, including a National Food Waste Baseline Report published in early 2019, focused on measurement, policy and innovation. It has also established the Fight Food Waste Cooperative Research Centre in Adelaide. Australia boasts a range of pioneers in reusing food waste, including GoTerra, a company that produces insect protein from food waste with minimal water requirements in shipping containers, and Yume, an online marketplace for quality surplus food.

Litara Higgie, staff member of GoTerra working in the organisation facilities at Canberra, Australia.



Chapter 2: The Case for Action

"Until you start focusing on what needs to be done rather than what is politically possible, there is no hope. We can't solve a crisis without treating it as a crisis. [...] And if solutions within the system are so impossible to find, maybe we should change the system itself."

Greta Thunberg, COP 24, Katowice, Poland

Food from the land and ocean is essential to human survival and integral to cultural and social life. Land also provides habitats for all terrestrial species, places of spiritual importance and natural beauty, and natural resources. And natural ecosystems — forests, the ocean, rivers, savannahs, mangroves, croplands and pasturelands — produce a vast range of vital services: food, clean air, oxygen, water filtration, biodiversity, soil fertilisation, protection against extreme weather events and carbon sequestration.

Our food and land use systems are threatened by – and among the main causes of – some of the most important challenges of our time: climate change, the loss of ecosystems and biodiversity, diet-induced public health crises, rising inequality and rural poverty. They are also riddled with inefficiencies. The effects of some of these challenges could become irreversible by the end of the coming decade.

This chapter outlines key facts about food and land use systems and their achievements before setting out the risks they pose to global food security, their hidden costs and related risks, their numerous operational inefficiencies, and the challenges that make financing for food and land use systems suboptimal.

While this chapter deals with the current risks, inefficiencies and cost, the main thesis of this report is that food and land use systems also offer indispensable, sustainable long-term solutions to those same challenges. That part of the story – more optimistic and arguably more important – is covered in Chapters 3, 4 and 5.

2.1 Key facts

Food and land use systems are important elements of the global economy. Generally, they are more important to a country the lower its income. In low-income countries, the agricultural sector on average accounts for around 25 percent of gross domestic product (GDP), 40 percent of net exports and over 60 percent of employment.[1]

Agriculture, forestry and fishing now account for just under 3.5 percent of the global economy, while food and land use systems as a whole account for around ten percent.[2] This larger figure includes all the downstream processing and distribution of food, amounting to around two-thirds of end-to-end economic value creation (as measured by GDP) in total food and land use systems. All that downstream activity depends on well-functioning agricultural production on farms upstream, whose economic significance is therefore arguably understated in conventional measures.

Table 1 provides an overview, based on standard indicators, of the importance of agriculture, forestry and fisheries to economies at different income levels.

TABLE 1

Overview of the Agriculture, Forestry and Fishing Economy (percent per country per category)

	Low-income countries	Middle-income countries	High-income countries
Share of GDP	25	8	1
Share of employment	63	30	3
Value add/employee versus national average	37	21	52
Share of investment	8	5	2
Share of exports	40	13	9
Share of imports	16	9	8
Percentage of global food production	3	72	26

Source: World Bank Data[3]

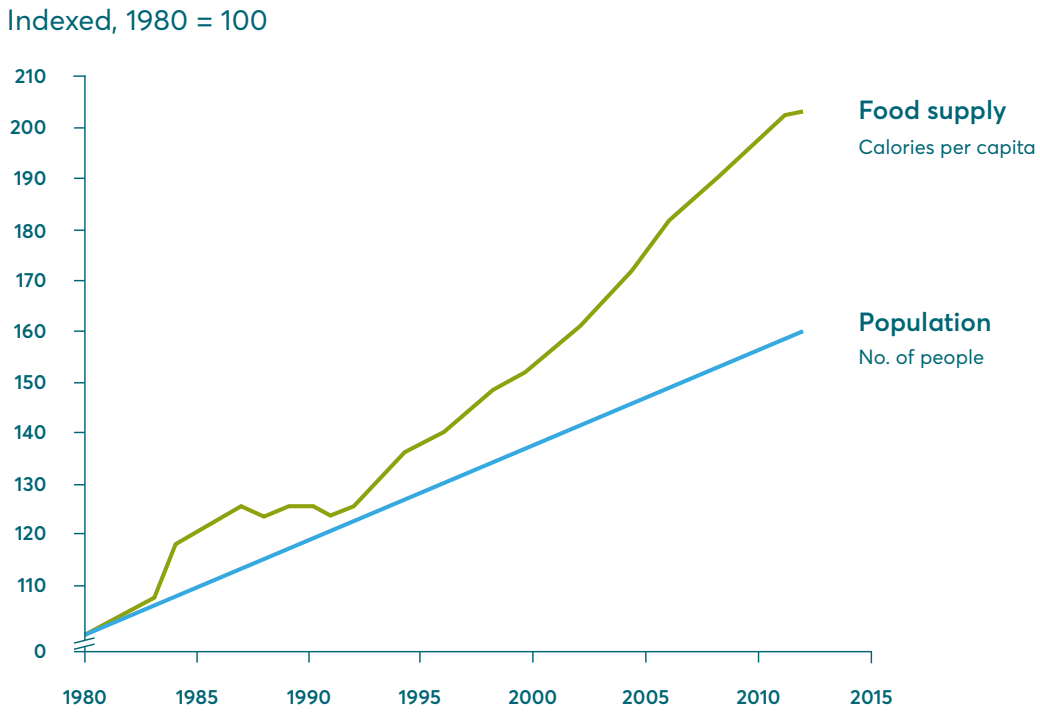
Trade is fundamental to food and land use systems, not only for food security but also for biodiversity and climate mitigation, as greater self-sufficiency would be likely to lead to greater loss of natural ecosystems. Over the past 20 years, trade in agricultural products has more than tripled to reach $1.33 trillion, driven primarily by demand growth in large emerging economies and greater south-south trade, which now accounts for roughly a quarter of total agricultural trade flows.[4] At least 80 percent of the world population depends on imports for some food and nutrition needs.[5] However, this level of import dependency makes it even more important for the international community to be prepared for disturbances of supply, which could otherwise – as was the case in 2007 - 2008 and to a lesser extent in 2010-12 – trigger protectionist impulses that aggravate the damage.[6]

Achievements of Food and Land Use Systems

In many respects, the performance of food and land use systems over the past decades has been remarkable. Government policies, scientific research and the agri-food sector have focused on increasing yields from a few major staple crops so as to provide enough calories for a burgeoning global population. Through a combination of research and development (R&D), subsidies and innovations in seeds, fertilisers and irrigation, agricultural output has grown steadily (Exhibit 7). In the second half of the 20th century, cereal yields increased by 93 percent globally.[7] Worldwide, deaths from undernourishment fell sharply in the 1980s.[8]

EXHIBIT 7

Food supply and population growth



Source: "World Bank DataBank," The World Bank, accessed August 30, 2019, https://data.worldbank.org/indicator/AG.PRD.FOOD.XD?view=chart.

Food has also become affordable for most people. Aside from the crises in 2007-2008 and 2010-2012, real food prices have declined since the 1980s.[9] Food spending as a percentage of total household expenditure in the United States fell from 17 percent in 1960 to ten percent in 2016.[10] Food safety and convenience have also improved, freeing up time and creating new opportunities, particularly for women who, in most cultures, tend to bear most of the responsibility for food preparation.

Today, we are seeing the contours of a fourth agricultural revolution. Exciting innovations are emerging, which could reshape food and land use systems over the coming decade. Precision agri- and aquaculture, guided by big data and deploying robotics, gene-editing and powerful remote sensing devices, could unlock significant improvements in crop yields and nutritional content, improve crop resilience and increase livestock productivity while reducing agriculture's environmental footprint. These trends have the potential to scale fast (although from a low base – in 2017, $16.9 billion of venture capital finance flowed into new food and ag-tech companies, five times the flow in 2012).[11] In parallel, regenerative approaches – no-till farming, winter crops, intercropping, agroforestry – are evolving and gaining traction. Combinations of many of these innovations play a key role in the critical transitions described in Chapter 3.

The world has experienced over 30 years of generally good harvests. Food prices have been mostly benign during this period, either stable or declining in real terms. Exceptional global price spikes in 2007-2008 and 2010-2012 were largely caused by adverse weather, exacerbated by certain policies, including biofuel mandates.[12] Weather patterns in the main agricultural areas have generally been favourable for food production, and weather-induced reductions in two or more of those areas at the same time have been rare. Meanwhile, technological progress has supported steady yield improvement of about one percent a year.[13]

2.2 Risks to food security

However, this stability masks numerous growing risks to food security. Just four crops (wheat, rice, corn and potatoes) account for around 60 percent of calories consumed by humans.[14] Production of these crops is concentrated in particular regions of just a handful of countries.[15] Moreover, there has been a gradual increase in dependency on food imports in a number of developing countries with fast-growing populations.[16] And there has been a similar increase in market concentration ratios[ii] throughout food systems, driven by corporate scale and geographic specialisation.[17]

The sum of these trends makes the production of food for the world's population vulnerable to shocks, particularly extreme weather events, even if these affect just one or two crops and upset only a small number of supply chains. These risks are exacerbated by increasingly volatile weather brought about by climate change. To illustrate, the likelihood of simultaneous production shocks affecting more than ten percent of production in the top four maize-exporting countries, which account for 87 percent of global maize exports, rises from close to zero at present, to seven percent under a 2-degrees Celsius warming scenario and to a staggering 86 percent under a 4-degrees Celsius warming scenario.[18]

In sum, the global population is highly exposed to food security risks. These are closely associated with the hidden costs and further risks inherent in today's food and land systems.

2.3 Hidden costs and risks

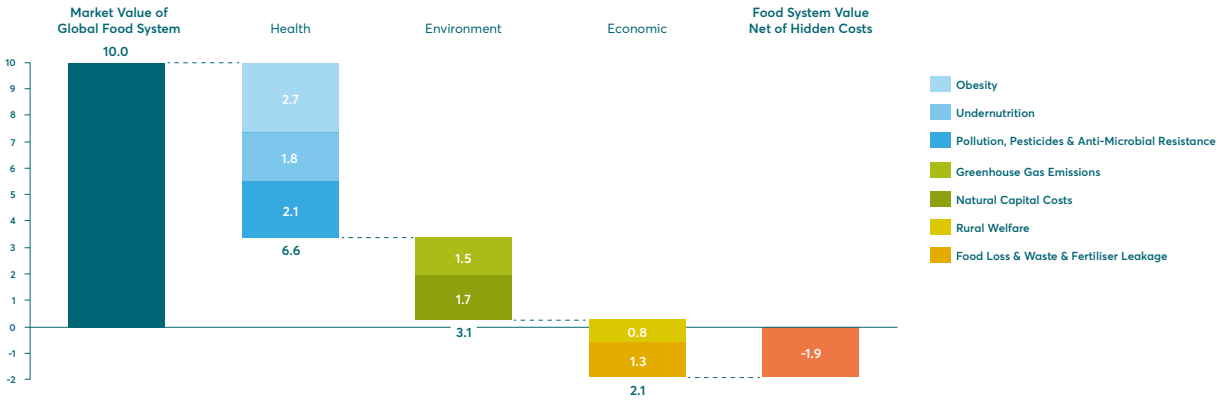
Food and land use systems incur hidden costs arising from their impact on health, nutrition, the natural environment and inclusion. Analysis for this report estimates these costs at $12 trillion a year.[19] This is approximately the size of China's GDP and is more than the current market-based value-added of the world's food and land use systems of approximately $10 trillion.[20] While the two figures are not strictly comparable, seeing them side by side nonetheless illustrates the magnitude of the hidden costs. If current trends in malnutrition, global warming, ecosystem degradation and biodiversity loss continue, these costs could rise to more than $16 trillion a year by 2050.[21]

[ii] Market concentration measures the extent to which sales in a market are dominated by one or more businesses. The concentration ratio measures the combined market share of the top 'n' firms in the industry.

EXHIBIT 8

The hidden costs of global food and land use systems sum to $12 trillion, compared to a market value of the global food system of $10 trillion

Trillions USD, 2018 prices



Source: SYSTEMIQ, Food and Land Use Coalition, 2019 (see online technical annex for methodology)

BOX 4

Hidden costs of today's food and land use systems

The global food industry has an estimated market value of around $10 trillion, accounting for more than ten percent of global GDP.[22] However, current methods of production and consumption mean that what the population eats costs twice as much as the figure on the bill, because every dollar spent on food is matched by more than a dollar added to environmental, health and economic costs.[23]

Unhealthy diets and harmful farming practices cost the world economy more than $6 trillion a year in lost productive life. The global agricultural system emits a volume of carbon dioxide equivalent (CO_2e) costing $1.45 trillion a year (assuming a social cost of carbon of $100 per tonne of CO_2e), while deforestation, water scarcity and land degradation impose costs of almost $1.7 trillion from losses in output and biodiversity. Millions of people remain trapped in vulnerable livelihoods that do not produce a decent return, at a cost of $0.7 trillion a year, while $1.3 trillion of resources are wasted along food supply chains.[24]

If market prices were to reflect the true costs of food, capital would be incentivised to flow where it would have the greatest social and environmental value. Momentum is growing behind new approaches to assessing the true value of food systems, including using sustainability indicators, valuing ecosystem services, and assessing the connections between food consumption and human health. Numerous companies, along with the global initiative The Economics of Ecosystems and Biodiversity (TEEB), are now conducting true cost accounting exercises to understand and measure their impact on nature and people (see Box 6 and Box 17 in Chapter 3). Supported by effective policies and civil society interventions, these trends have the potential to transform food systems and generate significant economic gains.

The hidden costs outlined above are almost certainly under-estimated since no existing models, including those used for this report, are able to take into account the increase in "tail risks" – i.e. the likelihood of events previously considered rare – associated with climate change and potential ecosystem tipping points.[iii] Any such event would have severe effects on livelihoods and food security. The potential impact cannot be estimated in terms of annual losses only, because the unmanageable volatility in supply and prices to which they would give rise would threaten overall system resilience. For example, if deforestation were to push the Amazon rainforests beyond the critical threshold where that forest enters a self-reinforcing cycle of drying out and burning, the consequent changes in rainfall patterns would have drastic, largely incalculable, effects on agriculture not only in Brazil but in Argentina and potentially in the mid-west of the United States as well.[25]

Similarly, there is no way to account accurately for the risks posed by the current lack of crop diversity, nor for the potential upsides and opportunities of increasing crop diversity.

Costs to human health

The largest hidden system costs arise from the impact of malnutrition on human health. One in three people today are malnourished.[26] By 2030, half of the world's population will suffer from malnutrition if current trends go unchecked.[27]

Despite the achievements of food and land use systems, hunger measured by the prevalence of undernourishment has been rising since 2014, to 820 million people.[28] The increase is attributed to factors including climate-related extreme weather, conflict and economic slowdown.[29] Most of those affected live in Asia (515 million people) and Sub-Saharan Africa (239 million people).[30] However, the latter region has the highest number of undernourished as a percentage of the total population (23 percent), largely because it experiences a high incidence of climate-related weather events, conflict and inefficiencies in agricultural value-chains.[31] Globally, about 1.5 billion people are deficient in micronutrients.[iv] One in five children under the age of five are stunted as a result of receiving insufficient calories, proteins and micronutrients, with lifelong implications for their wellbeing and productive potential.[32] Around half of those malnourished live on small farms, where decreasing soil health and population pressures (leading to ever smaller plot sizes) are influencing nutritional outcomes.[33] Some 33 percent of women of reproductive age are affected by anaemia, with serious implications for their health and that of their children.[34] The global cost of undernutrition is estimated at $1.8 trillion a year.[35]

Alongside the tragedy of undernourishment another malnourishment crisis is growing. Some two billion people are overweight, of whom 679 million are obese.[36] The incidence of obesity in young children delivers a warning about future trends as obesity is hard to reverse once acquired.[37] The obesity epidemic is driving up the burden of non-communicable diseases such as cancers, heart disease and diabetes.[38] The economic cost of this development is currently estimated at $2.7 trillion a year.[39] Additionally, many countries face undernutrition and obesity, thus bearing a double burden of malnutrition.[40]

Food and land use systems place further burdens on human health. Roughly 25 percent of outdoor air pollution deaths are attributable to agricultural emissions and particulates, at a cost of $1.3 trillion a year to human health.[41] Indoor air pollution, largely related to the use of traditional biomass for cooking, is estimated to result in 1.64 million premature deaths a year.[42] There are also large costs associated with the over-use of antibiotics in meat and fish production. Premature deaths from food-related anti-microbial resistance (AMR) are estimated to cost the global economy over $300 billion a year. By 2050, food-related AMR could cause upwards of 100 million deaths a year.[43]

[iii] A "fat tail" risk is one where the likelihood of very large impact is greater than would be expected under typical statistical assumptions.

[iv] The prevalence of undernourishment, as a share of the population, is the main hunger indicator used by the Food and Agriculture Organization of the United Nations (FAO). It measures the share of the population which has a caloric (dietary energy) intake which is insufficient to meet the minimum energy requirements defined as necessary for a given population.

The total economic cost to human health associated with global food and land use systems is estimated at $6.6 trillion and set to rise to almost $10 trillion by 2050.[44] This figure includes only costs arising from the loss of productive life. Including the direct and indirect medical costs from diseases related to food and land use systems would significantly increase the estimates.

Climate and other natural capital costs

Current food and land use systems take a heavy toll on the climate, soil, biodiversity and water resources. Land use change is at the heart of these challenges.

Food production has a major impact on global land use, as it covers 32 percent of arable land globally. Of that area, total agricultural land used to produce livestock proteins, including land used to grow feedstocks for animals, stands at 62 percent. That land, however, contributes only 17 percent of calories and 33 percent of proteins produced (Exhibit 9).[45] While the majority of the world's native grasslands cannot grow crops or trees, and their alternative use potential is thus limited, such lands are already heavily used for livestock production, with little room for additional expansion. Thus, rising demand for animal proteins is likely to increase pressure on tropical forests or other ecosystems, with resulting risk of massive greenhouse gas emissions, biodiversity loss and ecosystem degradation.

Continued pressure on tropical rainforests is particularly critical because of their role in regulating climate and water cycles, protecting against flood, drought and erosion and maintaining soil and water health, as well as being the source of 80 percent of terrestrial biodiversity and the livelihoods of over a billion people.[46] In 2018 alone, an area of primary tropical forest the size of Belgium was lost. Greenhouse gas emissions from tropical deforestation are now at least as large as total emissions from the European Union.[47] Agricultural commodities are the leading driver of forest loss and could be responsible for as much as 80 percent of clearance worldwide.[48]

Pressure on peatlands is also a threat to the wider environment. Peatlands cover just three percent of the world's land but store up to a quarter of all soil carbon.[49] Currently between one and two billion tons of carbon dioxide are lost from peat soils a year, despite limited benefits from the economic activities that disturb them.[50] Peatlands are more plentiful in the northern hemisphere than in the tropics, and there is growing evidence that they are under threat in the north as well.[51]

Climate costs

According to the Intergovernmental Panel on Climate Change (IPCC), agriculture and land use change are responsible for just under one-quarter of global greenhouse gas emissions.[52] This figure rises to one-third when all emissions from total food value chains are taken into account.[53] The emissions arise from two main causes – changes in land use (especially clearing tropical forest for agriculture) and production processes (for example, methane from rice production, nitrous oxide from fertilisers and emissions from direct energy consumption). The production of animal proteins – in particular cattle production (Box 16 in Chapter 3) – is the main contributor to both categories.

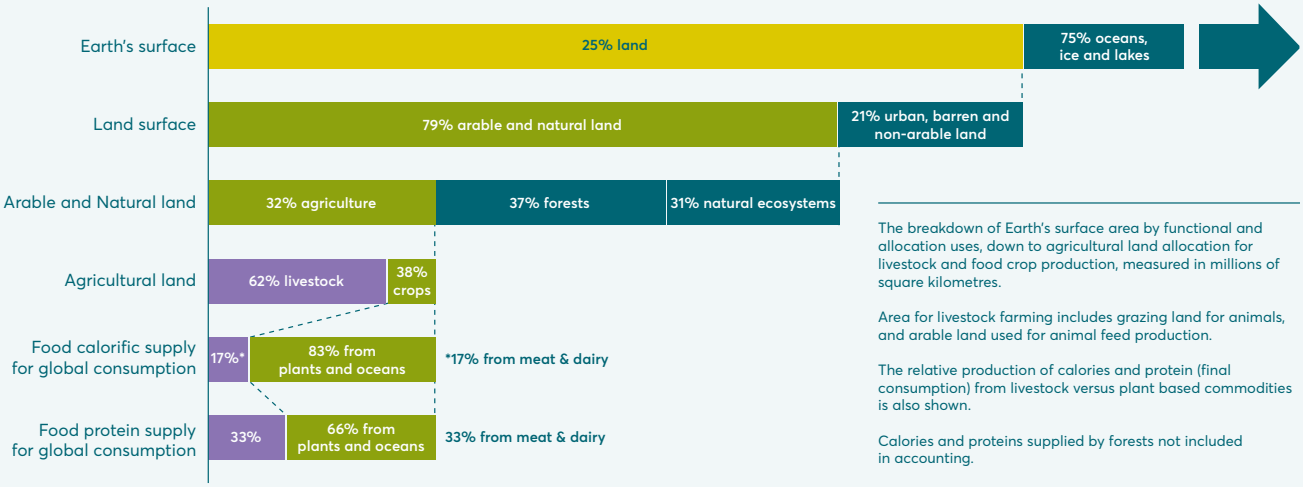
Particularly threatening to the climate is the fact that agricultural production (particularly livestock and rice) accounts for 50 percent of anthropogenic methane emissions.[54] Although there is some scientific debate about the exact magnitudes, it is undisputed that methane's per tonne potential impact on global warming in the next few decades will be far more powerful than the likely impact of carbon dioxide, making reducing methane emissions an urgent priority to minimise the risk of overshooting temperature targets in the short-term and immediate future.[55]

BOX 5

How we use land

EXHIBIT 9

Breakdown of global land area dedicated to food supply



Source: IIASA, GLOBIOM, 2019
Note: According to IIASA estimates, parts of the permanent pastures, as defined in the IPCC 2019 Special Report on Climate Change and Land report, are pastures without significant contribution to total livestock production and thus, are included in the land use classification 'Natural Ecosystems Land'. The 'Pasture' land use classification includes only grassland utilized for agricultural production.

Exhibit 9 shows a progressive breakdown of Earth's surface area first by its natural properties and then by allocation to particular uses in food and land use systems. The proportion allocated to livestock farming includes grazing land for animals and arable land used to produce animal feed crops. It highlights the relative contributions of livestock and plant-based foods to the total supply of calories and proteins consumed by humans.

Humans also source calories and proteins from forests, bushmeat in particular.[v] Other forest foods often sourced in lower quantities and more sustainably, such as Brazil nuts, sago and acaii, also play an important role in local food security.[56]

Global food systems are a leading driver of climate change, but they are also vulnerable to the impacts of climate variability and change. The expected increase in frequency, intensity and impacts of extreme weather events such as coastal storms and droughts will place chronic stress on food systems. The effects of climate change are already apparent: for example, it takes only six days of extreme heat to reduce maize yields in Iowa by six percent.[57] If current trends continue, a combination of increasing heat and humidity ("wet bulb heat") is likely to make it increasingly difficult to work outdoors during the day across half of India within 20 years.[58]

[v] The Convention on Biological Diversity (2011) defines bushmeat as "the meat of wild animals harvested in tropical and sub-tropical countries, for food and for non-food purposes, including medicinal use."

Soil costs

Soil degradation resulting from conventional farming practices is another area of concern.[59] Half of the planet's topsoil has been lost in the past 150 years.[60] Soil quality has also been affected by compaction, loss of structure, nutrient degradation and increasing salinity. These trends have intensified over time.[61] The European Union estimates its total annual societal losses from soil degradation at about $100 billion.[62] In sub-Saharan Africa, over two-thirds of productive land is degraded,[vi] compromising its carbon sequestration capacity and undermining the livelihoods of at least 450 million people.[63] Degraded soils can be susceptible to flood damage and reduced yields, with negative consequences for farmers' livelihoods. The effects on yields are likely to be more adverse in regions where food demand growth is highest and food security lowest.[64]

Biodiversity costs

Biodiversity loss is also compromising the resilience of agricultural systems.[65] The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) synthesis report, released in May 2019, found that land use change and sea use are together by far the leading drivers of the current unprecedented loss of biodiversity, posing a serious risk to global food security.[66]

The loss of agrobiodiversity (the species, varieties and breeds of animals, plants and micro-organisms used in agriculture to produce food) is particularly worrying as it greatly increases agriculture's vulnerability to pests and local weather extremes. Crop diversity has declined by 75 percent during the 20th century,[67] to the extent that just four crops – wheat, rice, corn and potatoes – now provide 60 percent of global calories.[68] Additionally, the near extinction of certain pollinators jeopardises five to eight percent of agricultural production and $235 billion to $577 billion worth of annual output.[69] Pollination is particularly important for the production of "healthy" foods such as fruits, nuts and many vegetables. Production of these foods needs to increase by approximately 95 percent by 2050 to provide healthy diets.[70] Achieving healthy diet targets globally will be impossible unless biodiversity is conserved in agricultural production landscapes. The United Nations (UN) Environment initiative known as The Economics of Ecosystems and Biodiversity: for Agriculture and Food (TEEBAgriFood) has completed a thorough analysis of these issues (Box 6).

The concentration of agricultural research on a handful of staple crops – notably wheat, rice, corn and potatoes – has also indirectly limited the benefits that could have flowed from crop research to smallholder farmers (mostly in Asia and Africa), particularly those in low-potential, rain-fed areas.[71] These farmers could play a key role in guaranteeing national food security and protecting natural ecosystems if sufficient resources were channelled to that end.

[vi] Land degradation is defined according to the United Nations Convention to Combat Desertification (UNCCD) as the loss or reduction of biological or economic productivity and complexity.

BOX 6

The Economics of Ecosystems and Biodiversity: for Agriculture and Food (TEEBAgriFood)[72]

Conventional economic assessments fail to capture externalities of food supply chains. The UN Environment TEEB AgriFood initiative has developed a comprehensive evaluation framework to capture these externalities and address the question: "What should we value, and why?" The initiative looks at positive externalities, such as regenerated land and enhanced biodiversity, improved local livelihoods and the availability of healthy food, and negative externalities such as degraded landscapes, desertification and the collapse of insect populations, poverty and diet-related chronic disease.

The initiative also considers social, cultural, and health-related externalities that are not typically incorporated in environmental economics. For example, studies of corn systems in Mexico, Malawi and the United States (US) revealed the economic, social, and cultural value smallholders provide by managing genetic diversity and the ecological and health impacts of conventional genetically modified (GM) maize value chains compared to organic maize value chains (i.e. maize grown using organic farming practices, for example without use of synthetic fertilisers or pesticides).

The framework can be applied in regional, national and local contexts and across sectors. It can be used by businesses to support decision-making and transparency, and by governments to evaluate national and international policies, compare diets and inform national accounting. For example, the Mexico, Malawi and US studies found that disproportionate funding goes into maize research programmes at the expense of support for dryland cereals. It can also be used by farmers to assess agricultural practices.

The initiative's studies of South America's La Plata basin found that $250 billion of annual agricultural production is at risk there because of the impact on the water cycle of deforestation in the Amazon rainforest. In the same region, palm oil production caused $43 billion of natural capital losses in 2013 – over 80 percent of the commodity's $50 billion total market value.

By providing a means of holistically analysing and evaluating the food system, TEEBAgriFood equips decision-makers across sectors to identify risks, understand trade-offs and make more informed policy and strategic choices.

Water and marine resource costs

Agriculture is responsible for over 70 percent of global freshwater withdrawal, contributing significantly to the freshwater stress affecting two billion people today.[73] Moreover, competition for water from agriculture, urbanisation, industrialisation and population growth will increase stress in the future. Dealing with the resulting strain will require integrated policy, planning and pricing solutions. Currently, freshwater governance is generally inadequate to meet this challenge. It often creates incentives that are at odds with efforts to conserve water resources and to align water allocations with development priorities.

India, for example, has four percent of global freshwater resources to support 19 percent of the global population. 80 percent of India's freshwater is used in agriculture.[74] By 2050, half of the world's population will live in water-stressed areas.[75]

Increased irrigation has the potential to improve yields dramatically, particularly in sub-Saharan Africa, where 95 percent of cropland is rain-fed.[76] However, the development of irrigation will take place against a backdrop of increasing water stress, over-exploitation of groundwater and hydrological uncertainty associated with climate change. Innovation will be essential. Moreover, conventional irrigation can result in water logging or salinisation. The UN Food and Agriculture Organization (FAO) estimates that 30 percent of irrigated land is severely or moderately impaired in these ways, with salinisation effectively shrinking the total irrigated area by one to two percent a year.[77]

Agriculture – specifically, agricultural wastewater – affects ocean health and the quality of many freshwater lakes, rivers and aquifers, as agrochemicals, organic matter, drug residues and sediments cause contamination. Agriculture is the single largest producer of wastewater by volume, and livestock generate far more excreta than do humans. In addition, as land use has intensified, countries have greatly increased the use of synthetic pesticides, fertilisers and other inputs.[78] Excess fertiliser washing out of farmland is accumulating in the ocean and creating dead zones, such as the dead zone in the Gulf of Mexico that is about the size of New Jersey.[vii] In China, agriculture is responsible for a large proportion of surface-water pollution and is the leading cause of groundwater pollution by nitrogen. This has severe effects on aquatic ecosystems and human health.[79]

Overexploitation of ocean fisheries has resulted in 33 percent of fish stocks being critically overfished.[80] This puts at risk a main protein source for the 3.2 billion poorer people for whom fish represents 20 percent or more of their animal protein intake.[81] Widespread tolerance of overfishing is particularly perverse as better environmental management of the ocean would lead to increased yields.

Inclusion costs

The concentration of market power and uneven distribution of the value created in food and land use systems tend to disempower and impoverish small famers and rural populations generally.

Concentration

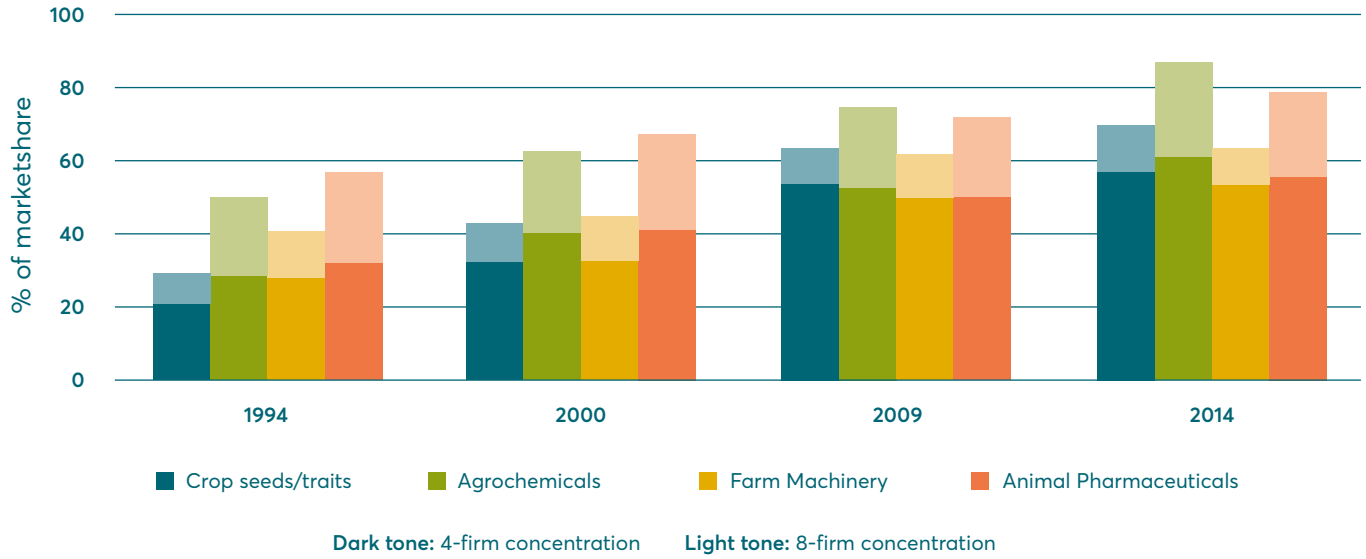
Concentration of market power, capital and political influence in food and land use systems is undermining innovation, efficiency and equity. Market concentration has increased sharply over the past two decades. Exhibit 10 illustrates the increase over time in the proportion of food and land use related industries that are dominated by less than eight firms. It raises the dependency of producers, especially small farmers, on a small number of suppliers. It stifles innovation as protecting market segments becomes more important to concentrated incumbents than exploring new opportunities. And it heightens barriers to entry because of the benefits of scale and the ability of incumbents to buy up any newcomer that looks likely to disrupt their markets. Consolidation increases the risk that hidden costs will continue to be ignored, since the giant incumbents battling for market share wield unmatchable influencing power over lawmakers and regulators.[82]

The International Panel of Experts on Sustainable Food Systems (IPES-Food) concludes that *"dominant firms have become too big to feed humanity sustainably, too big to operate on equitable terms with other food system actors and too big to drive the types of innovation we need"*. Several mergers have avoided the scrutiny of regulators and those that have been scrutinised tend not to have been tested for their impacts on farmers, dilution of governance through increased lobbying power, or implications for sustainability. According to the Organization for Economic Co-operation and Development (OECD), consolidation in the agri-food sector currently faces fewer obstacles than at any previous time.[83]

[vii] Dead zones are hypoxic (low-oxygen) areas in the ocean and large lakes, often caused by excessive nutrient pollution from human activities which deplete the oxygen required to support most marine life in bottom and near-bottom water.

EXHIBIT 10

Concentration of firms in agricultural input industries



Source: IPES-Food "Too Big to Feed," International Panel of Experts on Sustainable Food Systems, (2017)

The fourth agricultural revolution in general and big data in particular are central to this consolidation. Improvements in plant genomics, chemical research, farm machinery and consumer information based on big data could be powerful drivers of more sustainable and productive food and land use systems. However, the potential benefits of controlling these developments are also fuelling the mega-mergers and acquisitions of new, more innovative firms that tend to drive systems in the opposite direction. The current wave of corporate mergers risks exacerbating existing power imbalances, dependencies and barriers to entry across the agri-food sector.

Uneven value distribution

Value created in the food and land use economy is unevenly distributed, a critical factor in the rising economic and social costs of rural poverty. The agricultural transformation of the past 60 years has been key to reducing poverty, notably in East Asia. However, 736 million people are still living below the international poverty line.[84] This means the world is far from on track to achieving SDG1, the eradication of poverty by 2030.[85] Around 80 percent of the extreme poor live in rural areas.[86] Many of them make their living from agriculture, either as smallholders or wage labourers.

There are several reasons for the persistence of rural poverty. The rural poor generally lack opportunities to increase agricultural productivity or find off-farm employment to improve their livelihoods. Reaching people in remote areas with extension services is costly and difficult. Ongoing technological developments, such as precision agriculture, are more readily accessed by larger farms, extending their advantages and further contributing to the marginalisation of small units.

Demographic trends are also increasing the risks to food and land use systems and exacerbating rural poverty. Farming is failing to attract enough young people to replace and rejuvenate the profession. Population growth, particularly in sub-Saharan Africa, is increasing pressure on farm size and natural resources. Small farms today are less than half the size of those that benefited from the Green Revolution.[viii] Many of those now working on the land are producing for subsistence rather than selling produce for the market.[87] This leads to increased pressure on remaining natural ecosystems, as farmers struggling to make a living see no choice other than to increase production through encroachment.

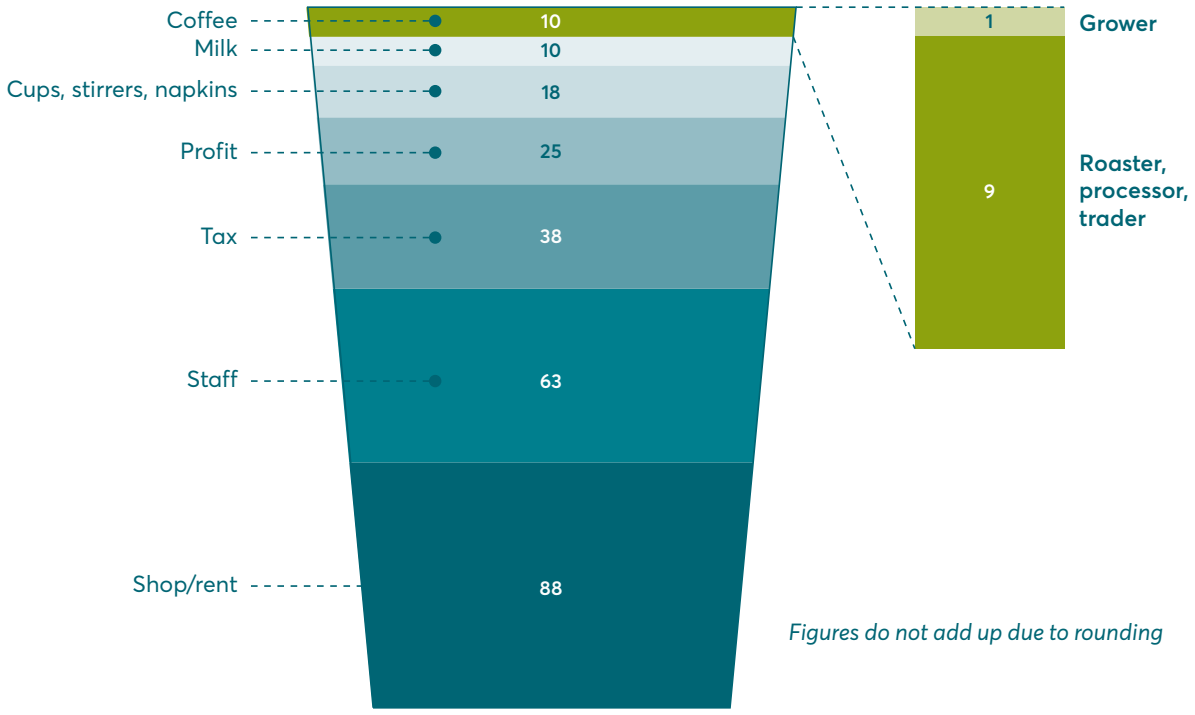
[viii] The Green Revolution, also known as the third agricultural revolution, is a set of research technology transfer initiatives occurring between 1950 and the late 1960s, that increased agricultural production worldwide, particularly in the developing world, beginning most markedly in the late 1960s (Wikipedia).

Trade requirements tend to give an advantage to larger producers more able to meet quality, reliability and phytosanitary[ix] import requirements. Generally, too numerous, too diffuse and insufficiently networked to be directly integrated into longer and more formal value chains, smallholders often miss out on the opportunities that these value chains can offer, such as longer-term contracts, extension services and support on quality. To the extent that they participate at all, they often do so indirectly and informally through short-term trading arrangements.

However, participating in long international supply chains does not automatically improve conditions for the rural poor. Many primary producers involved in international supply chains, such as coffee and cocoa, are living below the poverty line. Cocoa farmers in Cote d'Ivoire and Ghana earn between $0.50 and $0.84 a day despite together producing 60 percent of cocoa for the $50 billion a year chocolate industry upstream.[88] Exhibit 11 illustrates how this form of exclusion plays out in coffee supply chains, in which growers at one end can receive as little as a cent and a half from each $2.50 cup of coffee bought at the other end of the chain.

EXHIBIT 11

Who captures the value from a $2.50 cup of coffee?



Source: Allegra Strategies; International Trade Centre; FT Calculations. 2019.

Farmers often lack effective negotiating power compared with others along the supply chain, such as processors or retailers. A "whole-chain" focus on keeping consumer prices low can drive farm margins below what is sustainable in terms of farmers making a living wage.

[ix] Phytosanitary certification is used to attest that consignments meet phytosanitary (regarding plants) import requirements and is undertaken by an NPPO (National Plant Protection Organization).

Right: Volunteers with freshly plucked organic cherries at the Tianfu Garden Farm (God's Grace Garden) in Beijing, China.

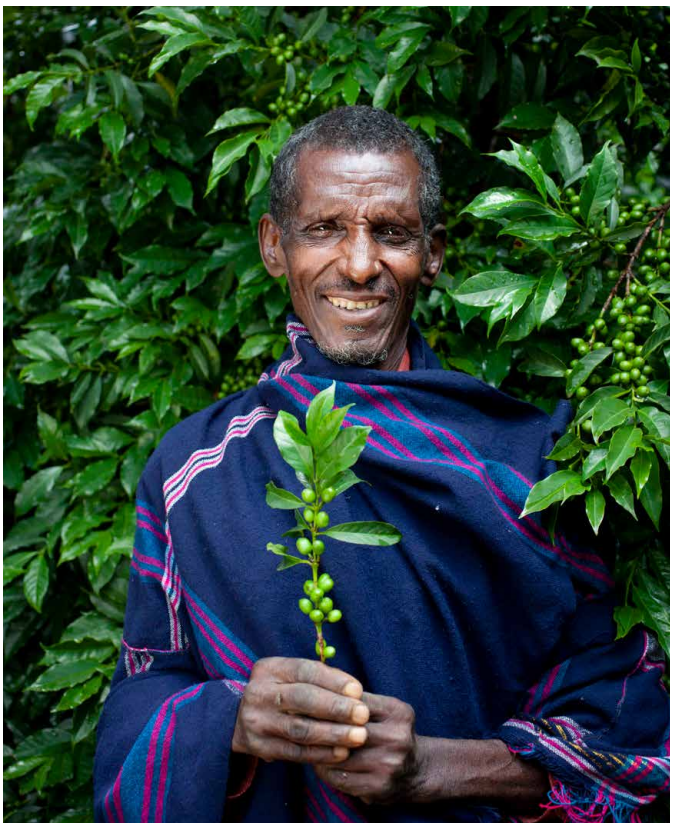
In many rural communities, weak or unprotected tenure rights, including communal or customary rights that are not recorded or recognised, put communities and poor farmers at risk. Land grabs and involuntary removals have seen some communal lands acquired by agribusinesses without any notable local benefits or jobs being created.[89] These land acquisitions tend to be large-scale, for the development of plantations. There is evidence that some have involved businesses illegally obtaining permits to clear forested land.[90]

Underinvestment in rural infrastructure (electricity, roads, irrigation, information technology) also constrains the potential to boost farmers' incomes and diversify economic opportunities. Weak storage, limited refrigeration and inadequate handling technologies allow produce to get damaged. The small scale of local markets accessible to smallholder farmers creates little incentive for them to increase production, while city dwellers unable to access local production need to rely on imported food. The effect of infrastructural weaknesses in limiting market growth by increasing the costs of trade, including intra-regional trade are very visible in sub-Saharan Africa. Sub-Saharan Africa's agricultural trade costs are estimated as more than 50 percent higher than those in East Asia and the Pacific, Latin America and the Caribbean.[91]

2.4 Inefficiencies in food and land use systems

The $12 trillion of hidden costs in our food and land systems make up one group of challenges these systems pose. The other main group comprises their multiple operational inefficiencies and the widespread misallocation of resources. Together, these add up to at least 50 percent of end-to-end system losses, with some estimates suggesting a much higher cumulative number.[92]

First, land and freshwater are widely misallocated. Multiple failures in land markets lead to large areas of land being locked up in low-productivity activities. For example, in many large agricultural economies, land which is currently used for extensive cattle-rearing (see Box 16 in Chapter 3) could either be used for more intensive cattle production, yielding a far higher output per hectare, or switched into higher-value cropping or returned to its natural forested state. This misallocation is first and foremost a loss of value creation to the country itself.



Left: Women working in the fields of Kahansingh Bhai in the Sankdi village in the Narmada district of Gujrat, India, where the local community have been given rights to the lands.
Right: Tilahun Gelaye grows a number of crops including mangoes, coffee, and papaya at a watershed restoration and homestead development project in Bahir Dar, the Amhara Region of Ethiopia. He says: "The difference with being involved in the project is huge. Now we are living cleanly and safely. We don't have to go to the market to buy fruits to feed our children, and we feel very healthy."

Second, there are widely acknowledged inefficiencies in agricultural production activities, especially in the use of inputs such as energy and agri-chemicals. Estimates for nitrogen use efficiency vary widely across crops, farming types and regions, but while efficiency is increasing widely, it rarely exceeds 60 percent even in well-managed commercial farming operations.[93] This is just one form of resource productivity loss, which entails a direct economic loss to farmers and has large environmental downsides.

Third, there are well-documented losses between farm gate and fork. Average losses are around one-third of the value of food produced across developing countries.[94] The loss rates for fresh fruit and vegetables – key to a healthy diet – may be 50 percent or more in some areas, reflecting in particular a lack of cold storage facilities or lack of international trade agreements facilitating rapid flow of such produce across borders (in western Africa, for example).[95]

Fourth, there are similarly well-documented costs of post-consumer purchase food waste. In many developed markets these are estimated again at around one-third of the value of food produced.[96]

Each year, food loss and waste leads to an estimated eight percent of greenhouse gas emissions, consumes one-quarter of all water used by agriculture, and uses an area of land the size of China.[97] The direct economic penalties of food loss and waste equate to around $1.25 trillion a year before these external factors are taken into account.[98]

Fifth, by encouraging over-consumption, many food systems not only create health costs and the first global epidemic of a non-communicable disease. They also produce more food than is needed at a time when planetary boundaries[x] – that is, the sustainable level of pressure on land, biodiversity, water and climate – are being significantly exceeded. This inefficiency is compounded by the fact that many over-consumed foods (like many of the foods wasted post-consumer purchase) are meat and dairy products, which have very inefficient input/output ratios.

Sixth, since most food systems are made up of linear processes, only a small fraction of their waste streams are captured for nutrient recycling. Animal waste is to some extent recycled in this way, but most human waste, which contains a large quantity of nutrients, is lost from food systems.[xi]

All these inefficiencies are exacerbated by the exceptionally inefficient under-use or non-use of human capital in food and land use systems. For example, young people in rural areas are only one-third as likely to have contracted employment as their urban counterparts.[99]

The extent of these inefficiencies offers huge potential for value creation. They show how much room there is to improve performance and create triple wins for consumers, producers and nature. That is not to say the inefficiencies are easy to fix. It will be just as hard as improving energy efficiency in buildings, transport and industrial activities. There are complex cultural, institutional and technical reasons why inefficiencies accumulate and ossify over time.

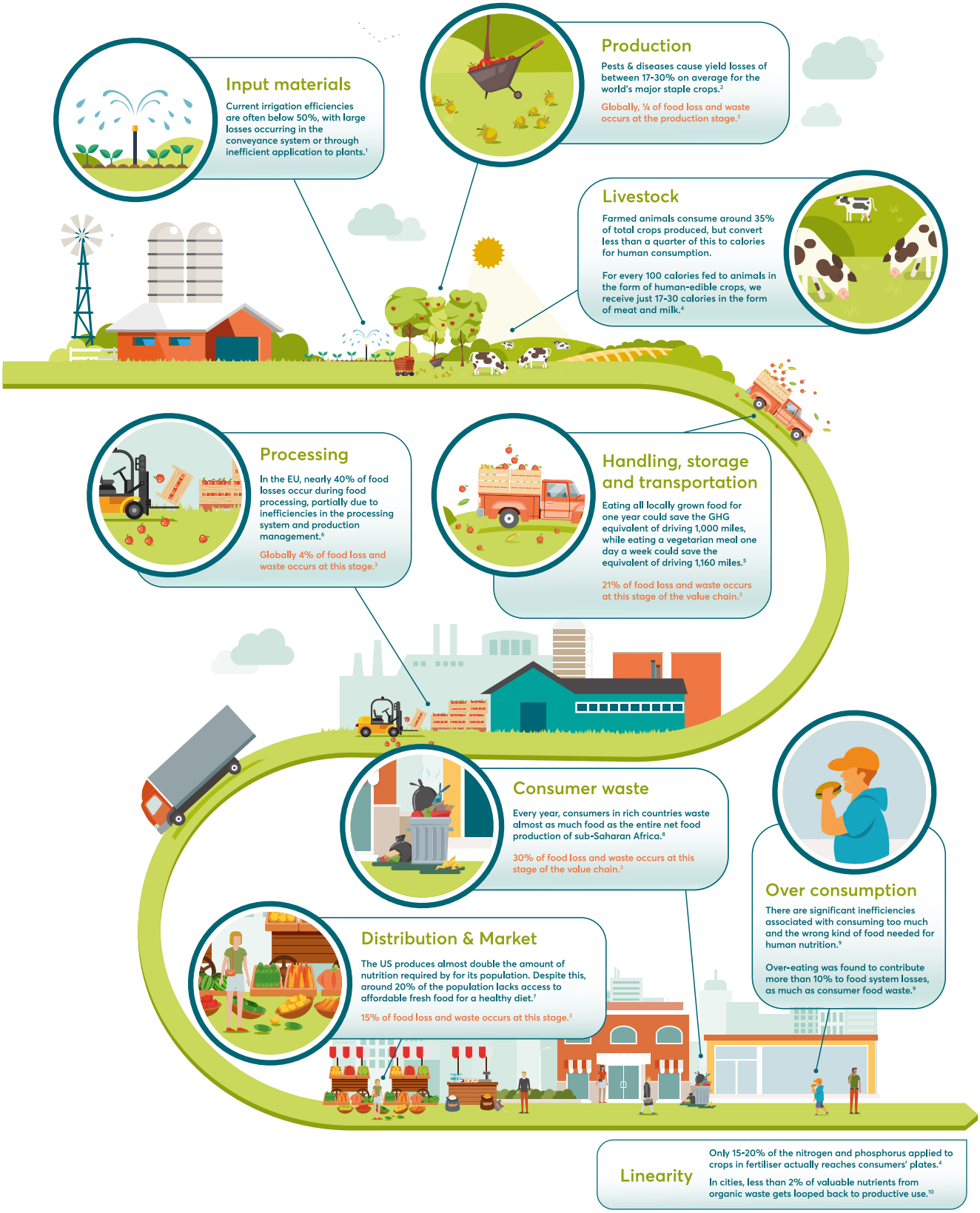
It should also be noted that the costs and benefits of reducing single sources of inefficiency should be evaluated from a systems perspective. For example, the regenerative approach to agriculture that this report argues for in Chapter 3 is less labour efficient – in the sense of requiring more labour per calorie of output – than current models of industrial agriculture. But when taking into account long-term sustainability, regenerative approaches are overall preferable. In contrast, the inefficiencies described above, are not balanced by corresponding upsides. They are simply wasteful.

Nevertheless, they suggest that food systems lend themselves to the kind of creative disruption beginning to transform the mobility sector. New mobility service companies in many towns and cities are challenging the case for car ownership by exposing a huge inefficiency: the average European car is used productively only five percent of the time.[100] The other 95 percent represents a vast misallocation of capital. That wasted capital is the source of mobility service companies' potential to disrupt the auto industry, since many consumers can now rely on these services instead of buying a car. The multiple forms of inefficiency in food value chains suggest similar opportunities for disruption at different stages that could greatly improve overall value chain performance.

[x] Planetary boundaries is a concept involving Earth System processes which contain environmental boundaries, proposed in 2009 by a group of Earth system and environmental scientists led by Johan Rockström from the Stockholm Resilience Centre and Will Steffen from the Australian National University (Wikipedia).

[xi] In cities, which by 2050 are estimated to consume 80 percent of the world's food, less than two percent of the valuable biological nutrients in food by-products and organic waste (excluding manure) is composted or otherwise valorised.

Inefficiencies across food and land use systems



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2.5 Inefficiencies in financing food and land use systems

There are major inefficiencies in the way food and land use systems are financed. Current practices typically fail to price in the hidden costs of climate-related financial, social and environmental risk. They therefore expose investors to significant stranded asset risk and potential loss of shareholder value. The limited availability of investable business models and large-scale bankable projects also means that critical elements of food and land use systems – such as smallholders or ecosystem services – are underserved. Finally, a majority of market support mechanisms, such as agricultural subsidies, fail to incentivise sustainable farming practices that contribute to positive outcomes for the environment, public health and inclusion.

Inefficiencies in capital allocation, especially for smallholders

High upfront costs, long payback periods, untested business models that incorporate conservation, lack of training for farmers, and the often small or disaggregated nature of more sustainable projects can make it difficult for private investors to justify the transaction costs of investing in small-scale food production. The volatility of food prices, increasingly unpredictable weather patterns and other commercial, technical and macro risks also pose significant barriers to investors in a sector that is often considered high risk and low return. This is especially the case in emerging markets, where the perception of political, regulatory and currency risk is particularly high, compounded by weaker local capital markets. Current bank lending to farmers is typically in the form of short-term seasonal credit and a majority is not linked to any kind of sustainability outcome.

This has resulted in major gaps in local currency financing, early-stage risk financing for project development, liquid investment instruments and vehicles that aggregate projects to make them viable for larger players. Providers of development and philanthropic capital are underusing instruments such as guarantees and insurance to mitigate the challenges and investors' risks. Such risks are especially apparent in the food and agriculture sector compared to, for example, the energy sector, because sustainable business models and their revenue streams are less well-established and projects are typically smaller and harder to exit.

These risks are exacerbated by information asymmetries and poor collection and dissemination of data, especially in developing countries. Where information (including from development banks) does not flow freely, ratings agencies and private investors are not equipped to price risk adequately. Nor can they evaluate creditworthiness or identify predictable patterns in, for example, weather, pests, market access, price and performance.

Investors are also concerned about the credit risk of borrowers – especially that presented by smallholders, who often have no collateral, unclear land rights, and a limited track record or formal financial history. This means that almost 90 percent of smallholder farmers do not have access to formal finance, despite constituting the vast majority of the global farming population.[101] An even smaller percentage of their portfolios, possibly less than five percent, goes to women farmers.

Lending is also limited to the intermediaries who finance smallholders. In developing countries, microfinance institutions and other value chain actors meet more than 75 percent of smallholder financing needs, but often at high cost and with limited balance sheet capacity themselves.[102] Lack of even short-term seasonal financing for inputs and harvest costs leaves smallholders trapped in a cycle of low productivity and poverty. Although farmers have a long-term interest in investing in sustainable practices, their lack of knowledge about affordable finance and its scarcity are major barriers, leaving smallholders particularly underserved. Farmer cooperatives, which can support members by providing information about sustainable farming practices and bulk purchasing production inputs, also often lack proper management capacity and other resources and have difficulty accessing credit.

EXHIBIT 13

Key risks faced by investors in the food and land use systems

Macro risk	**Political risk:** political decisions / events in the investment country which negatively impact the attractiveness of an investment opportunity **Currency risk:** potential depreciation of local currencies against hard currencies like USD
Commercial risk	**Credit/counterparty risk:** the risk of default from borrowers on debt repayments, especially for smallholders who may have limited track record and lack of collateral **Demand Risk:** risk around commercial viability and sales **Liquidity Risk:** inability to exit / sell an asset when desired
Finance risk	**Access to capital:** risk of not being able to secure financing
Technical risk	**Construction risk:** risk of project not completing as planned **Operational / technology risk:** risk that asset or supply chain does not operate as planned
Litigation risk	**Litigation risk:** risk of legal action for negative health impacts attributed to consumption of specific foods or exposure to chemicals in fertilisers and pesticides or from unfounded claims regarding health benefits of products
Regulatory risk	**Regulation/policy changes:** risk that policy and regulatory changes such as carbon pricing, taxes on sugar and salt, liability payments for deforestation, regulation on land management, subsidy reform affect the profitability of investments
FOLU-specific risk	**Off-take risk:** inability to secure long-term contractual commitment for purchase of a commodity **Pipeline risk:** challenge to generate and develop investable projects or bring enough projects from concept to bankability **Scale risk:** assets are too small to attract mainstream investors / unable to be aggregated **Physical risk:** assets are exposed to natural disasters and other climate-related risks

Source: Blended Finance Taskforce, Food and Land Use Coalition, 2019

Inefficiencies in risk assessment

While investors find it hard to allocate capital to assets which may drive better overall system performance, they may also be unaware of major risks which currently sit in their portfolios. Today's risk assessment methodologies fail to capture many of the hidden costs of investments or subsidies in the food and land use system.

This leaves the financial sector significantly exposed to the related risks. These include the risk of assets being stranded by climate-related physical risks (natural disasters or loss of natural capital), likely regulatory changes (such as land management codes, taxes on sugar and salt, payments of carbon liabilities, subsidy reform), operational risks arising from environmental stresses such as water scarcity and loss of soil health, credit risks associated with rapidly shifting market trends driven by technological developments and consumer preferences (which can affect the credit profile of borrowers), and liability risks driven by the hidden costs of current food and land use systems. Some companies have lost significant shareholder value following lawsuits related to the health consequences of chemical components in fertilisers.[103] The United States has also seen cases (so far unsuccessful) of obesity litigation. The risk of litigation for agri-food companies is likely to rise.

By definition, financial systems are exposed not only to the returns of the current food economy, but also – as yet indirectly – to its hidden costs. Many financial institutions hold assets that are large drivers of greenhouse gas emissions, biodiversity losses, nitrogen-based eutrophication and air quality problems. They may also hold processing or marketing assets that have been linked to major public health challenges. Not only are such assets major drivers of the climate crisis, they are also vulnerable to its consequences. In particular, the agriculture sector is deeply exposed to physical climate risk, with hundreds of billions of dollars in losses from flooding, fires, drought and other natural disasters each year. Many of these losses are uninsured, and this protection gap is growing, especially in developing countries.[104] This exposure also poses a threat to global financial stability, as identified by the financial regulators gathered under the Network for Greening the Financial System with the aim of better understanding and managing climate-related risks.[105]

Despite the scientific evidence for climate change, only 13 percent of all assets managed by the world's largest pension funds have yet undergone any formal assessment for climate risk.[106] This is even more pronounced among investors in the food and land use value chain. Arguably, the food and agriculture portfolios of most financial institutions are "4-degrees Celsius" portfolios, meaning they are aligned with a 4-degrees Celsius global warming scenario. This is because these portfolios tend to be skewed towards conventional livestock and dairy assets, which are responsible for around half of total greenhouse gas emissions from food and land use systems.[107]

Farm Animal Investment Risk and Return (FAIRR) is an investor network that advocates for sustainable animal farming, backed by 180 fund managers with assets worth $10.5 trillion. The FAIRR network recently found that 70 percent of the world's 60 largest publicly listed meat, dairy and aquaculture producers are failing to manage climate risk.[108] FAIRR found that, of the 16 global food companies, only six – Marks and Spencer, Tesco, Walmart, General Mills, Nestlé and Unilever – have set targets to reduce supply chain emissions from livestock agriculture. Investors holding assets that are not meeting such targets risk seeing them stranded by a combination of the physical effects of climate change, regulatory changes and shifting consumer preferences.

Rapid advances in disruptive, capital-light technologies also put investors in relatively capital-intensive animal-protein value chains at risk.[xii] Such investors may be more exposed to this disruption risk than their modelling indicates.

Inefficiencies in public finance

There are also significant inefficiencies that stem from the ways in which governments provide agricultural support. These include market mechanisms, like tariffs and quotas, and subsidies paid directly to farmers. Of the over $700 billion of support, about $530 billion is paid in agricultural support to farmers worldwide each year.[109] Only around 15 percent of this support is for public goods[xiii] according to the International Food Policy Research Institute (IFPRI).[110]

Few governments are currently putting in place integrated policy frameworks or making use of the tools available (including the alignment of public finance with public goods) to shape economically efficient food and land use systems that protect biodiversity, align with positive public health outcomes or support inclusion.

A significant repurposing of subsidies or change in the support regime could dramatically alter the creditworthiness of many farmers and change the valuation of farm assets. As a result, banks with substantial agricultural loan books are heavily dependent on the current subsidy regimes. They may be much more at risk than they realise from a shift in regulations and a repurposing of the public subsidies to food and agriculture sectors that currently underpin them.

[xii] The increasing frequency and severity of extreme weather events, changing rain patterns, pest infestation and soil degradation, as well as risks linked to technology disruptions (e.g. sudden advancements in genetically modified organism (GMO) production), changes in legislation (e.g. increased carbon pricing), and shifts in consumer preferences (e.g. fast reduction in demand for meat due to increase in vegetarian and flexitarian diets – largely driven by the health conscious rather than climate or sustainability) can have a major impact on food and land use portfolios, causing short-term losses and medium- to long-term "stranded assets" for financial players.

[xiii] The amount of subsidies aimed at "public goods" is captured by the OECD definition of General Services Support Estimates, that is "public financing of services that create enabling conditions for the agricultural sector".

2.6 Conclusions

Despite their visible success in providing affordable food for most consumers, global food and land use systems are wasteful, harbour large hidden costs and contribute to growing risks that pose fundamental threats to human and planetary health, inclusion and food security. These risks are exacerbated by rapidly growing market concentration. As a result:

- **Many diets are bad for human health.** They reduce quality of life for billions and incur an annual health bill of $2.7 trillion.
- **Some 820 million people are undernourished**, resulting in widespread human suffering and economic losses of $1.8 trillion a year.
- **Food and land use systems** are emitting greenhouse gases, depleting soils, polluting water and dangerously reducing agrobiodiversity and dietary diversity through their focus on producing large volumes of a few staple products at low prices. The bill for these environmental effects is more than $3 trillion a year.
- **Animal proteins** in general and beef in particular make an outsized contribution to environmental and human health costs relative to the nutrients they provide.
- **Food and land use systems are being allowed to destroy forests and other natural ecosystems** upon which the planet and humanity depend for vital ecosystem services. Some 50 percent of emissions from the food and land use sector are from deforestation, with a social cost of around $750 billion.
- **The ocean is overfished beyond maximum sustainable yields**, at an annual cost of $83 billion, while its potential to contribute far more to healthy and environmentally friendly nutrition than it currently does is being overlooked.
- **Large, medium and downstream players in agriculture value chains are gaining market power** at the expense of upstream – particularly smaller – producers and customers. This is contributing to a hidden rural inclusion cost of at least $800 billion a year and inhibiting innovation and sustainability.
- **Structural inefficiencies are rife**, ranging from poor use of land and fresh-water and ocean resources, to excess application of chemical inputs, food loss and waste from the farm-gate onwards, and failure to recover nutrients from waste.
- **Environmental crime**, national and international, including land grabbing and illegal logging, is largely being tolerated.
- **Women, smallholder farmers and poor and marginalised communities** are being put at ever greater risk from exposure to financial and environmental shocks and power imbalances that prevent them from acting with greater agency and autonomy.
- **Public subsidies targeted at food and land use systems** are rarely being deployed to drive sustainable outcomes, and more often pull in the opposite direction. Other public and development finance in food and agriculture could be used more catalytically to mobilise private investment in a sustainable food and land use economy.
- **Existing private investment in food and agriculture assets** is at high risk from, and a major contributor to, the hidden system costs and risks.
- **Underinvestment in agriculture** in developing countries is the norm, in particular for smallholder farms.
- **Underinvestment in human capital** as well as in energy and transport infrastructure is driving huge costs by limiting potential productivity and innovation.

The reasons for these systemically related outcomes are complex. But their common thread is that the rules governing food and land use systems are generally stacked against sustainable practices.

On the bright side, the scale of the inefficiencies – the total slack in the system – means the potential for improvement is of similar magnitude. The right programme of reforms can deliver triple wins for the environment, health and inclusion, as well as strengthening food security. The next chapter offers such a reform programme.

China: Food and Land Use

Chen Li (on the left) and Li Jian (on the right) working in the Beijing Farmers Market shop in the Jin Xing Yuan residential area of Beijing, China.

Context

China is a vast country of 9.6 million square kilometres that has made great strides in feeding its population of 1.4 billion people – 18 percent of the global population – on only nine percent of the world's arable land. At the same time, it faces enormous environmental challenges related to food production, including climate change, declining arable land area, groundwater depletion, water pollution, widespread soil degradation and pollution, and over-use of chemical fertilisers and pesticides. The country's nutrition and health challenges are also growing, following its recent transition from a traditional diet high in fibre and fresh vegetables to a high-fat, high-salt and low-fibre model with rising amounts of ultra-processed and fast food. About 11 percent of the population is now diabetic and 12 percent obese. Food loss and waste is also a significant problem – consumers in big cities alone waste enough food to feed 30 million to 50 million people.

Agriculture contributed 7.2 percent of China's GDP in 2018, with total agricultural imports of about $137 billion and exports of about $80 billion. As the largest agricultural market in the world, China has major impacts on other countries. For instance, it is the largest importer of timber and soy (accounting for two-thirds of global soy imports) and the second-largest importer of beef, palm oil and lumber – all commodities that lead to deforestation.

In recent years, China has made progress on afforestation and "ecological zoning" to protect critical habitats, important in a megadiverse country that is home to ten percent of the planet's plant species and 14 percent of its animal species. China has also taken steps to reform agricultural subsidies. Since 2015, subsidies and preferential policies on electricity, gas, transport and tax incentives for chemical fertiliser production have been gradually reduced or cancelled, leading to a decline in chemical fertiliser use. Since 2017, pilots have been rolled out in 100 counties to replace chemical fertiliser with organic fertiliser.

Critical transitions

Each of the ten critical transitions is addressed by government policy. Priority transitions identified by FOLU China include:

1

Healthy diets. China's revised Dietary Guidelines for Chinese Residents (2016) and the Food Pagoda, a visual guide to the different food groups, provide a solid foundation for healthy diets and are widely available in schools and the health care system. Further measures are needed to limit growth in meat consumption and curb consumption of the ultra-processed foods and fast foods that are leading to rising rates of obesity, diabetes and other non-communicable diseases.

2

Productive and regenerative agriculture. A combination of top-down and bottom-up initiatives are contributing to the spread of productive and regenerative agriculture in China. As well as policies to curtail chemical fertiliser subsidies and promote the use of organic fertiliser, initiatives include increasing the use of crop residues, promoting crop rotations and fallowing, and establishing 40 sustainable agriculture demonstration sites around the country. At the same time, a growing number of new farmers – many of them young and college-educated – are establishing ecological farms and supplying the burgeoning domestic market for sustainably produced foods. Improved rural infrastructure, health care and educational facilities are needed to keep these new farmers in the countryside.

3

Protecting and restoring nature. China plays a pivotal role in the supply and demand dynamics for key agricultural and forest commodities that are associated with deforestation, such as soy, palm oil, beef and timber. As such, a commitment to ecologically friendly supply chains on the part of corporate and government actors, through sustainable sourcing, procurement and other measures, could make an enormous contribution to curbing deforestation around the world.

4

Food loss and waste. China has set targets of reducing annual food losses by 13 million tonnes by 2020 – a 40 percent drop compared with current levels. To achieve this target, the country has adopted measures to reduce food losses at source and from processing, circulation, transportation and consumption. For instance, by investing in advanced grain storage equipment, storage losses have already fallen by six percent compared with the national average before 2015.

Teresa Zhang (left) and Chang Tianle (right) at the Tianfu Garden Farm (God's Grace Garden) in the outskirts of Beijing, China. Teresa started this organic farm after suffering from poor health as a result of a high-profile job working in international trade. Chang runs the Beijing Farmers' Market and on this day was volunteering at God's Grace Garden to pick ripe organic cherries.

Chapter 3: Ten Critical Transitions to Transform Food and Land Use

"What the theory of endogenous technological progress supports is conditional optimism, not complacent optimism. Instead of suggesting that we can relax because policy choices don't matter, it suggests to the contrary that policy choices are even more important than traditional theory suggests."

Paul Romer, Nobel Laureate 2018

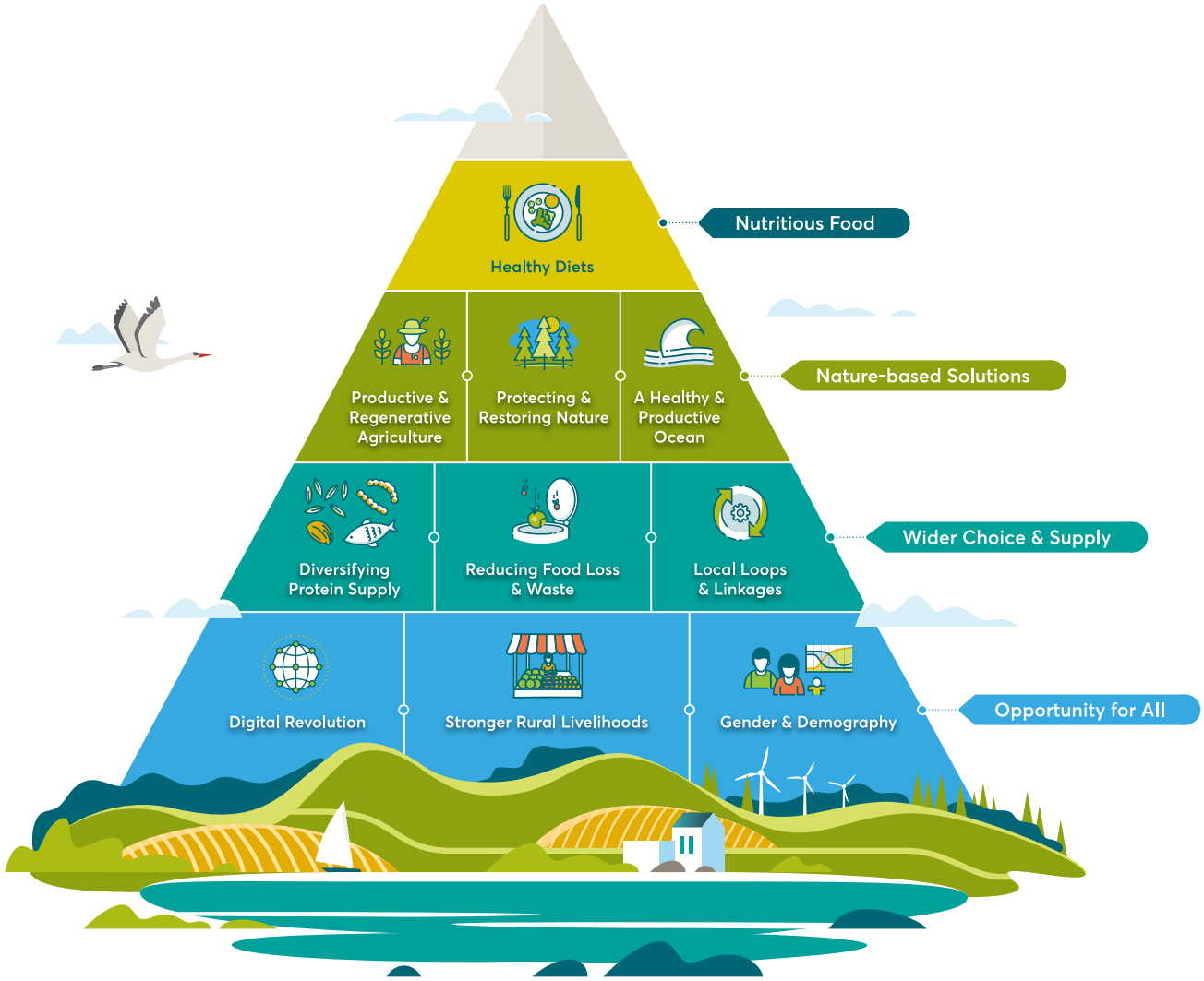
Chapter 2 showed that food and land use systems have done remarkably well at producing affordable calories. At the same time, the chapter showed that they generate almost $12 trillion worth of hidden costs a year and are riddled with inefficiencies.

It does not have to be this way. The research and modelling carried out for this report show that it is possible – by some margin – to design and implement food and land use systems that can deliver greater, more equitable food security for a growing, increasingly affluent population. Moreover, they can do this at the same time as delivering major public health, environmental and economic gains. In other words, policymakers do not need to trade off food security against these other public goods.

The scale of inefficiencies in the current system is what makes large-scale improvements possible in a relatively short space of time. They present numerous opportunities for public and private players to innovate, disrupt and create value.

This chapter focuses on the ten critical transitions that our research has identified as critical to delivering greater food security, a better environment and better public health through more inclusive food and land use systems. They offer a future with more equality, less poverty and greater opportunity for all.

Food and land use: transformation pyramid



The transitions are organised into the Food and Land Use Transformation Pyramid (Exhibit 14). The pyramid groups them into four main clusters: the first around the shift towards healthier diets and patterns of consumption; the second around nature-based contributions to better food and land use systems (including use of the ocean); the third around diversifying supply, especially the supply of foods found in healthy diets; and the fourth around greater inclusion. All parts of the pyramid are essential to delivering a coherent transformation programme. All ten critical transitions are interdependent and mutually reinforcing, although the relative importance of each will differ from one country to the next.

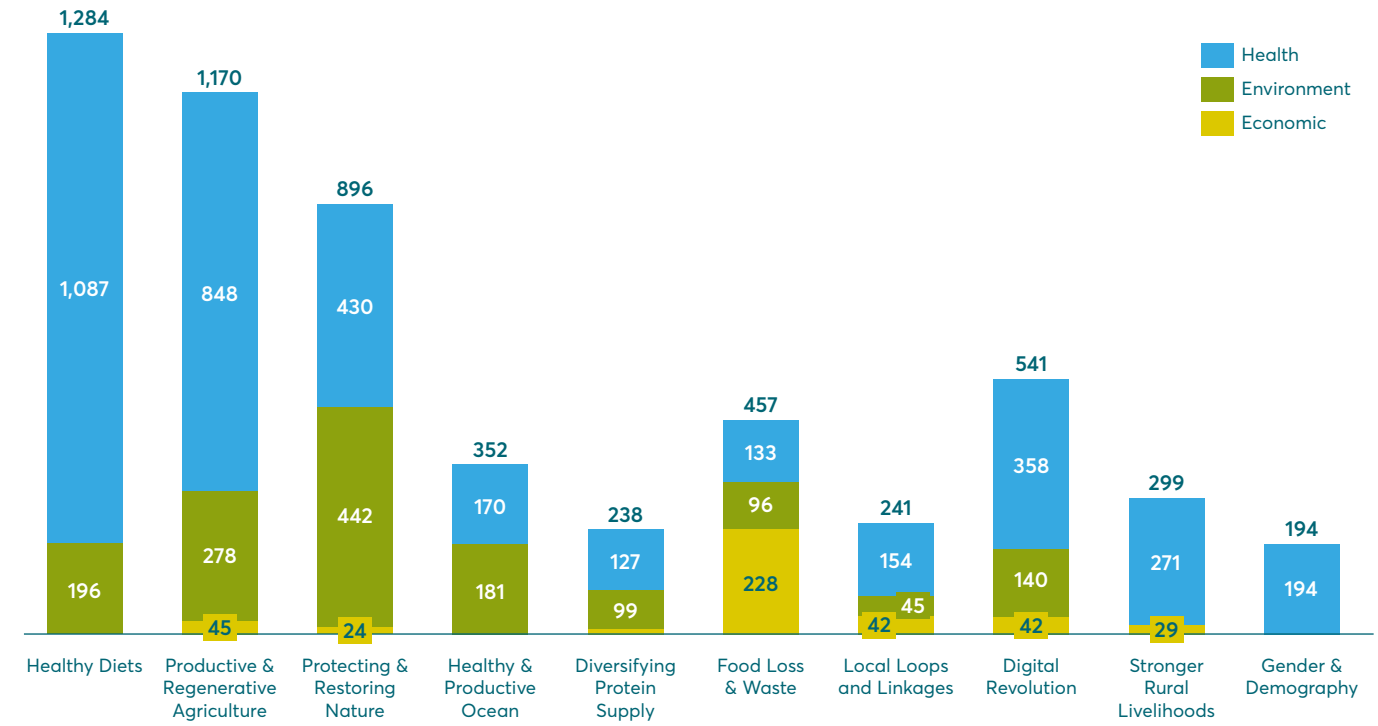
The ten were selected to deliver qualitatively significant changes in the way food and land use operates, that is, they should have systemic impact. Ideally, they all should address two or more target outcomes – for example both health and the environment. For every transition, the overall contribution to addressing the hidden costs needs to be substantial. Each should be politically viable, even if challenging. And implemented together, they would collectively shift food and land use systems on to a sustainable, healthier pathway.

The combined global contribution of the transitions to reducing hidden costs in food and land use systems is estimated at $5.7 trillion a year by 2030 and $10.5 trillion by 2050. Healthy diets look likely to be the single largest contributor, at $1.3 trillion, followed by productive and regenerative agriculture, at $1.2 trillion, and protecting and restoring nature, at $900 billion.

EXHIBIT 15

There is a 5.7 trillion USD economic prize from reducing hidden costs via the critical transitions by 2030

Billions USD, 2018 prices



Source: SYSTEMIQ, Food and Land Use Coalition, 2019 (see online technical annex for methodology).

This chapter divides into two main sections. The first explains each transition from the top to the bottom of the pyramid, considering its potential benefits, the main challenges and trade-offs involved and key areas for action. The second section considers how to develop change programmes which integrate the transitions. The transitions are all interlinked. For example, changes in diet feed into changes in the agricultural system that reduce demand for land and thus take pressure off nature. And all involve multiple stakeholders, including governments, businesses, the farming community, the finance sector and civil society, that are already forming into different coalitions and movements and starting to drive the transitions. Government action to reset the rules of the game is central to them all. The second section considers how stakeholders can together develop, implement and scale new design principles and practices.

Critical Transition 1. Promoting Healthy Diets

Healthy Diets

Better Futures Additional Investment Requirements 2030 *(USD billions)*	Better Futures Business Opportunity *(USD billions)*	Economic Prize from Hidden Cost Reductions *(USD billions)*	
2030	2030	2030	2050
$30	$2,035	$1,285	$1,920

Chapter 2 showed how unhealthy diets are responsible for serious effects on human health. Current dietary choices are also the main force behind the ongoing conversion of natural ecosystems to agriculture, which in turn drives climate change and the loss of biodiversity. Disconcertingly, on current trends, as incomes rise, people on average choose to eat more foods that are bad for their health. This is thus not a challenge that will disappear as economies grow.

The dismal consequences of unhealthy diets can be addressed by global convergence towards a human and planetary health diet (Box 7). In almost all countries, this will mean a major transition. Every country, region and city will need to make the transition in its own way, in accordance with its own cultural and socio-economic environment. And each will arrive at different changes in what people eat, depending on their unique starting point. For example, in parts of sub-Saharan Africa, many people – in particular children and young women – need to eat more animal-sourced foods, including red meat, to fill protein and micronutrient gaps in their diets. In most other places, particularly the United States and Canada, red meat consumption needs to fall significantly.[1]

Global convergence on a human and planetary health diet does not mean less tasty or appealing diets. On the contrary, this shift is about expanding everyday choice for most people, making it possible and affordable to enjoy a far broader range of high-quality foods. The convergence, moreover, is about nutrient content, not a specific set of foods. There is room for variety, and a number of great culinary traditions such as traditional Chinese and Mediterranean diets can be compatible with a human and planetary health diet.

It means people everywhere will eat more "protective" foods than they do now, such as vegetables, nuts, leafy greens, seeds, beans, pulses, fruits and whole grains.[2] Protein consumption everywhere will need to reach the levels currently enjoyed in some high-income countries, although with a broader variety of proteins in the everyday diet. Animal proteins will need to be significantly lower than in those countries. A bigger share will come from fish and plants such as beans and legumes. Everywhere, sugar and salt will be consumed in smaller quantities. Most diets will also comprise lower quantities of current staple foods (wheat, rice, potatoes, corn) to make room for healthier, micronutrient-dense foods. Consumption of processed foods high in unhealthy ingredients will generally go down, although targets for how far consumption of these foods needs to fall are not yet established.[3] Consumption of salt, sugar and unhealthy fats should be kept to a minimum.

A transition to healthier diets must also include getting more nutritious foods to the two billion people living in moderate or severe food insecurity.[4] Some 820 million people continue to face hunger, and their numbers are rising in regions across sub-Saharan Africa and parts of Latin America and western Asia.[5] Food insecurity is more prevalent among women than men on every continent, and particularly in Latin America.[6] Acute economic and climate shocks, as well as conflict and chronic income and wealth inequalities, undermine food security and drive undernutrition, in high- and low-income areas alike. The relative cheapness of unhealthy calories in higher-income countries and the expense of foods high in proteins and micronutrients (eggs, milk, fruits and vegetables), compared to starchy staples in lower-income countries, are important factors behind these trends.[i]

BOX 7

Key parameters of a human and planetary health diet

Achieving human and planetary health requires people's diets to:

- Converge to predominantly plant-based diets, though with still significant room for consumption of animal, oceanic and alternative proteins.
- Include more protective foods like fruits, vegetables, whole grains, legumes, and nuts.
- Limit unhealthy food consumption, such as salt, sugar and saturated fats.
- Moderate red meat consumption – meaning a reduction in settings currently consuming beyond their fair share, an increase where consumption is below dietary recommendations.
- Transition to increased consumption of whole, rather than refined, grains.
- Include little, preferably no, ultra-processed foods high in saturated fats, salt, and sugar.

Food group intake ranges as recommended by national dietary guidelines or the EAT Lancet Commission's Planetary Health Diet allow flexibility to accommodate food types, agricultural systems, cultural traditions, and individual dietary preferences – including variations on flexitarian, omnivore, vegetarian, and vegan diets.

A universal healthy diet is attainable, and, at the same time, options and pathways to affordable and desirable healthy diets are not uniform and can be applied locally.

Goals and benefits

Shifting to a human and planetary health diet is fundamental to achieving the Sustainable Development Goals (SDGs) and the Paris Agreement targets on climate change. Analysis conducted for this report shows the benefits of a transition to healthy diets.

- **Environment.** Zero gross expansion in the area of land under cultivation for food production by 2025, reduction in total territories used for livestock of about one-third by 2030, and a consequent freeing up of nearly 500 million hectares of land for natural ecosystem restoration by the same date. This would lead to reductions in greenhouse gas emissions (see Exhibit 16 below for the Intergovernmental Panel on Climate Change's (IPCC) illustration of the potential) and ecosystem and biodiversity loss.

[i] The nature of food itself helps drive these outcomes, such as for example through the perishability of healthy food (see critical transition 1 on healthy diets) and the high density of calories in sugary food, as opposed to, for example, leafy greens.

- **Health.** Reductions in micronutrient deficiencies, including deficiencies in iron, zinc, vitamin A, folate and iodine (which lead to stunting and wasting when combined with deficiencies in protein, fat or carbohydrates). This would improve cognitive development in children. It would also reduce the incidence of obesity and diet-related non-communicable diseases, particularly in higher-income countries.[ii] Globally, 11 million diet-related mortalities would be prevented per year by 2050, approximately 20 percent of total deaths among adults.[7]

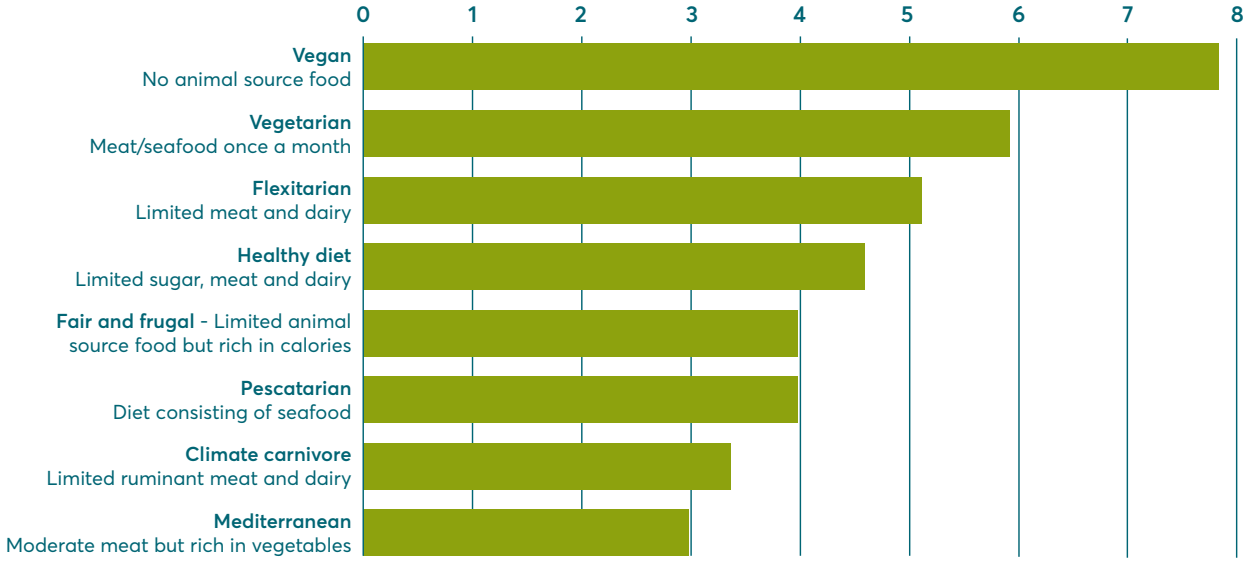
- **Inclusion.** Greater food security and availability of healthy, nutritious food for lower-income communities, rural and urban.

EXHIBIT 16

The effects of various types of diets on greenhouse gas emissions according to the IPCC

Dietary changes could help reduce greehouse gas emissions

GHG mitigation potential (billion tonnes of CO_2 equivalent per year)



Source: Leslie Hook and Steven Bernard, "UN Climate Report Warns of Rising Air Temperatures over Land," Financial Times, August 8, 2019, https://www.ft.com/content/dda8b286-b928-11e9-96bd-8e884d3ea203.

The annual economic gain from this transition is an estimated $1.285 trillion by 2030, and $1.920 trillion by 2050. A reduction in public health costs of $1.090 trillion a year by 2030 would be the biggest driver of the gain.

The public investment required to deliver the transition is estimated at $30 billion. The economic gain would therefore greatly outweigh the costs.

[ii] Note: modelling in this report did not cover the health impacts of ten critical transitions, but used as a supplementary resource research conducted by the Institute for Health Metrics and Evaluation at the University of Washington on the impacts of introducing a human and planetary health diet, one of the key modelling assumptions for this report (see technical annex – Annex B).

BOX 8

Tackling nutrition and financing gaps with a Nutritious Foods Financing Facility

Across developing countries, between 70 and 90 percent of food is produced, processed, transported and sold by small- and medium-sized enterprises (SMEs). Supporting SMEs is a crucial part of the work done by the Global Alliance for Improved Nutrition (GAIN) towards improving the availability, desirability and quality of sustainable, safe, nutritious foods sold to low-income consumers.

Access to finance is the foremost barrier to growth and delivery of nutritious foods, as highlighted in a recent study of over 300 African SMEs.[8]

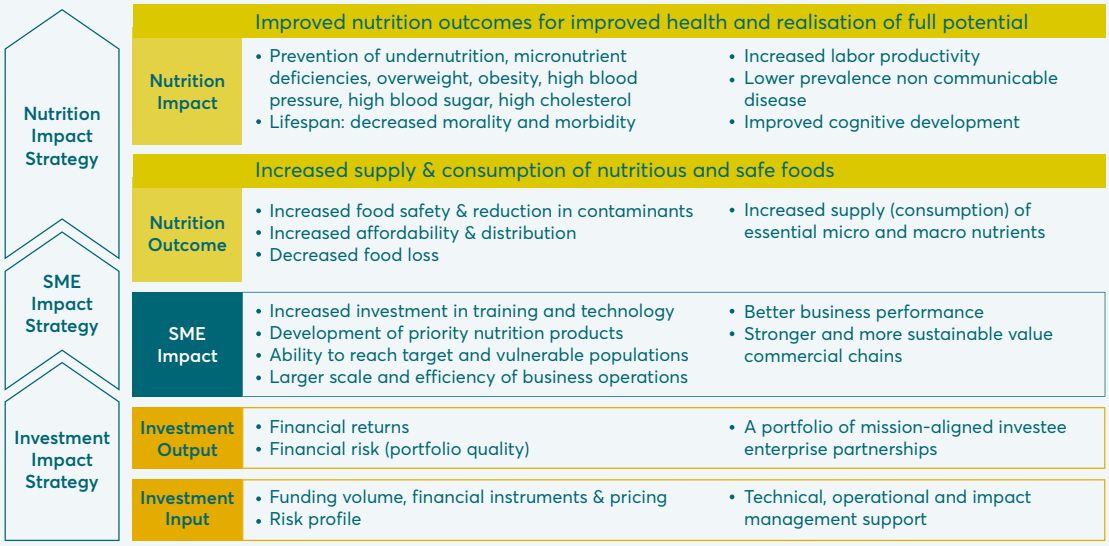
While investors accept the strong need for dedicated funds and facilities to improve the quality of food supplied, viable deal flows to boost nutritious and safe foods from SMEs in developing markets are considered challenging to find and risky. On top of this, funds have no experience in defining what nutritious food is or in knowing how to measure nutrition outputs and outcomes.

Innovative financing mechanisms are sorely needed to address public funding gaps and accelerate progress towards global nutrition targets. Blended finance (that is, public-private finance) can expand the reach of nutrition-sensitive interventions, leveraging additional capital and reducing other constraints, including the risk aversion of banks, the high transaction costs of reaching SMEs and high interest rates.

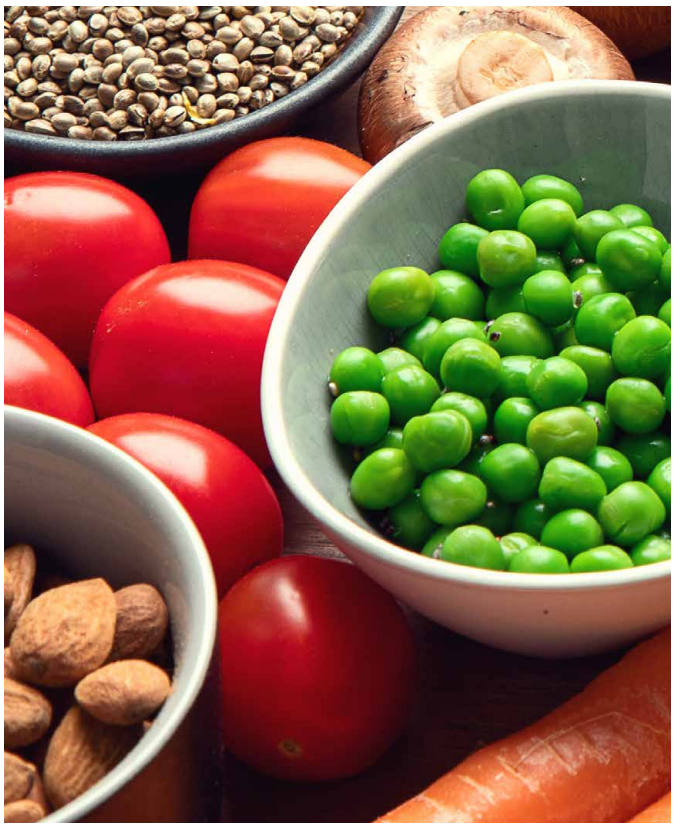
GAIN's Nutritious Food Financing Facility (N3F) aims to catalyse private sector financing and channel investment capital to companies to accelerate the expansion of locally produced nutritious foods in Africa and Asia. It works by filling gaps in capital and debt markets available to SMEs, with a focus on mature SMEs producing nutritious foods for local markets, while facilitating the provision of technical assistance to deliver improved, sustainable business models. The N3F also aims to develop nutrition-enhancing investment tools for replication in the agri-food sector. Exhibit 17 sets out the theory of change leading to improved health impacts.

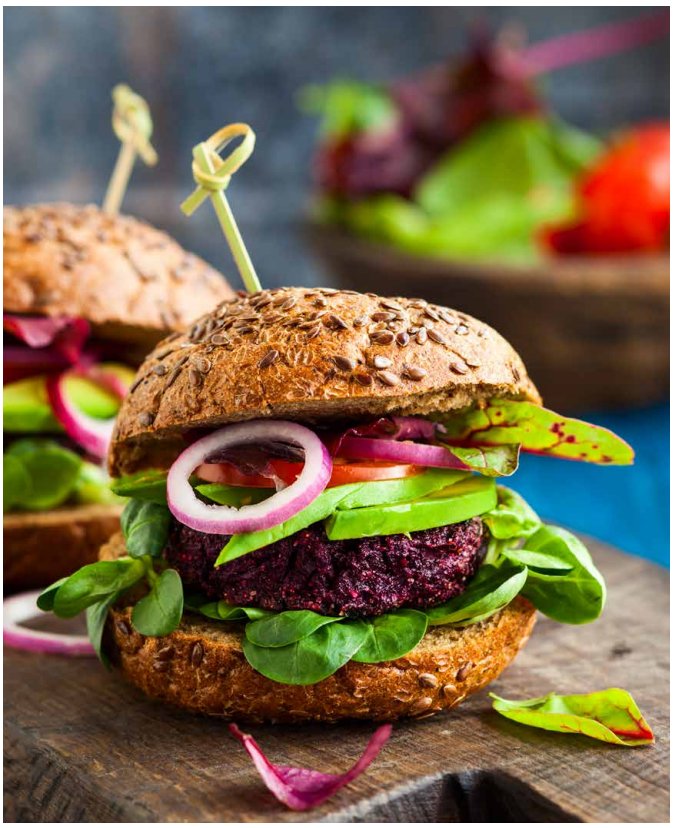
EXHIBIT 17

From investment to impact: How the Nutritious Food Financing Facility seeks to improve nutrition



Source: 'Nutritious Foods Financing Facility (N3F),' Global Alliance for Improved Nutrition & ISF, 2019





Such a big change in human eating habits worldwide has never happened before. However, there are many positive signs around the world that a movement to healthier food could be emerging. Europe and North America are experiencing rising consumer demand for nutritious diets that are also less damaging for the environment. Increasing numbers of young people are switching to plant-based diets. Beef consumption in the United States fell by over 15 percent between 2005 and 2014 and meat consumption is also falling in France.[9]

Businesses are seizing the opportunity to provide healthier, nutritious foods. The alternative protein movement (critical transition number 5) is taking off, with Impossible Foods, Beyond Meat, Vbites and many others providing plant-based alternatives to animal proteins. Vegan and vegetarian options are also mushrooming. Fast food chain restaurants and food retailers are expanding their vegan and vegetarian offerings. Companies such as Alpha Food Labs are working with large food companies to develop nutritious and sustainable product lines, such as plant-based yogurts.[iii] While the environmental impact of these alternative foods appears positive, more work is needed to understand and assess their health effects.

[iii] To date, Alpha Food Labs have worked with Barilla, Beyond Meat, Campbell's and Danone among others.

BOX 9

Future 50 Foods

The Future 50 Foods Report, written by Knorr together with WWF-UK and Dr Adam Drewnowski, identifies 50 foods we should eat more of in order to reduce the environmental impact of our food while increasing the nutritional value of our meals.[10] The 50 foods have a lower impact on the environment, many can grow in challenging environments, some naturally replenish the soil and others work as cover crops. The report has reached 476 million people across 19 countries.

The Future 50 Foods are built into Knorr (a German food and beverage brand, owned by Unilever) product innovations in ten countries with 14 products launching in coming years. Many of the 400 chefs employed by Unilever have created recipes which feature on websites, on packaging and in stores, inspiring and educating consumers to eat more of these foods. Knorr professional chefs have partnered with World Wildlife Fund (WWF) to bring Future 50 Foods into recipes used in thousands of kitchens operated worldwide by the French food services company Sodexo. Knorr continues to work with partners and experts to amplify the impact of the Future 50 Foods initiative through farming, retail and consumer-facing programmes.

In sub-Saharan Africa, Africa Improved Foods is developing nutritious food products for children and pregnant or breastfeeding women in Rwanda (Box 11). Through its Marketplace for Nutritious Foods, GAIN is also working with SMEs in Kenya, Mozambique and Tanzania to support the development of nutritious foods for low-income consumers. Through the Marketplace's Innovation Accelerator (Box 8) GAIN coordinates a network of local entrepreneurs, investors and institutions and provides financing and technical assistance for entrepreneurs developing viable and profitable nutritious food innovations to scale.

National and city leaders already recognise how the right policies with better ministry coordination can help to deliver more nutritious food and healthier diets. Acknowledging the crucial role of city authorities in this context, the Milan Urban Food Policy Pact, signed by almost 200 cities worldwide with a total of more than 450 million inhabitants, challenges signatories to provide permanent and reliable access for all to adequate, safe, local, diversified, fair, healthy and nutrient-rich food.[11] The World Health Organization (WHO) has recorded over 1,000 national policies in 191 countries in its Global Database on the Implementation of Nutrition Action, a repository of national policies on healthy diets.

To give some examples, Singapore introduced a Healthier Choice programme in 2001. More than 2,600 food products are now entitled to carry the programme's symbol, owing to a concerted national approach to establishing healthier eating patterns as part of the culture. In the United Kingdom, a new cross-government initiative to develop a National Food Strategy recognises the interdependence of healthy diets, sustainable land use and economic prosperity for all. Chile is confronting unhealthy consumption by taxing food and drink with high sugar content and setting limits on advertising to children (Box 10). And for more than a decade, New York City's authorities have been tackling "food deserts" and the scarcity of outlets for nutritious foods in low-income neighbourhoods. They have developed food policies supporting healthier diets, including the Green Cart Initiative, launched in 2008, which aims to bring more fresh produce into food deserts.[12]

BOX 10

Sugar taxes in Chile

Chile has been a pioneer in using tax as a tool to limit consumption of unhealthy foods. The main target is sugar-sweetened beverages, on which Chile levies taxes of up to 18 percent. The result has been a 21.6 percent reduction in consumption since the policy was introduced. The taxes are now paired with restrictions on advertising to children. These include limits on food packaging that targets children through, for example, cartoons, measures to stop schools selling unhealthy foods, restrictions on television adverts, bans on promotional toys and the introduction of large black health warning labels on foods high in salt, saturated fat, sugar and calories.[13]

Despite these encouraging signs, major barriers inhibiting the shift to a human and planetary health diet remain. Changing consumer behaviour on a large scale is not easy. Any attempt needs to take account of the specific features of local diets. However, international food and beverage companies have been very successful in producing and marketing ultra-processed products, with high sugar and sodium content, that have wide cross-cultural appeal. Doing something similar for supply chains that produce, manufacture, market and distribute healthy processed foods and drinks will take innovation and investment, but there is no reason why it could not be done.

Solutions will need to tackle the following barriers:

First, incoherence across policies, guidelines and public investment decisions encourages consumption of unhealthy foods. For example, the food environments and marketing that consumers are exposed to every day powerfully influence their choices. In most countries, however, food policy does not sit squarely with one government department at the national or sub-national level. As a result, national governments can set healthy dietary guidelines while, in parallel, city officials allow fast food chains to open up near schools. Historically, food marketing has been concentrated on highly processed food categories high in salt, sugar and fats. Public regulators of communications and marketing often struggle to limit advertising of highly processed food, confectionary and sugary drinks, which tend to be aimed at children. Food companies in the United Kingdom spend around £150 million a year marketing crisps, confectionary and sugary drinks, compared to public health spending on better diets of £5 million.[14] These are some of the reasons why the Standing Committee on Nutrition, a United Nations group including the Food and Agriculture Organization (FAO), International Fund for Agricultural Development (IFAD), United Nations Children's Fund (UNICEF), World Food Programme (WFP) and WHO, is focusing its work on food environments in 2020.

Second, today's supply chains are geared towards the production of high-quantity, affordable foods that are of low nutritional value and based on a limited number of crops. Analysis by the International Food Policy and Research Institute (IFPRI) found that unhealthy food has a much lower caloric "price" than healthy food. Put simply, unhealthy calories are generally the most affordable option. This is particularly true in low-income countries. For example, in Niger the calories in an egg cost 23 times as much as the same number of calories in the staple crops of rice or corn.[15] This is partly due to the perishability of eggs and other nutrient-rich foods, such as leafy green vegetables, which makes them difficult to transport across long supply chains. And in many low-income countries, transport and cold chain storage costs are too high (see critical transition number 6 on food loss and waste). By contrast, international trade policies often encourage imports and exports of highly processed food of low nutritional content because these, as opposed to "pure" agricultural products, are rarely protected by tariffs and quotas.

Consumer behaviour has been and continues to be a major barrier to changing diets. Factors such as convenience, cultural preference and affordability are important to consumers and differ from one country and region to the next. That said, there has been a general trend – largely influenced by private sector marketing – towards greater consumption of processed and highly processed foods. In Europe, purchasing of highly processed foods as a proportion of total household purchasing is highest in the United Kingdom, where it accounts for over 50 percent of all household purchases. In Germany, Belgium, Ireland and Poland, rates are between 35 and 45 percent.[16] Rates in Asia and Africa are growing significantly, albeit from a lower baseline. Between 2005 and 2017, sales of highly processed foods grew by 30 percent in Africa and by over 60 percent in Asia.[17]

Despite these challenges, there is significant potential for more coordinated policies combined with "nudges", new business models and better investment decisions to improve diets. And there will be a multiplier effect: the pace of improvement is likely to pick up as public understanding of the health and environmental benefits of better diets improves and attitudes change.

Priority actions

To achieve a global transition to healthy diets at the speed and scale needed, governments, business, finance and civil society need to work on four priorities:

Align government policies

Closer alignment between agricultural, public health and environmental policies would give a big push to a healthy diet transition in every country. Governments have numerous tools at their disposal, including public health guidelines, public procurement, regulation (of product labelling or advertising, for example), and fiscal incentives, as well as simple acts of political leadership. Alignment will never be perfect. But every country has opportunities to make policies more coherent at relatively low cost. To illustrate, consumers and companies need encouragement to change their conduct and create new norms. Imagine the impact if governments consistently used their top five communication channels to promote dietary guidelines based on planetary and healthy criteria. Imagine the difference it would make if teachers as well as doctors and other public health professionals were all trained in these guidelines. Similarly, governments could boost demand for healthy foods through their control of public procurement. Imagine the impact on the market for healthy foods if schools, hospitals, prisons and the military consistently bought food in line with national human and planetary health dietary guidelines.

To fortify these efforts, governments need to regulate labelling and marketing – particularly of products aimed at children – to make sure they give good information to consumers on nutritional value, both positive and negative. As with marketing for cigarettes and alcohol, food marketing should inform consumers – based on the best available science – about the negative effects of their choices (for example, the effects of dangerous levels of saturated fats, salt or sugar). Businesses could also collaborate pre-competitively with their peers, governments and civil society to commit themselves to promoting the national transition to healthy diets in a transparent and traceable fashion. This includes businesses giving their public support to the necessary policy measures. Civil society organisations can campaign loudly for the transition to healthy diets as a solution to public health and environmental problems. Armed with good scientific evidence, they can target public information campaigns against particularly harmful foods, inspired by similar campaigns against smoking. And they can hold governments, business and finance to account, promoting progress towards best practice from all of them.

Redirect public finance towards healthy foods

Governments can redirect public finance away from unhealthy foods and repurpose it to support healthy foods. The aim is to promote healthy food production and consumption and discourage the production and consumption of unhealthy food.

Agricultural subsidies are critical tools here (see critical transition number 2), but taxes and fiscal transfers will be important too. Chile has led the way on taxing sugar (Box 10), but there is a lot more that could be done with this tool. For instance, taxes could be levied on highly processed food with high levels of harmful ingredients. There are as yet few cases of governments using fiscal incentives to expand the supply of healthy foods, but this too is an area ripe for experimentation. Governments could pay farmers incentives to increase the supply of healthy, affordable foods, strengthening the local provision of fruit, vegetables and nuts.

Although experience is rather thin, one study suggests that cash incentives could be the most effective policy in reducing unhealthy food consumption.[18] Another review, while calling for more studies, suggests that a combination of subsidies and taxes – at a fairly high level and preferably applied in tandem – would yield the best effect.[19]

Target investment and innovation

This priority is critical to harnessing the power of business. If companies are to develop successful nutritious and sustainable food product lines, they need to start by scrutinising their business through the lens of the human and planetary health diet. Action on the other three priorities will give businesses strong incentives. The result is likely to be changes in their research and development (R&D) investments, product development, lobbying and advertising strategies, and acquisitions and marketing spend (see Box 12 on Nestlé's efforts to reduce sugar content in its products).

Developing business models that can provide nutritious, affordable foods to low-income populations in different contexts will be crucial to completing this transition. They will offer start-ups opportunities for effective and disruptive innovations. New public-private partnership models could also help to scale safe, nutritious food value chains, in particular to serve customers in low- and middle-income countries. Existing blended-finance and other innovative finance mechanisms could be adapted to finance them. Municipal governments can help by directing public procurement towards healthy foods and by using zoning and other regulatory approaches, as well as taking part in public-private partnerships. And the financial sector can contribute further by adding nutrition to environmental, social and governance screening of investments and stepping up their analysis of nutrition-related risk accordingly.

BOX 11

Africa Improved Foods

Africa Improved Foods (AIF) produces locally nutritious food products (mineral and vitamin-rich porridge, for example) for local populations, especially pregnant and lactating mothers and stunted children, from locally sourced crops. By improving access to nutritious food, AIF is trying to address stunting and malnutrition, particularly in Rwanda, where almost 40 percent of children under five suffer from stunted growth (which costs Rwanda 11.5 percent of gross domestic product (GDP)).[20]

By producing food locally, AIF supports farmers. The 25,000 farmers who sold their corn to AIF in 2018 received training through the company and its partners in how to improve quality. The farmers (mostly women) get a reliable income so they are able to start investing in the local economy. Further along the value chain, the company's factory generates jobs, increases demand for regionally sourced packaging, equipment and services, and increases the value of Rwanda's exports. According to Chicago University, AIF will contribute approximately $750 million to the economic development of Rwanda.[21] AIF has a number of core partners, including the life sciences company DSM, the International Finance Corporation, the United Nations (UN) World Food Programme and the Rwandan government, whose commitment to business-friendly policies, including the simplification of tax procedures and land tenure reform, will be key to AIF's ability to scale successfully.

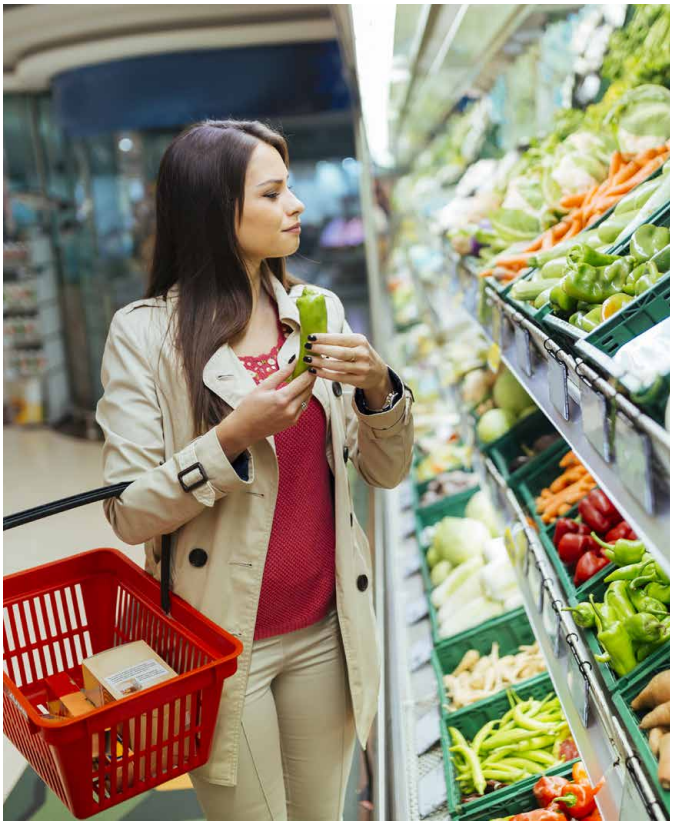
BOX 12

Nestlé's commitment to reduce added sugars in foods and beverages

Nestlé started its sugar reduction journey in 2000 followed by a series of public commitments to reduce sugars in a range of products. By the end of 2016 Nestlé had reduced the added sugar content by 8 percent, the equivalent of 39, 000 tonnes. Efforts in this area are continuing through a new commitment to reduce the sugars added to foods and beverages by a further 5 percent by 2020 to support individuals and families in meeting WHO recommendations.

For adults and children alike, WHO's strictest recommendation (conditional) is to reduce the daily intake of free sugars to less than 5 percent of total energy intake. Currently, around 45 percent of Nestlé foods and beverages provide less than 5 percent added sugars, enabling consumers to use those products while meeting the WHO's strictest recommendation. Of the 55 percent remaining, 45 percent are in the scope of Nestlé's sugar commitments and 10 percent are not relevant to the exercise as their sugar content is regulated. To meet its commitments, Nestlé is undertaking reformulations to ensure that these changes do not affect the taste or texture of products.

Nestlé has been reducing sugar content in popular products such as its cocoa malt beverage products, while also offering natural alternatives with significantly less sugar and sweetness. Nestlé Indonesia launched an improved Milo chocolate malt drink with 25 percent less sugar and in Singapore the first Milo powder with no added table sugar or artificial or natural sweeteners was launched.



Promote behavioural change

Behavioural science has shown that "nudges" can influence how consumers make their purchasing and eating decisions.[22] Shifts in context (for example, which foods are presented first in a supermarket, school or corporate cafeteria) or in how information is presented (on menus, say) can significantly alter consumer behaviour. Smaller plate sizes (in the hospitality sector and commercial catering) reduce over-consumption and food loss and waste. The UK Government Behavioural Insights Team has developed the EAST framework (easy, attractive, social and timely) as a guide to combining nudges and policy. This approach has significant potential to speed the transition to healthy diets.

Recent advances in big data analytics and artificial intelligence present an opportunity to understand consumer trends and patterns more rapidly and at greater scale than before and to engage with consumers more effectively. Research institutions and international organisations can also help to close information gaps on nutrition, test innovations that could influence consumer demand and share lessons on scalable solutions. The Global Nutrition Summit in Tokyo in 2020 will offer a chance to put momentum behind this priority. Much more public and private R&D could focus on how to enable and accelerate shifts in consumer behaviour towards choosing healthy diets.

Platforms for community engagement can create a space to share ideas across social groups and sectors. For example, Sustainable Diets for All is an advocacy programme led by Hivos, a development aid organisation based in the Netherlands, and the International Institute for Environment and Development (IIED), that supports civil society organisations and low-income communities to advocate for better food production, trade and consumption.

Colombia: Food and Land Use

Context

Colombia is the world's second-most biodiverse country, and home to a striking variety of landscapes, climates and soil types. With a population of 50 million people, the country is also characterised by great disparities of wealth between urban and rural populations. Some 27 percent of its land mass (almost 32 million hectares) is devoted to extensive cattle ranching, while only seven percent is used by other forms of agriculture (when the ideal use of its soil types would suggest the reverse). Agriculture accounted for 6.3 percent of GDP and 19 percent of the country's exports in 2017. The value produced per hectare of cultivated land is less than one-third of that produced by OECD countries. High rates of informality and inequality persist: smallholders represent 65 percent of the population and hold less than two percent of the land, while large landowners own 65 percent of the land and represent just 1 percent of the population.

Productivity rates among farmers and forestry workers are the lowest among all national industries. Colombia also has one of the highest rates of agrochemical use in Latin America, although this has not led to overall increases in agricultural production. While deforestation has risen significantly – nearly 198,000 hectares of forest were lost in 2018 – national plans to reduce deforestation and promote restoration are in place. Meanwhile, 50 percent of Colombia's national territory is marine, and the national government has declared its ambition to improve marine governance, ensure better fisheries management and raise the consumption of marine protein.

Approximately one-third of all food intended for human consumption in Colombia is lost or wasted between the farm and the fork each year. This equates to nearly $5.4 billion in economic losses, at a time when more than half of Colombian households do not have enough food to live a healthy and active life. At the same time, rates of malnutrition and obesity cost the state at least $1.5 billion a year in lost economic activity.

Critical transitions

Colombia's National Development Plan (2018 to 2022) addresses each of the ten critical transitions in different ways. FOLU Colombia has also developed a comprehensive Roadmap for a New Food and Land Use Economy for Colombia which speaks to the transitions, including priority actions on the following four:

1

Healthy diets. The national government has approved a new food loss and waste law that will be delivered with the support of FOLU Colombia members. An equivalent law on nutrition and food security, which proposed regulation on labelling ultra-processed food and sugar beverages to address unhealthy diets, did not pass through Congress. The FOLU Coalition is supporting the governments of Antioquia and Bogota to promote healthy diets among schoolchildren, with the aim of these approaches being adopted nationwide.

2

Productive and regenerative agriculture. The FOLU Coalition is working in partnership with regional governments, including those of Quindio and Urabá, to deliver a new vision to increase agricultural competitiveness while ensuring the adoption of more regenerative agricultural practices. It also supports public and private actors to deliver on their commitments to reduce fertiliser and pesticide use, and to expand investment in agroforestry systems including cocoa and coffee growing and silvopastoral livestock. A shift from extensive cattle-grazing systems to more productive, silvopastoral systems, using less land, would be a major contribution to transforming food and land use systems.

3

Protecting and restoring nature. Colombia has an ambitious national anti-deforestation strategy, which it is working hard to implement. The strategy includes strengthened policing and governance in deforestation hotspots and increased flows of finance (including from the national carbon tax) to efforts to support conservation and sustainable use of forest resources in particular territories.

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4

A protected and productive ocean. Colombia has sought to broker a "regional pact for the ocean", focused on enhancing ocean governance, improving the extent and management of marine-protected areas, and supporting the transition to more sustainable fisheries models.

A volunteer collecting organic coffee beans in the Kakataima community, Colombia.

A volunteer is grinding maize in the Kakataima community, Colombia.

The Kakataima community has worked for the last 22 years using agroecological approaches to producing organic coffee, plantain and cacao. They have created the Kakataima Agroecology School to teach other farmers to implement agroecological system and partnered with several governmental bodies to promote this vision of sustainable agriculture. Last December, the community was hit by a dramatic landslide that killed 6 people. After the catastrophe, they started to work on reforesting through partnerships with other entities to prevent future landslides, reduce climate risks and improve the productivity of their farming system. They are also working with volunteers who come from different parts of the world and are involved in all the activities.

Critical Transition 2. Scaling Productive and Regenerative Agriculture

	Better Futures Additional Investment Requirements 2030 *(USD billions)*	Better Futures Business Opportunity *(USD billions)*	Economic Prize from Hidden Cost Reductions *(USD billions)*	
Productive & Regenerative Agriculture	2030	2030	2030	2050
	$35 - 40	**$530**	**$1,170**	**$3,035**

Much of world food production takes place in industrial farms that make heavy use of synthetic chemical inputs. This form of agriculture has significant benefits: generally high productivity per hectare, reliable output, and delivery of affordable food in large quantities at a time of rapid population growth. There are areas of the world that do not have access to this technology, and there are many opportunities to improve its productivity, through forms of precision agriculture for instance. However, as Chapter 2 demonstrated, high-input agriculture carries hidden costs.

Alongside improvements in mainstream high-input agriculture, a regenerative farming movement is emerging. There are a number of definitions of regenerative agriculture. For the purposes of this report, a broad definition is used that includes a set of practices that regenerate soil, that reduce but do not necessarily eliminate synthetic fertilisers and pesticides, and that go beyond the reduction of negative impacts to ensure that agriculture has a positive environmental effect.[23] It seeks to maintain high levels of productivity while reducing inputs, to restore soil health, to increase agrobiodiversity and to reduce negative effects on freshwater and the ocean. It is supported by related techniques such as sustainable land management and integrated water resource management.

An increasing proportion of farmers are adopting regenerative farming practices, often employing digital tools (to monitor soil health, for example), new forms of biological inputs and in some cases practices such as regenerative grazing. It is crucial both to scale such approaches and gradually integrate them into mainstream agriculture to make it more sustainable.

BOX 13

Agriculture is affecting the quality and quantity of freshwater

As discussed in Chapter 2, freshwater is increasingly scarce. By 2050, half of the world's population will live in water-stressed areas.[24] Agriculture is responsible for over 70 percent of global freshwater withdrawal and is thus a leading contributor to the freshwater stress affecting two billion people today.[25] India has four percent of global freshwater resources to support 19 percent of the world's population. Some 80 percent of water in India goes to agriculture, primarily from groundwater sources.[26] This is unsustainable.

Irrigated agricultural land represents 20 percent of total global cultivated land (about 300 million hectares) yet produces 40 percent of all food worldwide.[27] Increased irrigation thus has the potential to improve global yields dramatically, particularly in sub-Saharan Africa, where 95 percent of cropland is rain-fed.[28]

However, conventional irrigation cannot be the whole solution. It too has an environmental impact, because of associated water logging and salinisation. The Food and Agriculture Organization of the United Nations (FAO) estimates that around 30 percent of irrigated land is now severely or moderately impaired by these side effects, with salinisation effectively reducing the world's irrigated area by one to two percent a year.[29] Technologies such as precision agriculture and genetic breeding could address some of these challenges.[30]

Agriculture also affects the quality of freshwater as large quantities of agrochemicals, organic matter, drug residues and sediments contaminate water bodies. In China, agriculture is responsible for a large proportion of surface-water pollution and is the leading cause of groundwater pollution by nitrogen. This has severe impacts on aquatic ecosystems and human health.

Agricultural impact on waterways can be alleviated via policy and regenerative agricultural practices. Supporting farmers to develop water impact plans, manage manure away from areas with high groundwater levels, invest in riparian planting and fence off waterways from cattle will all have an impact on water quality in agricultural environments. Similarly, smart irrigation technologies such as drip-fed precision irrigation can reduce water waste and excess fertiliser run-off.

Goals and benefits

Scaling productive, regenerative agriculture could deliver four main potential benefits.

- **Environment.** Improvements from rebuilding soil health and carbon content (so that soil acts as a carbon sink), lowering greenhouse gas emissions from synthetic fertilisers, protecting biodiversity through reduced use of pesticides, herbicides and fungicides, and reduced negative impacts on freshwater and the ocean.
- **Health.** Improvements from better air quality (by reducing nitrous oxide releases from chemical fertilisers and inadequate manure management and reducing particulate matter by cutting down on tillage) and reduced exposure to chemical toxins.
- **Inclusion.** Gains from developing more diversified, profitable markets for agricultural produce, creating more skilled roles in farming, and lowering dependency on chemical inputs. This last dependency creates a significant cost for most farmers and a major risk for smaller farmers. Production risk would decrease due to improved resilience against disease and drought associated with healthier soils and more regenerative forms of agriculture.[31]
- **Food security.** Healthy soils can store more water and, according to some studies, deliver more nutrients to food crops. Greater agrobiodiversity increases resilience to pests and weather instability and diversifies nutrition.

The annual economic gain from this transition is an estimated $1.170 trillion by 2030, and $3.035 trillion by 2050. A reduction in public health costs of $850 billion a year by 2030 would be the biggest driver of the gain.

BOX 14

Agrobiodiversity[32]

The potential benefits of agricultural biodiversity in regenerative food and land use systems is often not realised because of poor conservation, lack of information and/or restrictive policies. Public policies, which often focus on a narrow variety of staple seeds and as a result, crowd out the informal seed sector, need to explicitly support and stimulate the production and distribution of a diversity of crops and varieties of high-quality seed through both formal and informal seed systems. Successful conservation in support of regenerative systems needs an integrated approach that safeguards genetic diversity and would be:

1. Backed up in ex situ facilities (gene banks) for posterity and in perpetuity and made readily available and accessible for use by researchers and farmers.
2. Conserved "on farm", managed by farmers and allowed to respond to natural and human selection.
3. Conserved in situ in the wild, in natural habitats responding to natural selection.
4. Underpinned by effective information systems at the international, regional and national levels on the availability, status, threats, characteristics/traits of genetic diversity for food and agriculture.
5. Coordinated across agricultural and environmental ministries responsible for genetic resources use and conservation.

The regenerative farming revolution now under way is comparable to the renewable energy movement of ten to 15 years ago. Some large companies are heavily engaged in forms of regenerative agriculture, in dairy as well as crop production. Many farmers in livestock, fruit and vegetables as well as staple crops are progressively reducing chemical inputs, using more crop rotation, building up soil health and making their production mix more biodiverse. This change in farming practice is taking root not only in food production, but also in other areas of the agriculture sector such as fibre production (see Box 15 on the Better Cotton Initiative).

BOX 15

Better Cotton Initiative

The Better Cotton Initiative (BCI) is the largest cotton sustainability programme in the world. It has over 1,600 member organisations spanning the global supply chain from civil society and farmers' organisations to retailers and brands.[33]

With its partners, it provides training in sustainable, regenerative farming practices to more than two million cotton farmers in 21 countries. In the 2017-2018 cotton season, licensed BCI farmers produced more than five million metric tonnes of "Better Cotton", making up around 19 percent of global cotton production.

The BCI Better Cotton Standard System is designed to ensure the exchange of good practices, and to encourage the scaling up of collective action to establish Better Cotton as a sustainable mainstream commodity.[34] It is made up of the following components:

- **Principles and criteria.** Key principles provide a definition of Better Cotton, including: minimisation of the harmful impact of crop protection practices, promotion of water stewardship, use of practices that care for soil health, enhancement of biodiversity, responsible land use, care and preservation of fibre quality, promotion of decent work, and operation of an effective management system
- **Capacity building.** Support and training for farmers in growing Better Cotton, through working with experienced partners at field level
- **Assurance programme.** Regular farm assessment and measurement of results through consistent results indicators, encouraging farmers to improve continuously
- **Chain of custody.** Linking of supply and demand in the Better Cotton supply chain
- **Claims framework.** Communication of data, information and stories from the field to spread the word about Better Cotton
- **Results and impact.** Monitoring and evaluation mechanisms measure progress to ensure that Better Cotton delivers the intended impact

Regenerative farming is likely to scale further as practices improve and consumers demand food that is more sustainable. The British Broadcasting Corporation's (BBC) Blue Planet documentary series, narrated by Sir David Attenborough, initiated a social movement against single-use plastics. A consumer-led revolution centred on food could be triggered by a similar exposure of the kind of evidence that fuels health and environmental concerns. The differences in environmental impact between various types of livestock production would make a striking example (see Box 16).

BOX 16

Cattle systems

In many parts of the world, animals – cattle, sheep, goats, chickens, pigs and fish – are important both as a store of wealth and in enabling rural communities to secure resilient livelihoods, in particular those of women. In rural areas of lower income countries with high levels of malnutrition, animal protein can provide important nutrients of which it may be the only available or accessible source. Well-managed animals can also play a vital role in enhancing the resilience and health of the soil. Furthermore, much of the land used for producing ruminants (cattle, sheep and goats) is grassland that is unsuitable for growing crops or trees. Animal protein therefore should and will remain a key part of diets and livelihoods.

It remains the case, however, that the amounts of animal protein consumed by some parts of the population, and the way it is produced, are highly problematic. This is particularly true in relation to ruminants, which were responsible for nearly half of the greenhouse gas emissions from agricultural production in 2010, or about 6 percent of total global greenhouse gas emissions that year, even before accounting for land use change.[35] On average, meat from ruminants is far more resource-intensive than other commonly consumed foods. Beef on average requires ten times more land and emits ten times more greenhouse gases per gram of edible protein than chicken, for example.[36] Compared to common plant proteins such as beans, beef is on average 20 times as land- and greenhouse gas-intensive. Beef production in a number of key producer countries is also a leading driver of tropical deforestation. And, since most suitable native grasslands are being used for pasture already, increasing demand for beef will put further pressure on tropical forests, the climate and biodiversity. One estimate projects growth in demand for ruminant meat of nearly 90 percent between 2010 and 2050.[37] This would be a major challenge for sustainability.

A number of studies have shown that high consumption of red meat (both ruminant meats and pork) is correlated with damage to health.[38] The exact connections remain debated, with some research focusing the concern more on processed meats such as bacon and sausages, but nutritionists generally agree that current levels of consumption in most higher income countries, in some emerging economies and in segments of lower income countries qualify as overconsumption from a health perspective.[39]

Limiting and thereafter reducing future global demand for red meat from ruminants, especially from cattle, and producing it at a lower environmental cost are therefore two essential features of an overall transition to sustainable food and land use systems. However, the global numbers mask significant regional and national differences in consumption and production that need to inform a balanced approach to both issues.

First, while total global demand for ruminant meat should ideally be halted and then gradually reduced, consumption throughout the world should converge towards the levels recommended in the human and planetary health diet, with people in some areas (children and women of childbearing age in sub-Saharan Africa) eating more meat, while people in other areas (such as in the United States and Canada) eating less (see critical transition 1).

Second, the land use efficiency of beef production varies by a factor of 100 across the world.[40] This means there are opportunities to boost livestock and pasture productivity, especially in lower income countries. This would free up land for other purposes, including forest and other ecosystem restoration, and decrease pressure on remaining natural ecosystems.

More efficient livestock farming can greatly reduce greenhouse gas emissions while boosting soil health and farmer incomes. The efficiency of beef production in terms of greenhouse gas emissions per kilogram of

BOX 16 - Continued

protein produced varies by a factor of 30, giving sizeable scope for improvement.[41] Actions farmers can take include improving pasture fertilisation, boosting feed quality and veterinary care, raising improved animal breeds, and using improved management systems and practices such as rotational grazing or silvo-pasture. Improving manure management and using technologies that prevent nitrogen in animal wastes on pastures from turning into nitrous oxide can reduce manure-related emissions. New inputs such as the feed additive 3-nitrooxypropan (3-NOP) can reduce enteric fermentation.

In summary: what is needed is to halt the growth in and thereafter gradually reduce global demand for ruminant meats, divide what is produced more evenly across the global population, shift production practices to ensure that all ruminant meat production is as close to best practice as possible, and invest in R&D and encourage innovation to drive emissions down even further.

Produced and consumed in limited amounts and according to best practice – the "right animals, in the right places, raised in the right conditions", in the words of one farmer – ruminants can continue to play an important though eventually more limited role than today in sustainable food and land use systems.

The regenerative agriculture movement faces a number of barriers, however. Government subsidies often support more input-intensive forms of agriculture and do little to drive better nutrition and environmental outcomes. There is little or no pricing or regulation of external factors to penalise unsustainable practices. Farmers face a transition risk and lack confidence that means that shifting to regenerative practices will not reduce yields in the short or long term. There is insufficient R&D in new biological inputs, and not enough open platforms for sharing knowledge across the multiple pilots and experiments taking place across the world. Logistics systems are not yet set up to segregate at scale more from less sustainably produced crops. And the large off-takers and food companies and traders are not making regenerative agriculture a priority, in part because it is not a priority for their investors. Natural capital is not explicitly on the financial balance sheet of most food companies or lenders (see Box 17 and Box 6 in Chapter 2).

BOX 17

Capitals thinking

Investment decisions are based largely on financial information. They do not consider the value of essential relationships between nature and people. But a growing number of organisations around the world are now applying "capitals" thinking to their strategies to take the value of those relationships into account. This movement has developed approaches to broaden the definition of capital to include natural, social and intangible assets alongside more conventional categories of physical and financial capital.[42]

Olam International, one of the world's largest suppliers of cocoa, coffee, cotton and rice, has a smallholder programme in India that is focused on water stewardship. By using a capitals approach, Olam has increased productivity and reduced its impact on water supplies. Rabobank, a Dutch bank committed to be a leading bank in the field of food and agriculture worldwide, has applied capitals thinking to develop a way to measure the influence of individual dairy farms on biodiversity, and the Australian government is starting to use capitals thinking to address drought stress.

Many of these barriers have been recognised. A number of coalitions and public-private partnerships aiming to promote regenerative practices are forming, among them Nature for Business Coalition, the One Planet Lab Business for Biodiversity (OP2B) Coalition (Box 18), the Natural Capital Coalition and a coalition led by the Consortium of International Agricultural Research Centers (CGIAR) to pull together the different research communities.

BOX 18

Business for Biodiversity

Businesses are starting to understand their dependency on a healthy natural world and the economic opportunities that a shift towards a sustainable economy will create. To support this shift, businesses are coming together in coalitions to rally for the nature agenda:

1. **The Business for Nature coalition** brings together a diverse group of organisations working with business on environmental issues such as the World Business Council for Sustainable Development, the World Economic Forum, the International Chamber of Commerce, We Mean Business and others, and is calling for action to reverse nature loss and for governments to create a positive policy feedback loop to encourage further business actions. The objective of this collaboration is to amplify and galvanise a business movement for nature by:

   - Convening a united business voice calling on global decision makers to commit to halt the loss of nature.
   - Demonstrating business ambition to protect and enhance nature by uniting, amplifying and helping scale existing business commitment platforms.
   - Showcasing business solutions that are already driving business action and translate commitments into actions for meaningful impact.
   - Communicating that nature protection makes economic sense: Nature provides over $125 trillion worth of environmental services per year to our economy.[43]

2. **One Planet Business for Biodiversity (OP2B)** is a business-led coalition aimed at contributing to the agenda and pillars of the Convention on Biological Diversity of the United Nations (UN) (1992): conserve, restore, transform. Its ambition is to propose solutions to prevent the ongoing loss of biodiversity. OP2B's members commit to work through their supply chains to:

   - Create an innovative framework that gathers companies, public bodies, academia, civil society and other groups to work together to preserve and restore biodiversity
   - Adopt concrete, transformational and scalable objectives for implementation throughout their own supply chains within three streams:
     i. Scale up regenerative agriculture practices for livestock and crops at farm level, with an emphasis on soil health, to preserve and restore biodiversity
     ii. Enhance cultivated biodiversity by offering consumers a more diversified portfolio of products
     iii. Develop local integrated approaches to protect and restore the most biodiverse and fragile ecosystems, including forests
   - Develop an advocacy and communication framework that will shape the global ten-year business, government and finance agenda for nature, connect climate-biodiversity-agriculture ambitions with SDGs, take part in UN and other international events and broadcast the coalition's commitments globally

Priority actions

To achieve a global transition to regenerative farming at speed and scale, governments, business, finance and civil society need to work on five priorities.

Shift agricultural subsidies towards regenerative farming

Research conducted by the Food Policy Research Institute (IFPRI) for this report indicates that only around 15 percent of public support is directly linked to the public benefit.[44] There are promising examples of progress, however. Between 1986 and 2016, European Union Common Agricultural Policy reforms resulted in market price support being reduced from 92 percent to 27 percent, nitrogen oxide emissions from fertiliser use fell by 17 percent and yields increased by 28 percent.[45] China is phasing out support for fertilisers and learning how to avoid their use without compromising yields. And the United Kingdom is shifting its agricultural support policies more explicitly to environmental public goods.

But there is a long way to go. These perverse subsidies need to be rapidly redirected or phased out.[46] One promising avenue to explore is repurposing them as payments for ecosystem services for farmers who increase soil carbon - a good proxy for soil health.

Use other public finance to incentivise regenerative farming

Governments have a range of other tools to deploy, such as taxing undesirable outcomes and subsidising desirable outcomes. They could start by levying payments on greenhouse gas emissions and over time extend levies to other types of pollution. Public procurement, at city and municipal levels of government, can also be used to encourage local producers using regenerative practices. Apart from the environmental benefits, this provides an opportunity to engage consumers in the transformation.

Share information through better open source networks and training

The combinations of farming practices and technologies that unlock yield productivity and natural capital regeneration are as diverse as the planet's crops, landscapes and farming systems. To disseminate the most effective practices and technologies, governments and businesses need to target agricultural extension services – including making seed banks drivers of both high productivity and agrobiodiversity – and training programmes tailored to specific farmer contexts. Farmer-to-farmer peer learning is also a powerful mechanism for sharing knowledge and helping to mitigate the perception that reforms are being imposed from above.[47]

As farmers innovate, there is growing awareness of profitable models that regenerate natural capital while increasing yields. These need to be further disseminated to farmers. For example, it has been demonstrated that large-scale, highly productive farms in Europe can transition gradually over five years to practices that regenerate soil health while achieving 30 percent reductions in the use of agrochemicals.[48] For a cereal farm in the United Kingdom, this translates into a 17 percent improvement in gross margin.[49] Precision agriculture technologies can also support regenerative agriculture by reducing fertiliser, pesticide or irrigation water use through careful targeting. Halting overuse of fertilisers would be a far-reaching measure to cut greenhouse gas emissions.

In 2018, the Andhra Pradesh state government in India launched a financing and training programme to help six million farms, many of them smallholders, to transition to zero-budget natural farming (ZBNF) practices[iv] by 2024.[50] The programme is intended to reduce farmers' input costs while increasing their incomes, restore ecosystem health and support production of a more diverse range of crop species. The programme recognises farmer-to-farmer knowledge dissemination as the most effective means of driving the changes.

[iv] ZBNF is a holistic alternative to the present paradigm of high cost chemical inputs-based agriculture and to address the negative and uncertain impacts of climate change. This is closely aligned to the principles of agro-ecology but is also rooted in Indian tradition. ZBNF is pioneered by Shri. Subhash Palekar, a Padma Shri Awardee, who is regarded as the "Father of zero budget natural farming" across India.[51]

Left: Farmer Usha Rani from Agripally village in Krishna, India, district showing seeds from inside drumsticks at a Zero Budget Natural Farm.
Right: A farmer uses Ghana Jeevamrutham as organic input in his Banana plantation in Agrapally village, India.

Brazil´s Low-Carbon Agricultural Plan is attempting to do something similar at scale with larger farmers. It aims to incentivise efficient integration of crops, livestock and forestry in the same farming unit, along with technologies that reduce the use of inputs.[52]

Increase R&D spending and innovation

A host of research areas have the potential to expand agricultural productivity and natural capital regeneration but are currently underinvested. They include research into regenerative agronomic practices, bio-fertilisers and other compounds that enhance soil health. There is growing interest in applying Internet of Things (IoT) technologies to agriculture, including in-field sensors and passive monitoring devices that complement remote sensing from satellites. Further out, there may be a role for gene editing, such as that pioneered by the Salk Institute to enhance nitrate fixation of root structures.[53]

Governments and the private sector need to increase investment and R&D spending in these areas. Investments in infrastructure, such as irrigation water recycling systems or nutrient recycling systems to make the most of animal manure as fertiliser, are also critical. More generally concerning innovation, much more public-private collaboration and a stronger emphasis on rapid field testing and open data sharing would be helpful. Much good field research is locked away in hard-to-access public databases and impossible-to-access private ones.

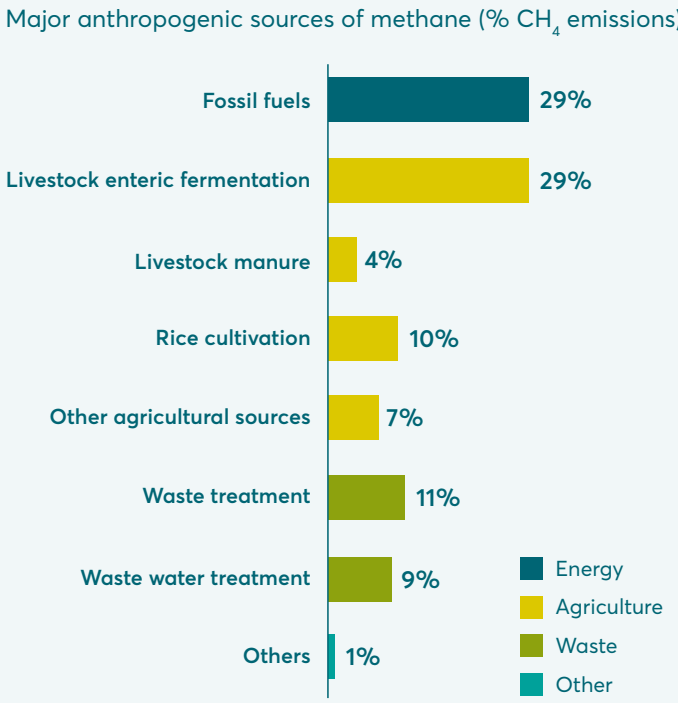
Governments have a distinct role to play in encouraging R&D focused on reducing the external environmental factors related to agricultural production and on the rapid dissemination of best practices. It would be essential for governments to put in place a mix of sticks and carrots (externality pricing, regulation, transitional incentives or feed-in type mechanisms) to drive private sector innovation to increase resource productivity and reduce the environmental footprint. Viable innovations could then be systematically rolled out at scale, where necessary supported by additional targeted or auto-ratcheting regulation.

BOX 19

Reducing methane emissions from agriculture

EXHIBIT 18

Agriculture makes up 50 percent of anthropogenic methane emissions



Source: "Methane," Climate & Clean Air Coalition, accessed August 30, 2019, https://ccacoalition.org/en/slcps/methane.

Cattle. Cattle are responsible for over half of methane emissions from agriculture. A 30 percent reduction could be achieved if global best practice, currently implemented by the ten percent of producers with the lowest emissions intensity, were adopted worldwide.[54] These practices include using better-quality feed and feed balancing, improving breeding and animal health to shrink herd losses, and manure management. Innovation through targeted R&D holds the potential for further reductions.

Rice. Flooded rice fields are responsible for roughly ten percent of total anthropogenic methane emissions. Methane emissions from rice can be reduced by up to 70 percent – without losses in productivity – using climate-smart agricultural practices such as removing the rice straw between harvests, alternate wetting and drying techniques and improved fertiliser application. Further R&D, field testing and rapid dissemination of best practice hold the potential to drive down emissions even further. The Sustainable Rice Landscapes Initiative, which brings together public and private partners to increase resource use and reduce greenhouse gas emissions from rice production, is driving forward this work in the Association of Southeast Asian Nations (ASEAN) region. If the approach can be standardised and scaled, it could be extended to other rice-growing regions in west Africa or Latin America.[55]

Engage business and investors

Most food companies purchase commodities on the spot market or through short-term contracts. This reduces incentives along the value chain for investment in preserving and valuing natural capital. There are good reasons, though, for businesses to make longer-term investments in farmers and landscapes that incentivise natural capital protection and regeneration: it can enhance their security of supply, mitigate reputational risks and give farmers greater certainty. Procurement models that value natural capital involve helping farmers to meet regenerative procurement standards, investing in farmer training in strategically important production regions and providing off-take guarantees to encourage regenerative production practices. Such models remain a minority, however, partly because too few mainstream investors are challenging business on their approach to natural capital or demanding specific metrics on regenerative sourcing strategies.

BOX 20

Business case for nature-based solutions in the watershed of Pasuruan, Indonesia (Danone and the World Agroforestry Center (ICRAF))

Pasuruan is home to Danone's second largest bottled water facility in Indonesia. The flow from the Rejoso natural spring that feeds Pasuruan has fallen by more than 20 percent since 2007.[56] Experts estimate that failure to conserve water benefits in this watershed will result in zero water discharge in this area by 2040. It is crucial to rebalance the watershed to ensure water security for all: economic and agricultural activities as well as communities.

Danone, the Danone Ecosystem Fund (DEF) and ICRAF have joined forces with public authorities to invest in land management to improve water quality and quantity and generate multiple long-term benefits for people and nature such as soil fertility improvement, increased yield or biodiversity preservation. Actions consist of featuring horticulture (10 percent) in upstream, complex agroforestry (25 percent) in midstream and rice fields (29 percent) in downstream of the 62,773 hectares of the Rejoso watershed.[57]

Maintaining and rehabilitating tree-based farming systems in the upstream and midstream of Rejoso will support an infiltrate water rate increased up to 9-23 percent and sequester about 43 tonnes of carbon dioxide per hectare or about 678,000 tonnes of carbon dioxide annually. Moreover, the water and soil conservation will increase soil health and smallholders' farming productivity, expected to result in an increase up to 40 percent of farmers' income on horticulture and 15 percent on agroforestry.[58] In addition, the implementation of System of Rice Intensification (SRI) method downstream is a promising option that significantly reduces methane emission, uses less water, minimises cost of production and increases the yield by up to 20 percent.[59]

To help farmers change their practices and adopt innovations while ensuring farm resilience, appropriate support will be provided to the farmers (technical skills, sharing of experiences) to cover the risk involved in the transition phase.

This example demonstrates the multiple benefits of appropriate watershed management beyond rebalancing the source and proves the importance of agriculture in supporting farmers resilience and climate change mitigation.

Critical Transition 3.
Protecting and Restoring Nature

	Better Futures Additional Investment Requirements 2030 *(USD billions)*	Better Futures Business Opportunity *(USD billions)*	Economic Prize from Hidden Cost Reductions *(USD billions)*	
 Protecting & Restoring Nature	2030	2030	2030	2050
	$45 - 65	**$200**	**$895**	**$1,310**

Expanding human activity at the expense of forests and other natural ecosystems has historically been a precondition for economic development. Today, this must and can change. This critical transition focuses primarily on tropical forests and peatlands because they are both of immense ecosystem value and under immediate threat. But the general message of protecting and restoring ecosystems applies globally. Fixing tropical deforestation requires global as well as local solutions, partly because many of the biggest drivers of deforestation are demand for globally traded commodities including soy, palm oil, cattle, paper and pulp, cocoa, coffee and rubber.

The argument for comprehensive protection and restoration of natural ecosystems is not made lightly. On the face of it, natural ecosystems seem to be converted for legitimate reasons, primarily food production. But modelling done for this report demonstrates that the conventional idea that nature is disappearing because there is a necessary trade-off between it and economic development is incorrect. It is both possible – and necessary – to halt tropical deforestation and protect other natural ecosystems while setting aside hundreds of millions of hectares of land for forest and ecosystem restoration, and to produce affordable, nutritious food for the global population. In other words, the conversion of natural landscapes to produce food is not a necessity, but a result of failures in markets and governance.

Those failures need to be corrected as a matter of urgency. Neither the SDGs nor the Paris Agreement goals can be reached without intact and abundant tropical forests and other ecosystems. Indeed, there is no pathway towards the Paris goals considered by the IPCC that does not assume a near immediate halt in forest conversion and significant forest restoration over the coming decades.[60] This transition is critical to ensuring that the planet can continue to sustain human civilisation.

Goals and benefits

Given the urgency of the climate crisis, the most carbon rich and geographically restricted biomes – mangroves and peatlands – should be protected, fully and immediately. Tropical forest deforestation rates need to be slashed, starting with a radical reduction from 2020 onwards to achieve at least a 75 percent drop by 2025 and a near complete halt by 2030. Forest degradation needs to be cut at similar rates. At the same time, around 300 million hectares of tropical forests need to be restored by 2030. The protection and restoration of savannahs, wetlands and certain other forest types should follow a similar trajectory.[v]

As well as the contributions that forest ecosystem services make to agricultural productivity and food security, achieving these goals offers specific benefits for the environment, health and inclusion.

Environment:

- Reducing annual net greenhouse gas emissions by more than five gigatonnes carbon dioxide equivalent by 2030 and more than eight gigatonnes by 2050,[vi] which is consistent with limiting global heating to 1.5-degrees Celsius and will yield a social benefit of $800 billion a year;
- By protecting and restoring ecosystems the Biodiversity Intactness Index (BII) starts to recover after 2020, a sign of halting and reversal of biodiversity decline. Avoiding the loss of tropical forests is crucial from this respect. In contrast, the world is currently on a path of steady biodiversity decline towards the "sixth extinction", at a speed similar to that of the last 40 years; locking-in natural ecosystems' continued ability to provide critical services like predictable rainfall, watershed management and pollination;
- Gradually removing the otherwise increasing risk that events once considered extremely low probability – such as a full collapse of forest basins like the Amazon – would materialise.[61]

Health:

- Halting climate change, natural ecosystem conversion and biodiversity loss, which is fundamental to human health and wellbeing;
- retaining the pharmaceutic potential of the biodiversity of the natural world, and in particular of tropical forests (already valued at more than $1500 per hectare, a value which is likely to grow);[62] and
- reducing the air pollution health costs of forest and peatland fires as well as the threat that they pose to life and property.

Inclusion:

- Preserving the livelihoods and sociocultural heritage of the hundreds of millions of poor and often vulnerable people living in and off the forests, including indigenous peoples' groups;
- preserving the varied and proven well-being effects of protected natural systems on communities near them;[63]
- helping forest frontier communities prosper and indigenous peoples' groups maintain their way of life, whilst at the same time raising standards of living by establishing and scaling payments for ecosystem services and the sustainable forest frontier business models described below.

Food security:

- The environmental gains from this critical transition are indispensable to secure medium and long-term food security.

[v] The climate and ecosystems services benefits of afforestation and reforestation vary widely by region, including the complexity of potential albedo effects at higher latitudes. As such, all planned restoration efforts should assess these before widespread implementation.

[vi] Note this benefit is derived solely from achieving the associated reductions in deforestation and increases in afforestation and does not include other 'Natural Climate Solutions'. For information on the benefits of other Natural Climate Solutions, see Griscom et al., 2017.[64]

The annual economic gain from this transition is an estimated $895 billion by 2030, and $1.31 trillion by 2050. A reduction in environmental costs of $440 billion a year by 2030 would be the biggest driver of the gain. However, it is important to recognise that this an extremely conservative estimate since we have not quantified tail end risks, for example the risk of significant reductions in rainfall across the breadbaskets of Argentina, Brazil and potentially the mid-west of the United States which could result from Amazon dieback.[65]

Feasibility

Evidence from several regions shows that decoupling development from deforestation is possible. For example, during a period of unprecedented economic and population growth in the temperate zone, temperate forests went from being the primary culprit of global climate change emissions to a relatively insignificant contributor.[66] Temperate deforestation reduced by 85 percent between the periods of 1920-1949 and 1950-1979. In the following 30-year period it came to a complete halt. More recently, studies show that one-third of the planet's total vegetated lands have been re-greening[vii] since 2000.[67] Remarkably, the key actors driving this phenomenon are China and India, the most populous countries: re-greening is part of their economic development. While maintaining high growth, China has contributed 25 percent towards the global afforestation that has taken place since 2000 despite having only seven percent of the world's vegetated land areas. Some 42 percent of this impressive contribution can be explained by extensive programmes to conserve and restore forest in an effort to reduce soil erosion and air pollution and mitigate climate change.[68]

Unfortunately, while providing positive lessons, there are caveats. The halting of deforestation in the temperate zone coincided with a rapid acceleration in deforestation in the tropical zone, driven in part by demand for commodities from countries in the temperate. Moreover, much recent re-greening is not desirable natural forest reforestation: it is made up of monocultural tree plantations and agricultural intensification, not all of it regenerative or sustainable.

Most importantly, these areas have deforested first and then – partly by default, partly by design – allowed their forest to regrow. This development trajectory, known as the forest transition curve, has contributed to the climate crisis faced today, and it certainly cannot be replicated in tropical countries without disastrous climate impacts. The global climate simply cannot afford an interim period in which the carbon from today's tropical forests moves from the earth to storage in the atmosphere before returning.

In addition, research shows that the benefits humanity derives from forests stem from their quality as well as quantity. Natural forests, which develop with little or no disturbance from humans, store 40 times more carbon than plantation forests.[69] Old growth or primary tropical forest is one of the most complex, rich and beneficial habitats on the planet, providing ecosystem services far higher in quantity and quality than any forest habitat that has been disturbed or engineered by man.[70, viii] To preserve biodiversity, analysis shows there is no substitute for protecting primary tropical forests.[71]

And those forests are still being lost at the rate of several million hectares a year. This means the urgent challenge is to decouple development from deforestation in tropical countries so they follow a new kind of climate-resilient forest transition curve. There are numerous examples of progress, from the remarkable return of forests in Costa Rica, driven by subsidy reforms and payments for ecosystem services, to the decoupling of deforestation from development in the Brazilian Amazon over the period 2006-2014 (which still is the case even if under pressure from recent developments), recent policy progress in Indonesia and Colombia and a pioneering ecological fiscal transfer scheme in India (Box 21).

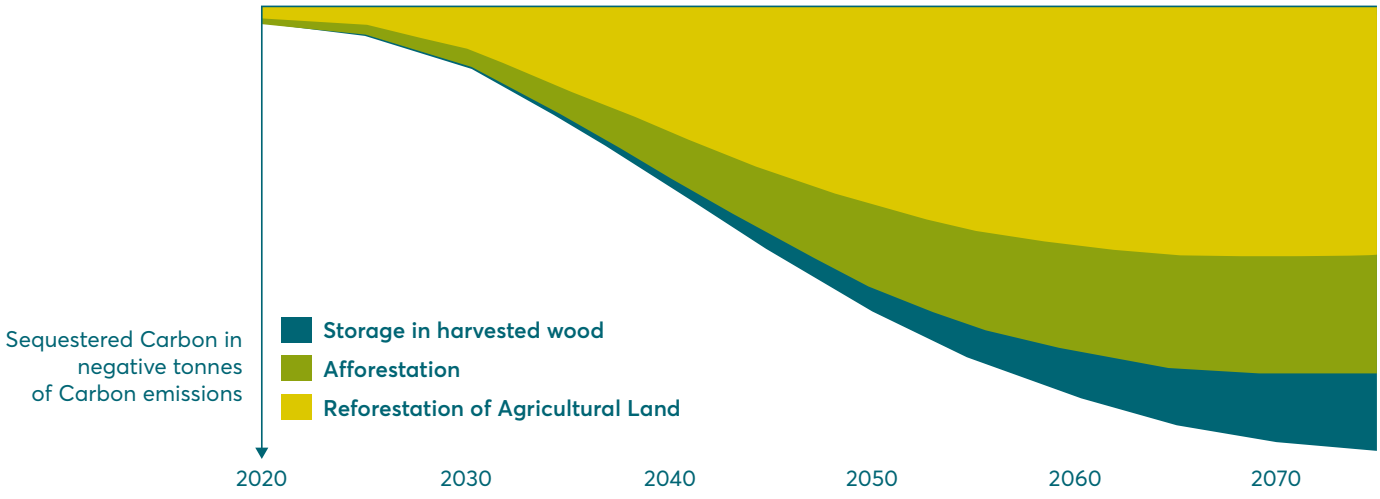
[vii] Increasing leaf area of vegetation.

[viii] Ecosystem services are the benefits that humans freely gain from properly functioning ecosystems, including: food, clean air, oxygen, water filtration, biodiversity, soil fertilisation, protection against extreme weather events and carbon sequestration.

Finally, it is important to emphasise that the carbon sequestration potential of forests builds over time. The gains produced from forests planted today take several decades to reach full fruition. As Exhibit 19 shows, carbon sequestration follows an s-curve that sees a slow start followed by rapid gains, emphasising that the best time to restore forests is now.

EXHIBIT 19

Carbon Sequestration potential of forested land follows an 'S-Curve' – we must plant now to get maximum gains later



Source: IIASA, 2019 (indicative analysis only)

BOX 21

Examples of tropical forest protection and restoration

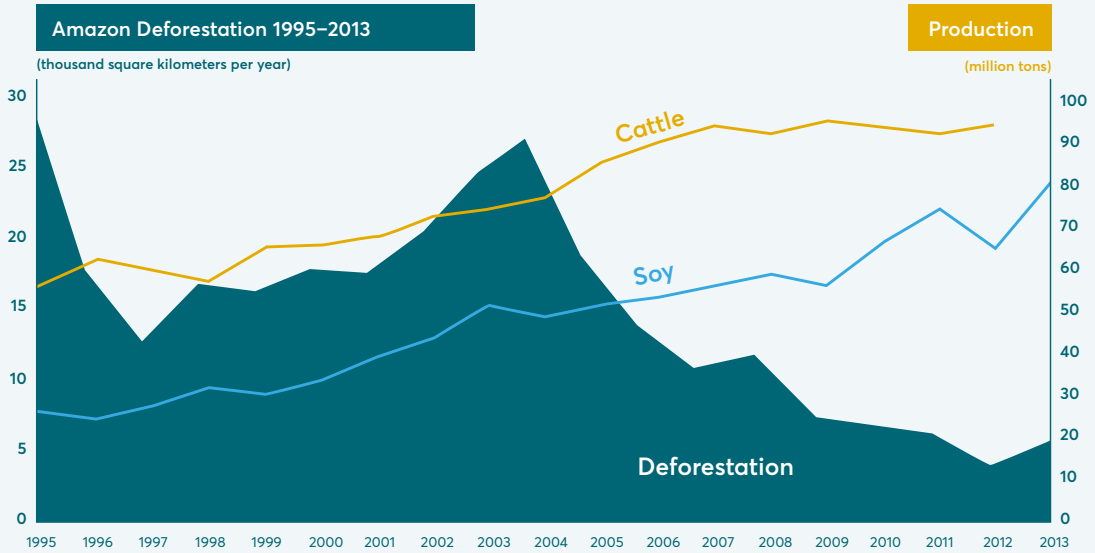
In many countries, effective policies and interventions have led to rapid reductions in deforestation and increases in total forest area. These examples by no means offer perfect answers but all indicate useful lessons that can be adapted to other settings.

Brazil. Facing some of the most extreme deforestation threats on the planet, Brazil has also pioneered some of the most innovative and effective counter-measures. The introduction of an advanced satellite monitoring system (DETER), coupled with robust enforcement on the ground, has been given much of the credit for drastic reductions in deforestation in the Amazon after 2005.[72] (In converse, lagging enforcement and contrary political messages have been given much of the blame for the recent upsurge in deforestation.) Supported by public-private cooperation and civil society engagement, the Soy Moratorium has since 2006 helped to reduce soya's share of recent Amazonian deforestation from 20 percent to less than one percent.[73] Through a combination of increasing law enforcement, expanding protected areas, recognising indigenous territories and increasing agricultural productivity, by 2012 Brazil had reduced large-scale deforestation by over 75 percent relative to the 1996 to 2005 average.[74] This reduction, accompanied by continued rises in GDP, amounted to decoupling development from deforestation (Exhibit 20).

Tragically, recent policy developments are reversing progress, and data seems to indicate that deforestation is increasing steeply. This case thus demonstrates both the importance of political will to progress on sustainable land use and the risks of its absence.[75]

EXHIBIT 20

Deforestation in the Brazilian Amazon 1995-2013



Source: Seymour, F. & Busch, J., 'Why Forests? Why Now?,' Centre for Global Development, 2016

BOX 21 - Continued

Colombia. Colombia has made an ambitious commitment to protect the 50 percent of its national land mass covered by forests. Since 2017, its government has put in place a cross-departmental strategy to combat deforestation and promote sustainable forest management. Although deforestation rose in the power vacuum that followed the peace agreement of 2016, the strategy is already showing progress: actual deforestation rates were down by ten percent from 2017 to 2018, owing to stringent government enforcement and the provision of alternative livelihoods for rural people.[76] International cooperation has also been a factor: the German, UK and Norwegian governments have together committed between $300 million and $400 million to Colombia if the country delivers quantifiable and pre-agreed results in reducing deforestation.

Costa Rica. Costa Rica is the first tropical country to have stopped and subsequently reversed deforestation: more than half of its land is now covered by forest, compared to one-quarter in 1983. Costa Rica has achieved this through a long-term vision of economic growth and development, innovative and progressive policies – particularly to eliminate cattle subsidies and introduce payments for ecosystem services – and consistent international support. On payments for ecosystem services, the government used a novel approach of deploying revenues from taxes on fuel and water to pay farmers and landowners to maintain the provision of ecosystem services on their land, such as carbon sequestration and protection of watersheds. Payments were significant: as much as $125 per hectare a year for the restoration of land with high levels of biodiversity and native species.[77] As large tracts of land were restored and preserved, the socio-economic benefits spread well beyond ecosystem services. Attracted primarily by its natural beauty and biodiversity, more than three million visitors a year travel to Costa Rica. The tourism sector is growing by more than six percent a year and foreign exchange from tourism alone makes up more than six percent of GDP.[78]

India. Since 2005, India's Finance Commission (FC) has included the forestry sector in fiscal transfers through grants and a tax devolution scheme. In the period 2010-2015, FC grants included a performance-based instrument through which the release of funds for the final three years was linked to completion of forest management plans by the state forest departments. Since 2015, the FC included forest cover in the tax devolution formula that compensates states for the opportunity cost of maintaining forests and providing ecosystem services. Estimates indicate that $6.9 billion to $12 billion will be transferred to states annually between 2015 to 2020, making this one of the largest ecological fiscal transfer systems in the world. If the Fifteenth FC retains forest cover as part of tax devolution formula for the period 2020 to 2025, states that increase forest cover are likely to gain tax revenues of $174 to $303 per hectare a year, whereas states that reduce forest cover before 2020 will stand to lose the same amount.[79]

Indonesia. Over the past decade, the Indonesian government has trialed and implemented a range of policies and initiatives to tackle the extraordinary pressures on its natural ecosystems. In 2010, it declared a complete moratorium on further concessions for conversion of primary forest. It has since then gradually expanded the reform agenda, which has included a national moratorium on peat drainage since 2016. Although challenges remain, the impact of specific policies demonstrates progress: in the year following the peat moratorium, primary forest loss in protected peat areas fell by 88 percent to the lowest level since official records began.[80] This downturn in forest and peat loss and related emissions made Indonesia eligible for results-based payment under the REDD+ Letter of Intent signed with Norway in 2010.

Although they are firmly in the driver's seat, tropical forest countries have not been alone in making progress on this transition. Under the United Nations Framework Convention on Climate Change, a comprehensive arrangement for north-south cooperation on reducing tropical deforestation has been negotiated. This is best known by the acronym REDD+ (Reducing Deforestation and Forest Degradation in Developing Countries, Box 26). In an early test of this arrangement, the Norwegian government in 2008 pledged $1 billion to Brazil by 2015 if Brazil reduced Amazon deforestation below an agreed reference level. Brazil overdelivered by a factor of ten, and Norway fulfilled its obligation. (This being a results-based partnership, payments have been reduced in recent years due to significant increases in deforestation. In 2019 Norway's announced that payments would be halted after unilateral Brazilian government changes to the structure of the fund.) More broadly, Germany, Norway and the United Kingdom promised at the Paris summit in 2015 to contribute $5 billion in tropical forest finance by 2020, a pledge they are on course to fulfilling. Significant steps forward have been made on forest monitoring, including increasingly robust national systems established in several countries, along with global satellite monitoring tools such as Global Forest Watch (Box 22) and international trade and supply chain transparency initiatives such as Transparent Supply Chains for Sustainable Economies (TRASE) (Box 23).

BOX 22

Global Forest Watch

Global Forest Watch (GFW) is an online platform that provides data and tools for monitoring forests. By harnessing cutting-edge technologies (satellite imagery, big data, machine learning) and free access, GFW allows anyone anywhere to obtain near-real-time information about where and how forests are changing around the world. Launched in 2014, GFW is being used by governments to enforce forest protection, companies to pursue deforestation-free supply chains, civil society to hold governments and companies accountable, indigenous communities to protect their homeland, researchers to better understand drivers and hotspots of deforestation, and the media to ring the alarm bell where needed.

BOX 23

Transparent Supply Chains for Sustainable Economies (TRASE)

Transparent Supply Chains for Sustainable Economies (TRASE) maps in unprecedented detail the complex and often opaque links in global supply chains between consumer countries, trading companies and the places where agricultural products are farmed. TRASE can show how commodity exports are linked to agricultural conditions – including specific environmental and social risks – in the production locations, allowing companies, governments and others to understand risks and identify opportunities for more sustainable production. TRASE is a partnership between the Stockholm Environment Institute and Global Canopy and brings together academia, NGOs, governments and corporates.

Left: A member of the Embera village of Chigorodó, Indigenous Reserves of Yaberaradó and Polines [Pueblo Embera de Chigorodó. Resguardos Indígenas de Yaberaradó y Polines] in Uraba, Colombia, holding a native plant, that has special significance to him.

The successes and failures over the past three decades show that progress on this transition is possible. It requires strong government action, supported by civil society and business. However, many tropical forest countries continue to struggle. More than 12 million hectares of tropical forest – an area almost the size of England – was lost in 2018.[81] Equally concerning, continuing high rates of forest degradation are causing forest fragmentation and increasing the fragility of ecosystems across the tropics. Of the fewer than two billion hectares of tropical forest cover standing today, under a quarter remains intact, meaning more than three-quarters is fragmented or degraded.[82] Despite many reasons for optimism, the barriers to progress should not be underestimated. They are extremely complex and wide-ranging. The following are the most important.

First, many governments lack the capacity or the political will to establish and then enforce clear regulatory frameworks for forests and other natural ecosystems. As noted above, political will is the essential ingredient. With that, all other barriers can over time be surmounted. Without it, little will be accomplished even if money is spent.

Second, there has been marginal respect for the traditional territories of forest-dwelling communities and even less legal recognition. But they are demonstrably effective in protecting forests (Box 24). Ignoring their rights impedes progress on this transition.

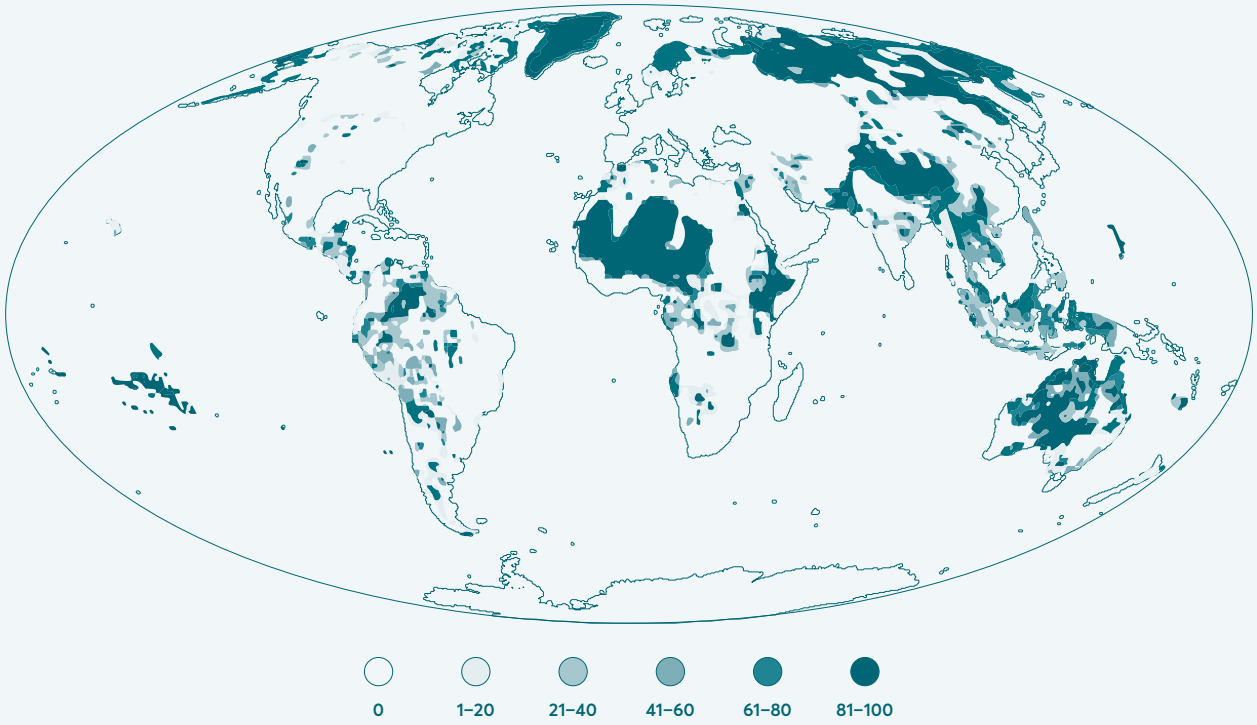
BOX 24

Stewardship of indigenous peoples

The potential contribution of indigenous peoples' groups to the future of the planet's natural lands is inestimable. Some 40 percent of remaining ecologically intact landscapes are under the tenure or management of indigenous peoples.[83] These areas store more than 200 gigatonnes of carbon and coincide with areas that protect as much as 80 percent of the world's biodiversity.[84] The 370 million indigenous peoples,[85] inhabiting 3.8 billion hectares of land, are essential partners and practitioners in the stewardship of the most vital but vulnerable remaining natural resources, and have an essential role in the design and implementation of upcoming and urgent global agreements.[ix]

EXHIBIT 21

Global land area managed and/or controlled by Indigenous Peoples



Note: Darker colour indicates a higher percentage of land area under Indigenous management.
Source: Garnett et al. 2018. 'A spatial overview of the global importance of Indigenous lands for Conservation'. Nature Sustainability.

Beyond the question of scale, nobody has proved themselves better at managing wild places and protected areas than their indigenous inhabitants. Between 2000 and 2012, average annual deforestation rates inside tenure-secure indigenous lands were two to three times lower than in similar forests without secure tenure in Bolivia, Brazil and Colombia (Exhibit 22).[86]

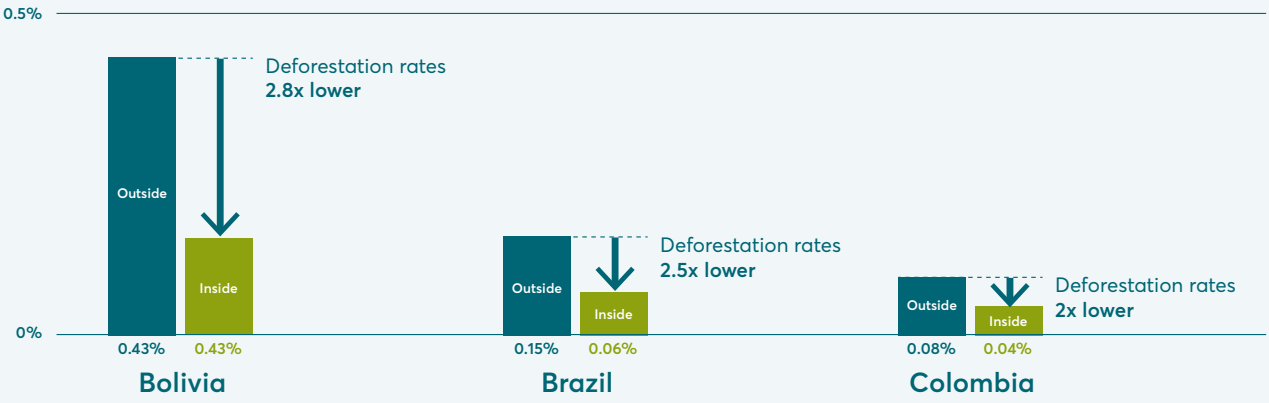
[ix] Such as the upcoming post-2020 global biodiversity framework.

BOX 24 - Continued

EXHIBIT 22

Deforestation in tenure-secure Indigenous Lands

Average Annual Rates, 2000 - 2012



Source: "Protecting Indigenous Land Rights Makes Good Economic Sense," World Resources Institute, October 7, 2016

As forest cover declines, securing the rights to land of indigenous peoples and local communities, and recognising them as forest stewards, is essential to mitigating the climate crisis. In the context of growing pressures from outside groups seeking to farm, log, mine, and drill for oil and gas on Indigenous and community lands and the threats these pressures pose to traditional norms, institutions, and knowledge, it is more important than ever to secure customary rights and strengthen traditional institutions. These efforts must be tailored to local circumstances. While Indigenous territories in the Amazon, community forests in Mesoamerica, and forest user groups in Nepal have all maintained healthy forests, each one's characteristics reflects its own unique context. Integrated approaches are needed – focusing not only on tenure security, but also on complementary regulatory frameworks and financial, technical, and legal assistance to support local forest management systems and advance sustainable livelihood alternatives.

Third, many governments have opaque processes and criteria for providing forest conversion concessions, price them well below their real value and enforce conditions on the concessions lightly if at all.

Fourth, dependence on wood for energy is a key driver of deforestation and land degradation. In sub-Saharan Africa, in the absence of alternative energy sources, 90 percent of the population relies on firewood and charcoal as a primary source of domestic energy.[87] Population growth and urbanisation are causing energy demand to rise, increasing pressure on forests as a source of wood fuel. In Tanzania, it has been estimated that every one percent rise in urbanisation has increased charcoal consumption by 14 percent.[88]

Fifth, there is generally no monetary return for keeping forest standing, even if the benefit to society is overwhelming. In the absence of regulatory frameworks or pricing of externalities, simple economics make it more valuable for an enterprise to convert a hectare of tropical forest to agricultural activities than to leave it standing. This is true for smallholders as well as large companies.

Sixth, consumers have so far not been willing to pay more for sustainable "deforestation-free" food. Major multinationals have struggled to develop reliable deforestation-free supply chains, partly because buy-in to that concept from companies around the world has been far from universal, and there has thus not yet been momentum for a race to the top.

Seventh, governments in many developed countries have created mandates that have added unintentionally to deforestation pressures, notably in the case of bioenergy (Box 25).

Finally, although estimates suggest that trade in illegal forest products adds up to as much as $100 billion a year,[89] national and international law enforcement agencies have generally not treated this as a priority crime. The commons have, in large parts of the world, been more or less free access, with predictable results.

BOX 25

Bioenergy

Bioenergy remains a contentious issue in climate change mitigation debates. Hailed by many as a significant opportunity to rapidly decarbonise our economy (in particular, transport), it also has considerable life cycle analysis weaknesses.

The key points to understand in bioenergy discussions, are that:

- Biomass is a poor converter of sunshine and land to energy. The energy output from a hectare of productive, well-watered land covered with solar methods is typically 30 to more than 100 times higher than the same hectare covered with energy crops.[90] On most global land, if 100 hectares of land were to become available from agriculture, devoting one hectare to solar and 99 hectares to reforestation rather than using that land for bioenergy would typically produce at least the same quantity of energy and more than 100-times the greenhouse gas reductions per year for decades.[91] Costs of bioenergy that divert the productive capacity of land are proportionally high relative to the energy and climate mitigation effect that is being produced.
- Bioenergy comes in different forms and is produced in many different ways – ranging from foraged wood for open cookstoves, through to advanced third generation biofuels (using algae, for example). For the purposes of this report, the essential questions include; (i) whether bioenergy production competes with land for food production or natural ecosystems; and (ii) whether it is a cost-effective climate mitigation approach.
- Land is a fixed and limited resource. A hectare of arable land always has an associated opportunity cost not merely financially but also in carbon terms. In scenarios that do not reduce agricultural land, bioenergy will compete directly or indirectly with carbon storage in existing natural ecosystems. In scenarios that reduce agricultural land, land could alternatively be used for bioenergy or forest regeneration. The carbon savings from the alternative uses can therefore be compared per hectare per year, and absent extremely high yields of energy crops, forest regeneration would sequester more carbon per year for decades. Regeneration is also likely to be cheaper financially. Even if high energy crop yields could be achieved, the net savings compared to regeneration would thus be much lower than the apparent gross savings. Whenever fossil energy can be replaced in other ways, therefore, using available land to restore forest provides added greenhouse gas reductions.
- The potential justification for biofuels is greater for hard to abate sectors – in particular long-haul air travel. For these sources, biofuels could help reducing use of fossil fuel and keep more oil in the ground. Even for these sources, however, the challenge cannot justify deploying biofuels solutions that sacrifice large quantities of either existing or potential carbon storage, and policies will need to come with robust sustainability schemes and incentives to moderate travel demand. It is therefore crucial to put sufficient resources into energy options, potentially including biofuel options, that do not come in competition with land for nature and food security.

BOX 25 - Continued

- While the science is clear about the comparative carbon benefits from using a hectare of land to regenerate forest versus produce bioenergy, the economic mechanisms to ensure optimal allocation of land still need to be put in place whether for forest protection or bioenergy. Hence, the argument presented in this report for a strong, determined push to formalise and enforce forest and other natural ecosystem protection and restoration, and to develop high-quality REDD+- and national payments for ecosystem-markets, both internationally and domestically, to drive appropriate land allocation and create alternative rural incomes and livelihoods.

This report recommends that while more advanced forms of bioenergy, including from waste, can likely play a modest though potentially important role in decarbonisation over the next 30 years, the focus of bioenergy efforts must be on forms of bioenergy that do not, or only minimally, increase pressure on land. For both environmental and economic cost effectiveness reasons, at no point should bioenergy be allowed to drive deforestation or other conversion of natural ecosystems, or to get in the way of degraded land restoration.[x] Existing bioenergy mandates, targets and incentives for crop based-biofuels should be phased out as is, and new policies introduced which better account for potential risks including adverse effect and risks of conversion of natural ecosystems and high carbon stock, including through land diversion. Inefficient sectors (low yielding or carbon-saving crops, feedstocks associated to deforestation) should be phased out of these policies, and incentives redirected towards more advanced bioenergy – including waste-based –or other renewable technology research and development, or tropical forest protection and regeneration.

Bioenergy plus carbon capture and storage (BECCS) could be a different story, because it actually removes the greenhouse gases from the atmosphere. It has therefore been used in a large number of scenarios of mitigation efforts needed to limit global warming to 1.5-2.0 degrees Celsius. On the condition of high energy yields, low losses of biomass between harvest and use and high carbon capture rates, BECCS could generate more carbon savings per hectare than reforestation and could continue to generate savings longer.

The Better Futures scenario of this report does not require the use of BECCS because it is based on a low-energy demand (LED) scenario.[92] However, if the necessary energy efficiency gains (or decarbonisation of the energy system) to stay on a 1.5-degrees pathway by 2040 are not realised, extraordinary measures will potentially have to be taken. In such a case, if and where these conditions for preferring BECCS to reforestation could be achieved, BECCS might be advisable deployed as a 'back-up' option to generate negative emissions. However, these specific conditions must be fulfilled, and even then BECCS would be more expensive than reforestation and come at a cost to biodiversity.

Fortunately, the BECCS choice does not have to be made now. Assuming land can be freed from agriculture, reforesting this land first could be cheaper and provide more benefits. If BECCS is ultimately deemed necessary and efficient, some of these forests could then be harvested and used for that purpose, and the areas be converted to fast growing biomass plantations.

Although this 'back-up' BECCs option keeps the world on a 1.5 degrees pathway, it does so at the expense of biodiversity. In the Better Futures scenario, a recovery of the biodiversity intactness index (see technical annex for description of this concept) is achieved due to protection and restoration of forests and other natural ecosystems. Switching to a BECCs solution would see a reversal of that gain from 2040, and this would continue to trend downwards through to 2100. BECCS, then, may at some point be a necessary last resort to avoid climate catastrophe, but it would involve significant trade-offs and every effort should be made to minimise its deployment. It is, moreover, an unproven technology at any meaningful scale, with poorly understood risks, and as of today, very expensive. If, by 2040, the need for extraordinary climate change mitigation measures becomes clear – far from an unlikely scenario – a thorough and timely analysis of BECCS versus other potential approaches in terms of effectiveness and efficiency must be completed. In the meantime, massive efforts should be directed at other potential solutions (e.g. direct air capture) with better environmental footprints.

[x] The 2019 IPCC Climate Change and Land report highlights that food security may be threatened if land-based bioenergy displaces crops and livestock, with associated risks to terrestrial ecosystems and water scarcity. It also estimates that if the global area dedicated to bioenergy production is less – under some circumstances far less – than 100 million hecates, there will be low to moderate risks to food security, land degradation and desertification.[93]

Priority actions

Success in this transition depends fundamentally on successes in other transitions, notably reducing pressure on land through changing diets, increasing agricultural yields and making more efficient use of land through regenerative farming. However, this will not automatically translate into protection and restoration of forests and other natural ecosystems. Success in this transition will require direct interventions, including measures to overcome the barriers described above.

The essential tools to protect and restore forests and other natural ecosystems are under the control of governments, both national and often subnational. So the jurisdictional approach – a series of different incentives and interventions as described below, targeted simultaneously towards the jurisdictional level – is generally accepted to have the greatest chance of success.[94] The UN climate change convention has recognised this in its REDD+ framework (see Box 26).

To achieve a transition to protecting forests at speed and scale, the global community needs to work on five priorities:

Establish and enforce protection and restoration of forests and other natural ecosystems

Forests and other natural ecosystems are public goods. Government action is needed to protect them. This means putting in place national spatial planning capacity to deploy land to its most socially effective use, and not selling or handing out publicly owned forests. It means developing appropriate forms of protection, including regulations and strict sustainable use regimes, and passing moratoria on converting forest to agricultural land. And it means strictly enforcing these measures.

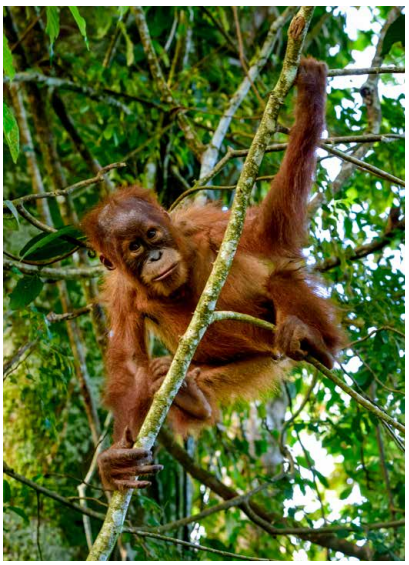
One proven form of forest protection that could be rapidly scaled – and has potentially outsized potential – is granting indigenous peoples' groups legal title to their traditional lands, and the means to defend them. Traditional protected area networks are also crucial, as is setting aside and policing areas for natural forest and ecosystem restoration, in particular the edges of forests. For all categories of protection, it is essential that regulations and enforcement protect both the ecosystem and the full variety of biodiversity thriving there. For example, the decimation of large mammal populations in parts of the world must be halted because of their intrinsic value and because the functioning of ecosystems depends on their continued presence (see also the recommendation in this report to establish a Global Alliance Against Environmental Crime).

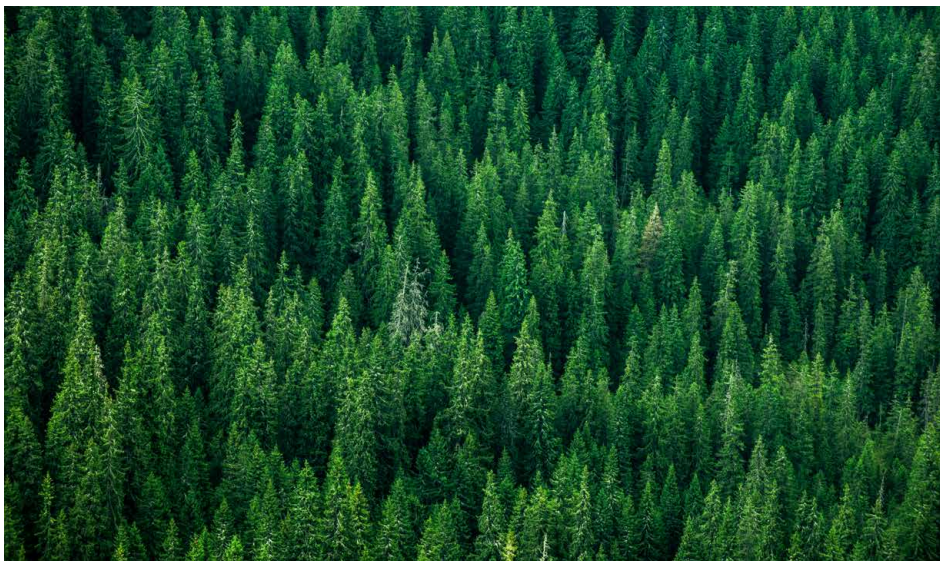
Supplementing regulations and enforcement, public finance needs to be redesigned to avoid perverse incentives for forest and ecosystem conversion. This involves reforming agricultural subsidies (see Box 21 on the impact of removing cattle subsidies in reversing Costa Rica's loss of forests), public procurement, tax regimes and transfer mechanisms. Where practical, public finance should be designed to promote forest protection. For example, governments – as well as multilateral development banks and private financiers – could tie low-interest credit to protection of forests, as Brazil has done. International development assistance for agriculture can also be linked to assistance for forest protection and restoration. And support for productivity gains should also be linked with efforts to protect natural ecosystems from further conversion to agriculture.

Extend payments for ecosystem services

To halt deforestation and other ecosystem conversion, large-scale payments for ecosystem services will be essential, between and within countries.

Tropical forests are located mainly in developing countries and emerging economies. Yet some of the benefits they provide, including carbon storage and biodiversity conservation, are enjoyed by all countries. The costs of protecting them should therefore be shared. The REDD+ cost-sharing scheme, which essentially provides payments for





ecosystem services to tropical forest countries from developed countries, and potentially from emerging economies, has been established by the UN climate change convention (Box 26). This report recommends scaling finance for this scheme to boost progress on this transition, starting with around $2 billion a year in 2021 and rising rapidly to reach $50 billion potentially in 2030, depending on results.

Governments would need to create and regulate markets for such markets to reach the scale required at the necessary speed. The regulations would include both determining which environmental, social and financial standards should apply, and which private sector entities should pay for which mandatory amounts of emissions reductions. The private sector could play a critical initial role by helping markets emerge through voluntary near-term purchasing commitments (see Box 18).

At the national level in tropical forest countries, payment for ecosystem services to farmers and communities on the forest frontier will be essential to ensure the effectiveness and political viability of measures to protect and restore the forest. In other words, farmers and communities need to see a value from keeping the forests standing. Optimal conservation benefits for a given payment, combined with mechanisms to promote sustainable rural livelihoods, should thus be key when designing payment for ecosystem services systems.

Incentives for countries with high forest cover and low deforestation present a particular challenge. Since they already have low deforestation, it is hard for them to reduce it by much. Moreover, they will sometimes be the exception to the rule that there is enough non-forested arable land to reach agricultural targets. One way to encourage such countries to maintain their high forest cover would be through higher prices per tonne of emissions reductions. Another would be to allow a reference level for deforestation/greenhouse gas emissions slightly above historical levels. Given the acute need to preserve intact ecosystems, this is a challenge that should be taken very seriously both at the international level, through REDD+, and at the national level to ensure sufficient incentives for particularly forest rich jurisdictions.

BOX 26

Reducing emissions from deforestation and degradation (REDD+)

Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (REDD+) is a mechanism defined by the Conference of the Parties of the United Nations Framework Convention on Climate Change (UNFCCC). It is designed to offer incentives to reduce emissions from deforestation and forest degradation while fostering conservation, sustainable management and enhancement of forest carbon stocks.

The relevant UNFCCC decisions on REDD+ set the main framework for payments for performance in the shape of verified emissions reductions from tropical forests. This includes provisions for measurement and reporting systems, guidelines for setting reference levels, and safeguards to ensure environmental integrity (the protection of natural ecosystems and biodiversity) and social integrity (the protection of the rights of indigenous peoples and local communities).

Going forward the REDD+ mechanisms could play a central role in achieving net zero emissions in the global economy both by driving down emissions and incentivsing additional removals of greenhouse gas emissions through forest restoration. The mechanisms could form the basis of long-term predictable arrangements for such payments, and potentially be extended to other ecosystems.

Payments would be made directly in proportion with results. For example, the target of $50 billion for tropical forests and peatlands by 2030, which this report recommends, would be based on reaching the goal of close to zero gross deforestation, accompanied by significant restoration. If the results are less impressive, the payments would be lower. Incentives should – in accordance with UNFCCC decisions – be targeted at the national or, in an interim period, sub-national jurisdictional level, and robust measures to ensure the environmental integrity of results would be essential for success.

However, while the UN convention on climate change has determined the basic framework for REDD+, its decisions are not specific enough in themselves to ensure the integrity of results and transactions. The Architecture for REDD+ Transactions (ART) and the Emergent Forest Finance Accelerator (EFFA) are designed to operationalise this framework and to catalyze financing and results at scale. Together, these initiatives have the potential to install confidence in both buyers and sellers of tropical forests emission reductions that REDD+ is now becoming a reality, and that being part of its transactions will lead to real and credible emissions reductions.

ART is a global voluntary initiative to promote the environmental and social integrity, and ambition, of high-quality carbon emission reductions from tropical forest countries. ART is overseen by an impartial global board. It includes a rigorous standard to quantify emissions reductions from REDD+ at a jurisdictional and national scale, and a comprehensive technical process to register, verify and issue high-quality, serialised credits transparently.

EFFA is a non-profit organisation that serves as an intermediary for transactions of ART credits. It provides a simple, standardised and credible method for private and public buyers to access ART credits, while providing forest countries with a guaranteed source of demand for their forest services and streamlined access to a wide range of financing sources. To catalyze both supply and demand, EFFA is designed to be able also to deploy public donor funds to provide purchase commitments through a guaranteed minimum price.

Extend deforestation-free supply chains globally

The deforestation-free supply chains movement has already stacked up some inspiring achievements on important commodities such as soy and palm oil. For example, the Brazilian state of Mato Grosso, which accounts for 85 percent of Brazilian Amazon soy production, saw dramatic reductions in forest conversion following the implementation of the Amazon soy moratorium in 2006.[95] Soy producers can choose to move to other areas without such restrictions, however, and demonstrably have. This is known as "leakage", and can be handled only by comprehensive global approaches.

Thus, achieving universal acceptance of the zero-deforestation principle and extending it to all relevant commodities will give an enormous boost to this transition, as will zero tolerance for environmental crime, land grabs, exploitation and human rights abuse in supply chains. Businesses could establish such principles throughout their supply chains and require all their suppliers to do the same. They could also educate their customers and investors on the value of forests (including their direct and indirect monetary value to production and supply chains, as well as their intrinsic importance). Financial institutions could require the companies they invest in to adhere to the same principles, rewarding high performers and disinvesting from repeat offenders. Governments could encourage the adoption of such principles by participating in public-private collaborations to promote their dissemination and implementation, such as the Tropical Forest Alliance. They could also provide free or affordable access to relevant public goods, such as the data from satellite monitoring services used for monitoring by Global Forest Watch (Box 22), as well as funding for such platforms. Civil society monitoring and campaigns can help to keep all actors accountable.[96]

Use new technology tools and networks to drive transparency and accountability

Tools and networks are needed to clarify the biophysical and legal state of the forests: what happens to them, who is responsible and who finances those responsible?

The platforms for such transparency are probably best provided by independent civil society institutions, such as the Woods Hole Research Centre or the World Resources Institute through its initiative Global Forest Watch (Box 22). Civil society should work with businesses to encourage them to offer full transparency in their supply chains and make data available on open platforms. Financial institutions should demand transparency across the food and land use value chains of companies they finance, analysing the relationship between sustainability factors and creditworthiness and rewarding high performers with improved interest rates.

Governments should lead by example and maintain full transparency on national land use planning and enforcement, including explicitly pricing in and articulating environmental costs and external factors in all land use decisions. Higher standards on transparency and accountability depend on sanctions for failing to meet them. This report therefore recommends establishing a Global Alliance Against Environmental Crime (Box 27).

BOX 27

Global Alliance on Environmental Crime

The International Criminal Police Organization (INTERPOL) and the United Nations Environment Programme (UNEP) estimate that natural resources worth between $90 billion and $260 billion annually are being stolen. Environmental crime is growing at two to three times the rate of the global economy.[97] Tackling this scourge requires coordinated political, economic and social efforts. Relevant international institutions like Interpol, UNEP and the United nations Office on Drugs and Crime could work closely with national law enforcement agencies through a Global Alliance on Environmental Crime to rapidly scale up the ability to crack down on this category of crime. Increased funding would be needed, both directly for the work of the relevant agencies and indirectly to strengthen the infrastructure needed to leverage modern technology (satellites, tracking, supply chain transparency) in this battle. Funding such an effort at scale would be an extremely cost-effective investment for ODA donors and philanthropies, for example.

Develop and scale forest frontier business models

Satellite-based analysis of deforestation reveals where and how humans are destroying the last remaining tropical forest. The main action takes place at the forest frontier, a 600 million hectare belt of land made up of three categories of land use: relatively intact natural forest, active agricultural land and degraded areas.[98] For each key land use category, a corresponding group of business models exist which are able to provide the socio-economic incentives to keep forest standing and encourage rapid restoration (Box 28).

Regenerative forest frontier businesses need to be rapidly scaled, with target compound annual growth rates of around 20 percent over the next decade. To become established, they will need innovative forms of finance including long-term, patient capital, blended-finance instruments and performance-linked payments. There are many examples to learn from. For instance, a consortium of 20 banks recently announced a $2.1 billion sustainability-linked loan to the commodity trader COFCO.[99] The banks agreed a lower rate on interest repayments, provided COFCO is able to meet a series of pre-agreed sustainability targets, including the production of fully traceable Brazilian soybeans on degraded (rather than forested) land.

BOX 28

Introducing regenerative business models

Primary forests are mostly disappearing from the outside in. Each year, millions of hectares of tropical forest edge are lost to make way for other land uses: commodity production, shifting agriculture, urbanisation. Investing immediately and decisively at this vulnerable boundary – the forest frontier – offers an opportunity to protect the vast quantities of carbon locked in the forests behind it and to try to limit global warming to 1.5 degrees Celsius.

Regenerative business models integrate the needs of society with the integrity of nature. They ensure that the natural sources of value on which society depends are renewed, rather than depleted, allowing the model to be sustainable. In tropical forests, regenerative models derive social, economic and environmental value from the protection, restoration or sustainable management of forests. In doing so, they provide tangible incentives to keep forests standing or to regrow them.

Importantly, most of these business models depend upon the regulatory and financial incentives recommended in this report being in place in order to be commercially viable at scale.

The three main categories of regenerative business model are:

- **Creating value from standing forest.** Models in this category depend on harnessing the variety, value and productivity of naturally occurring forest products and environmental services. They do not include timber plantations or other forms of man-made plantation forests. When implemented, high-value, low-intensity value chains are created: products and services produced by intact forests deliver high market value per unit and can be generated or harvested with minimal impact on the ecosystem. Examples of business models within this category include forest protection efforts to be compensated through payments for ecosystem services (the REDD+ market alone could potentially be worth $50 billion in the next two decades),[100] wild forest production (honey, nuts, pharmaceutical products) and ecotourism.

- **Sustainable agricultural production-protection.** These models involve increasing the productivity and reducing the environmental impact of agriculture in forest landscapes. Improved practices (particularly sustainable intensification) are combined with land use planning, robust local governance and incentive and reward mechanisms for forest protection. The result is increased productivity per hectare, the protection of forest with the highest conservation value and sometimes the restoration of degraded land. Examples of business models within this category include the sustainable production of commodities such as palm oil and cocoa, and the production of crops such as coffee using "climate-smart", shade-grown techniques.

- **Creating value from forest regrowth.** These models focus on restoring degraded land to a state as close as possible to natural forest. They use diverse regrowth mixes that increase above- and below-ground biodiversity and biomass. They do not include monocultural plantations. By mimicking natural ecosystems and using species suited to specific environmental conditions, forest regrowth models can stimulate environmental and economic productivity. Examples of business models within this category include replanting native natural forest for compliance or voluntary purposes (such as compulsory or voluntary corporate social responsibility commitments). A modified version of the latter involves tailoring regrowth to maximise its productivity, using a broad mix of native seeds but focusing on species from which a commercial revenue can be derived, such as sugar palm or rubber. Such near-natural "forests with a cash flow" have yet to be planted on a large scale but may expand rapidly because of the revenue streams and rich ecosystem services they could deliver.

Transition costs

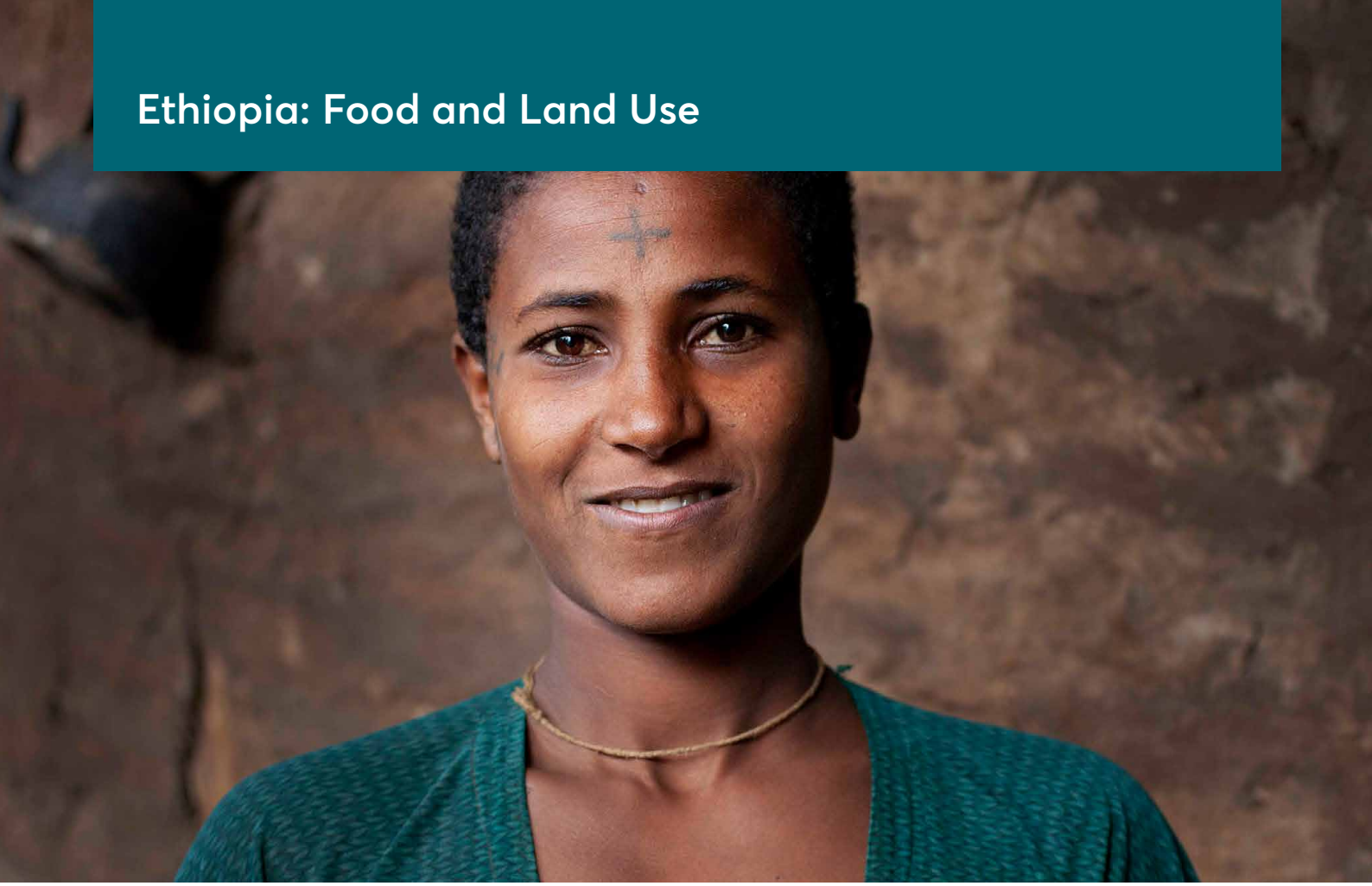
The global costs of this transition break down into the costs of forest protection and its enforcement and the costs of ecosystem restoration. There are good models of host countries and donors sharing the costs of protection and enforcement. For example, in the Brazilian ARPA programme various donors, including international development aid agencies, help Brazil to cover the costs of administering new protected areas.

The cost of restoring an ecosystem depends on circumstances and geographic location. High costs can be a barrier to rapid, widespread restoration, which is why finding ways to produce a reasonable return from restoring forests would be potentially transformational. Current public and private spending on research and development (R&D) could be redirected to R&D for new forest frontier models. Regenerative forest businesses will also be eligible for official development aid, given their large positive knock-on effects on rural livelihoods, economies and resilience.

Scaling up REDD+ to $20-50 billion a year – which could be funded largely by regulating high-emitting companies to purchase environmentally robust emissions reductions from tropical forest countries – will be an essential source of capital targeted mainly at reducing deforestation.[xi]

[xi] The social value of reduced greenhouse gas emissions from forests alone would – given eight gigatonnes of carbon dioxide equivalent mitigation and an assumed social value of emissions reductions of $100 per tonne of carbon dioxide – be worth $800 million a year. In other words, 16 times the cost of the REDD+ scale up if the full potential of tropical forests is realised.

Ethiopia: Food and Land Use



Balaynesh Kasa farms hops at a watershed restoration and homestead development in Bahir Dar, the Amhara Region of Ethiopia. This provides her with enough income to support her family and send her four children to school.

Context

With a population of 112 million people, Ethiopia is the second-most populous nation in Africa and the fastest-growing economy in the region. Despite persistent efforts over the past half century or more by various governments to transform the country from an agriculture-based economy into a manufacturing hub, agriculture remains the most important sector, contributing to almost half of GDP, 83.9 percent of exports and 80 percent of total employment.

Food and nutrition security remain a core challenge, despite impressive economic advances. Some 29 percent of people suffer from micronutrient deficiencies. Weather-related drought remains one of the key causes of food insecurity, contributing to high rates of chronic malnutrition that cost the country 16.5 percent of GDP each year. Exacerbating this are rates of post-harvest food losses reported to range from 30 to 50 percent.

Broader economic losses attributable to land degradation associated with land use and cover change in Ethiopia are estimated to be in the order of $4.3 billion a year. Similarly, continuing high rates of deforestation and land degradation threaten the natural resources on which many Ethiopians depend.

Critical transitions

The Ethiopian government is committed to action across nine of the ten critical transitions (excluding the ocean). Among its priorities are the following four:

1

Healthy diets. While good progress has been achieved in reducing chronic child under-nutrition in Ethiopia, levels are still high. A greater supply of and access to protein, fresh vegetables, fruits and legumes could boost diet diversity with positive health impacts for children and pregnant women in particular. Existing government and community programmes to end child malnutrition can be further scaled up. Future agricultural commercialisation and agro-processing can increase the supply of safe food including protein, fresh vegetables, fruits and legumes. Policies and incentives can be put in place to encourage the consumption of healthy food and the avoidance of unhealthy habits.

2

Productive and regenerative agriculture. Through its Agricultural Transformation Agenda, Ethiopia has embarked on a nationwide effort to commercialise smallholder farming and pursue more sustainable and regenerative agricultural practices, ensuring that the country optimises its use of land in accordance with soil type and meteorological conditions. In designated Agricultural Commercialisation Clusters, FOLU is collaborating with the Agricultural Transformation Agency to pilot models that encourage sustainable agricultural commodity production through innovative value chain alliances, and incentives that encourage sustainable resource management within agricultural landscapes. The commodities involved include barley, wheat, sesame and teff (a fine grain), and interventions include linking farmers' cooperatives to special economic zones.

3

Protecting and restoring nature. Ethiopia has been a global leader in landscape restoration, including a recently launched, massive tree planting campaign. Coupled with a renewed effort to protect remaining standing forests (and other ecosystems of value), this will provide immediate benefits to rural land users and is essential to secure viable food and land use systems for coming generations. Commercial opportunities lie in encouraging markets for sustainable wood and forest products, establishing deforestation-free coffee landscapes and value chains, and providing incentives for water-related ecosystem services.

4

Food loss and waste. The bulk of food loss and waste occurs between harvest and arrival at the processor or manufacturer. This inefficiency wastes millions of dollars every year, undermines farmers' incomes and exacerbates food and nutrition insecurity. There is so far no robust national data available on this issue, even though it is expected to become increasingly important with anticipated shifts in rural-urban demographics, diets and consumption patterns.

Ethiopia can pursue a two-step approach to make its food system more efficient. The first step is to reduce post-harvest loss for agricultural commodities prioritised under the Agricultural Transformation Agenda. Second, the country needs to measure and report loss and waste systematically across all agricultural commodities and use the data to develop national strategies and guide public and private sector commitments to action.

Mekle Wunete, beneficiaries of The Debre Yacob Watershed Learning Restoration Project in Bahir Dar, Ethiopia. She says, "We are benefiting so much! All my expenses are now covered. Before I was thinking we would have to move because there was nothing here, now there is everything."

Dr Birhanu, Research Directorate Director at Gullele Botantical Gardens, Addis Ababa, Ethiopia. Photographed with Commiphora Monoiccao, a critically endangered plant whose oil may be used to treat wounds.

Critical Transition 4.
Securing a Healthy and Productive Ocean[xii]

	Better Futures Additional Investment Requirements 2030 *(USD billions)*	Better Futures Business Opportunity *(USD billions)*	Economic Prize from Hidden Cost Reductions *(USD billions)*	
	2030	2030	2030	2050
A Healthy & Productive Ocean	**$10**	**$345**	**$350**	**$785**

A healthy diet for over nine billion people will require about 85-90 million metric tonnes (MMT) of edible-weight[xiii] ocean protein annually by 2050.[101] Today, the world produces half of that amount. The total wild fish catch is 46 MMT (forecast to decline to 40 MMT if overfishing continues).[102] Ocean-based aquaculture adds only ten MMT because it is heavily constrained by the availability of feed, which is also largely sourced from fish.[103] The total numbers amount to less than ten percent of global animal food supply.

This makes little sense at a time when land is under such pressure, since the ocean produces about the same volume of plants as the land but converts them to protein much more efficiently. Clearly, producing more protein from the ocean is possible and advisable – for human health,[xiv] food supply, the environment and the health of the ocean.

Ocean productivity and ocean health can be two sides of the same coin. Wild fisheries produce best when they are sustainably managed, even in the short term. Sustainable fishing and aquaculture can make their full contribution only if essential habitats – estuaries, wetlands, mangrove forests and coral reefs – are protected and restored and if nutrient and plastic pollution is reigned in. Aquaculture, when done right, can produce protein with much lower carbon and land footprints than the typical mix of land-grown meats. And healthy coasts and wetlands are essential for ocean productivity.

[xii] This chapter does not include land-based aquaculture, as this is structurally much closer to agriculture than ocean-based fisheries.

[xiii] All metrics here are in edible weight – e.g. the weight of the fish that ends up on a plate, rather than the landed weight. They also do not include fish caught in illegal, unauthorised or unregulated fashion, which may be as much as another ten MMT, and the weight of discards and by-catch, which vary widely by species (from zero to 10x the landed weight).

[xiv] The health implications of eating fish, though overall positive, are highly complex. They are fully considered in the EAT-Lancet global diet recommendations, which provide the baseline for this discussion.

Goals and benefits

The prize is considerable:

- **Environment.** This transition, properly managed, could relieve pressure on terrestrial protein production and achieve major benefits in terms of greenhouse gas emissions, biodiversity, climate resilience and overall system integrity.

- **Health.** As with the transition to alternative proteins (Transition 5), the real gain here is the potential to increase sustainable protein supplies by encouraging more fish consumption over other protein sources.

- **Inclusion.** The restoration of fish stocks would add $53 billion[104] to the world economy in terms of landed value – considerably more if the entire value chain were included (for example, Icelandic cod products retail for five times the landed price.).[105]

- **Food security.** Sustainable sourcing of ocean protein diversifies nutritious food supplies, particularly for poorer communities that depend disproportionately on fish for their protein consumption. Diversification also reduces risks from simultaneous breadbasket failures (see Chapter 2).

The annual economic gain from this transition is an estimated $350 billion by 2030, and $785 billion by 2050. A reduction in environmental costs of $180 billion a year by 2030 would be the biggest driver of the gain.

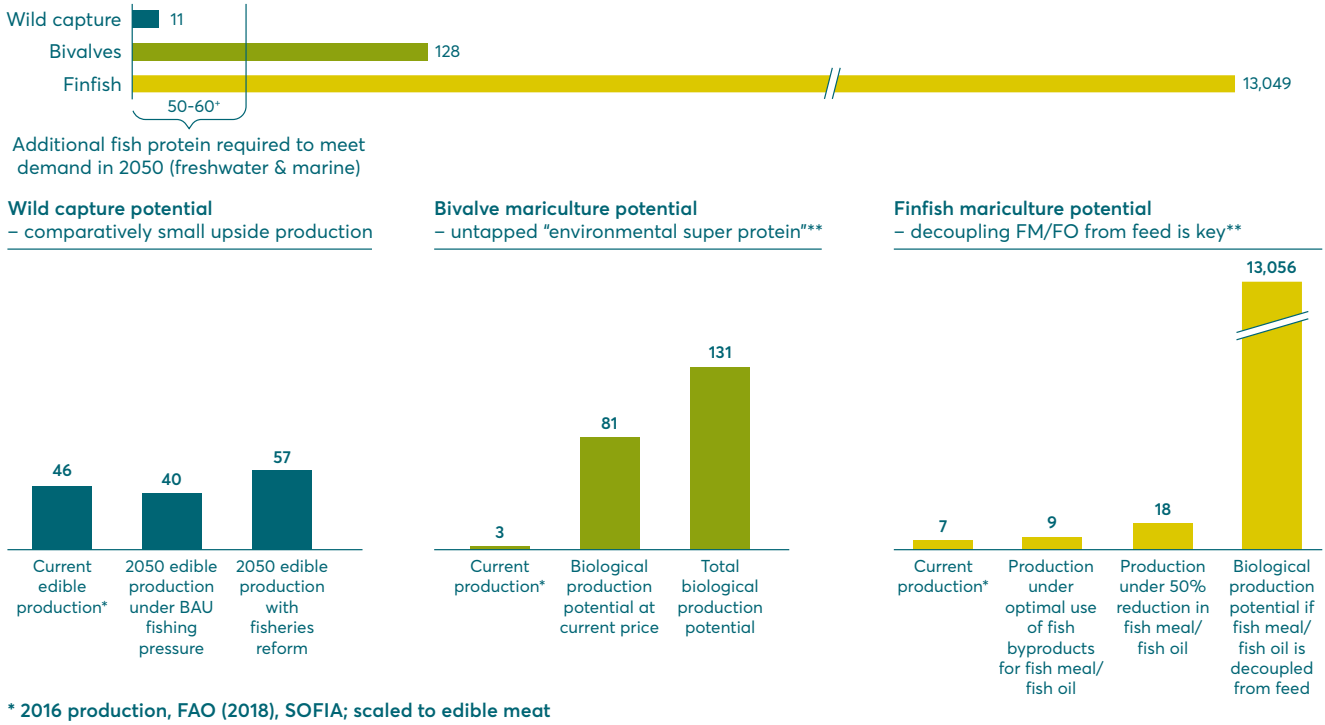
Capturing this prize depends on integrating the dimensions of production, allocation and equity, and protection (see Exhibit 23). On the production side, overfishing and illegal fishing needs to end. This would improve current yields by 11 MMT per year by 2050.[106] The farming of ecologically benign, filter-feeding molluscs (mussels and oysters) needs to increase.

EXHIBIT 23

Meeting global seafood production goals means recognising the mariculture potential

Million metric tonnes (MMT) edible weight

Comparing current production to maximum biological production potential



*** 2016 production, FAO (2018), SOFIA; scaled to edible meat**

**** Values are at current price of $1,296 per ton for wild capture, $1,700 per ton for bivalves, $7,000 per ton for finfish**

† Approximate range – assumes same live to edible weight conversion ratios.

Source: Estimating the Ocean's True Potential for Feeding the Planet, emLab, University of California, Santa Barbara, 2019

There are no bio-physical constraints on boosting current annual production of 2.6 MMT by a factor of 30. Lack of demand is the only drag on expansion. Finding alternative feed ingredients for fish farmed in the ocean is essential to reduce the need to "feed fish to fish". Some 18 MMT of farmed fish can be produced if the fish oil/meal content of their feed can be halved, and if all fish processing by-products go into fish feed production.[107] The quest for new feed sources and technologies and for low-impact fish farming technologies looks promising.

On allocation and equity, the needs of the artisanal sector are the priority. Some 90 percent of all fishers are artisanal. They provide over half of the global catch, 90 percent of which is consumed locally.[108] Their overfishing and pre-emption by commercial fishing interests can trigger severe humanitarian and food security concerns. There is no more important objective in this transition than to restore artisanal fish stocks to sustainable levels and restore food security and employment to coastal communities in the developing world.

On the protection side, health and productivity need to be tied together. Priorities to achieve by 2030 are restoring fish stocks to the healthy levels that sound economics demand, boosting tropical fish stocks by restoring 50 percent of former mangrove forests and eelgrass beds, and using the expansion of fish and mollusc farms, which require pristine waters and estuaries, to boost coastal protection and restoration efforts. By 2050, a 90 MMT protein production system will require the ecosystem services of a finely tuned network of protected areas, and an end to eutrophication fuelled by nutrient-run off from land-based agriculture.

The natural resource and overall economic efficiency of producing food from the ocean makes its own case: mussel farms use almost no land and emit no carbon dioxide, and well-run finfish farms can compete with the most efficient poultry operations.

Priority actions

Ensuring that governments, consumers, commercial fisherfolk and fish farmers, investors, and artisans benefit from the yields provided by a healthy and resilient ocean depends on tackling a set of regulatory and market failures. To achieve a transition to a sustainable ocean at the speed and scale needed, they need to work together on eight priorities.

Reform wild fisheries

Fishery reform is impossible without rules to protect stocks and allow for an efficient, fair and equitable allocation of catch. Commercial rights to fish need to be predicated on a plan to fully restore the target stock within ten years. Catch must uniformly be restricted to a level commensurate with maximum sustainable yields. Fishing rights must be allocated fairly to provide food security to artisanal fishing communities, and to align the economic and ecological goals of commercial fishers. In the developing world, this is hard to do. The data and governance capacities are still lacking. However, these fish-dependent nations are increasingly committed to reform. Their efforts could be accelerated by:

- **Providing titles and access rights.** Artisanal fishers need secure and exclusive rights to the fish stocks traditionally under their communal control. Commercial fishermen require a reliable registration of access rights to optimise their catch and fleet structure. Methods for defining, registering and trading assets and rights are quite advanced. But "free access" rights that forbid local fishers' control and stock ownership are still in force in many nations and need to be adjusted.

- **Packaging new technologies into fishery solutions.**[109] New sensing, tracking, mapping, simulation and ledger technologies can revolutionise fishery management in the developing world. The technologies are already available but applying them requires careful integration and customisation of the different tools. A network of technologists, system analysts, local technocrats and fishers is needed to design pragmatic packaged solutions in the areas of, for example, fishery simulation, fleet control, chain of custody tracking, and registering title and rights.

- **Innovating in insurance and finance.** New approaches and business models are needed for insurance against catastrophic events affecting fisheries (storms, warming events, reef collapse), and for compensating poor fishermen for cost of fish stock recovery.

- **Eliminating harmful subsidies.** Subsidies directly supporting fishery capacity currently amount to $20 billion. They need to be eliminated or redirected towards fleet control infrastructure and port improvements. This is because the most efficient and profitable fishing occurs at maximum sustainable yield levels. Capacity-enhancing subsidies distort this balance – they make fishing efforts in excess of maximum sustainable yield profitable and thus lead inexorably to overfishing. The most promising vehicle for eliminating harmful subsidies is a WTO-led agreement on fisheries subsidies.

Reform finfish aquaculture

- **Rewriting the rules.** Finfish aquaculture is underdeveloped, under-invested, over-regulated and constrained by the need to "feed wild fish to farm fish". Governments need to give feed developers clear targets (performance specifications), strong incentives (feed efficiency standards) and guaranteed demand (feed standards for government seafood purchases). Processes for awarding permits to farm fish need streamlining in light of new containment, vaccination and waste management technologies, without compromising strong, independent oversight. In addition, governments can support innovative model farms.

- **Increasing investments.** Investors need to recognise that new vaccine delivery, new feed and stronger breeding and genetics are making aquaculture investment-ready. The sector offers a range of opportunities in AI, genetic engineering and advanced technologies of the kind attractive to venture capitalists and corporate investors. Blended finance instruments are already used by China and Norway to advance large-scale aquaculture.

- **Making the case for fish to consumers.** Additional production of farmed finfish is more likely to meet new protein demand from younger generations than to replace meat in the diets of older people. But younger consumers still do not treat aquaculture finfish as a substitute for poultry, pork and beef. A stronger case for seafood needs to be launched. Civil society can play a key role in this as the problems of sustainable feed and sustainable production are solved.

There is a lot of coordination, negotiation and risk sharing required for this transition. Much of it will only happen when significant self-interest – the "use case" for each actor in ocean food production systems – makes this compelling. There are three main arguments for optimism. First, the current crisis in fisheries, especially in developing countries, is increasingly untenable. Political pressure is mounting to protect the food security of the most exposed populations. Second, new data and communication technologies can tilt fishery management, trade standards and consumer preferences decidedly towards greater transparency and better performance. Third, fishery and ocean management institutions are under unprecedented pressure to do things differently. They seem likely to rise to the challenge, given their considerable improvement in the past decade.

BOX 29

Producing omega-3 fatty acids from natural marine algae

Fish are a healthy source of protein. They contain omega-3 fatty acids that support human brain, eye and heart health. In 2018, the Dutch multinational company DSM and the German chemicals company Evonik teamed up to develop fish feed from algae. Veramaris is the first viable alternative to fish oil in fish feed. One metric tonne (MT) of Veramaris algal oil, produced through waste-free fermentation, saves 60 MT of wild-caught fish.

Owing to this collaboration, farmed salmon can have diets rich in omega-3 without fish oil. Not only does this keep the salmon healthy, it makes them a more sustainable source of omega-3 and protein for people.

India: Food and Land Use

Workers harvesting bananas in the fields at Tandalwadi village in Jalgoan, India.

Context

India is home to about 17 percent of the world's population, 15 percent of its livestock, eight percent of its biodiversity, nine percent of its arable land, and four percent of its water resources. While India is self-sufficient in food production, 39 percent of its population is under-nourished and it ranks 103 out of 119 countries in the 2018 Global Hunger Index. Small and fragmented landholdings, poor access to credit and modern inputs, high dependence on rainfall, and inadequate processing infrastructure are key constraints. Capital investments in agriculture have a bias towards irrigated areas, with rural employment programmes being seen as the main solution to the crisis facing rainfed and dryland areas.

Climate risks to food security, livelihoods, water supply and human well-being are projected to increase with rising temperatures. Changes in rainfall patterns, along with heatwaves and reduced availability of water, could lower farm incomes by 20 to 25 percent in the coming decades.

Agriculture contributes about 17.4 percent of Gross Value Added (GVA) and 12.8 percent of total exports. Some 70 percent of rural households depend on agriculture, with 82 percent of farmers being small and marginal. Forest cover accounts for 21.5 percent of the country's area, with trees outside forests contributing a further 2.8 percent of green cover. Forests are the lifeline of at least 250 million Indians who depend on them for food, fuel, fodder and non-timber forest products. At the same time, degradation affects one-third of the land, at a cost of about 2.5 percent of GDP.

Critical transitions

All ten critical transitions are addressed in national government policy. The following four are priorities:

1

Healthy diets. To tackle lifestyle diseases, the Eat Right Movement, launched by the Food Safety and Standards Authority of India in 2017, ushered in a new food culture by nudging businesses and consumers to cut down on salt, sugar and trans-fats. The government passed a National Food Security Act in 2013 that provides legal entitlements for food and nutritional security. This includes the Midday Meal Scheme for schoolchildren, an Integrated Child Development Services scheme for expectant and lactating mothers and their infants, and a Public Distribution System to ensure food grains are available at affordable prices to poorer families.

2

Productive and regenerative agriculture. Recognising the effects of input-intensive and environmentally exploitative agricultural production, as well as the adverse impacts of climate change, the National Mission on Sustainable Agriculture has laid out the broad contours of a plan to transform agriculture. Several state governments have taken strong action in recent years to promote sustainable practices, including a Zero Budget Natural Farming programme in the state of Andhra Pradesh.

3

Protecting and restoring nature. The government has set domestic targets, including under the National Mission for Green India to restore, maintain and improve forest cover. The Forest (Conservation) Act of 1980 contains stringent provisions against diversion of forest land for non-forest purposes, but its implementation is coming into increasing conflict with infrastructure development, urbanisation, mining, power generation and shifting cultivation. The 14th Finance Commission of India has established the largest ecological fiscal transfer in the world, through horizontal tax devolution and incentives to states to protect and restore their forests.

4

Stronger rural livelihoods. Several policy measures aimed at increasing farmers' incomes, as well as reducing the cost of cultivation, have been launched by the government, including improved resource efficiency (more crop per drop), drought-resilient seeds and nutrient use, integrated pest management, promotion of agroforestry, in situ conservation of biodiversity to tackle climate change, and expansion of integrated farming systems. The National Rural Livelihoods Mission of the Union Government, for instance, is creating self-help groups to increase opportunities for women in agriculture and create livelihood opportunities in off-farm and non-farm sectors.

During the village meeting at Sagai village, farmers compare satellite images of Kanji village prior to the community being awarded communal rights to the forest (in 2009) and after (2017) to assess their initiatives to enhance forest cover.

Men and women working in the fields of Kahansingh Bhai in the Sankdi village in the Narmada district of Gujrat, India.

Sankli village in Sagai forest in Narmada district in Gujrat, india. Land rights were reinstated to the community members of this village, enabling them to restore and protect the land and forests they depend on, greatly increasing tree cover.

Critical Transition 5.
Diversifying Sources of Protein

Diversifying Protein Supply

Better Futures Additional Investment Requirements 2030 *(USD billions)*	Better Futures Business Opportunity *(USD billions)*	Economic Prize from Hidden Cost Reductions *(USD billions)*	
2030	2030	2030	2050
$15 - 25	**$240**	**$240**	**$480**

Rapid development of diversified sources of protein would complement the global transition to healthy diets, with all its advantages. Over the next decade, three categories of alternative proteins can be scaled up: plant-based meat substitutes, proteins from insects, algae and worms, and proteins grown in the laboratory or "clean meat". These could compete with traditionally raised beef and other animals on price, offering consumers competitive alternatives to meat and dairy that will often be better for human and planetary health. Their development could also reduce demand for crops to feed to animals, cut land and water use and reduce methane and carbon emissions.

Goals and benefits

These diversified sources of proteins are new products, but which are facing new challenges. For example, it is not necessarily the case that non-animal sources of protein are good for human health, and they should be kept to the same standard as other products in respect of, for instance, HFSS (high in fat, sugar and salt) content. But it is safe to assume that experiments with alternative proteins will continue, and that they will deliver the following benefits.

- **Environment.** Alternative meats at scale will reduce requirements for agricultural land, lower the pressure on forests and other natural ecosystems and create space for more ecosystems restoration.
- **Health.** Increasing the supply of affordable proteins will contribute to human nutrition and health, with particular benefits for child and maternal health in poorer households.
- **Food security.** Alternative proteins can be produced in a wide range of locations using new technology. This means they could improve food security in food-importing regions. For example, many protein-importing countries in the Middle East could be excellent locations for producing laboratory-based insect and algae proteins.

The annual economic gain from this transition is an estimated $240 billion by 2030, and $480 billion by 2050. A reduction in public health costs of $130 billion a year by 2030 would be the biggest driver of the gain. The economic gains associated with this transition could scale rapidly as technologies improve and costs fall, mirroring developments in the renewable energy sector.

How might this play out in practice? Alternative meats are likely to be the visible disruptors of consumer markets. Some disruption is already evident in the rapid expansion of products from Beyond Meat and Impossible Burger. However, other forms of alternative protein are likely to disrupt less visible business-to-business markets much more. For example, single-cell animal products (insulin, globulin, whey, gelatine) are easier to produce in the laboratory than ground beef, steak, or milk, and will soon compete on price with proteins used in protein-fortified foods. At the same time, protein products derived from highly processed insects, algae and worms will become more broadly marketable, ranging from finely milled protein flour to Omega 3 and protein products for aquaculture feed.

Consumers will not see these changes in business-to-business protein supply, making it feasible that alternative proteins will significantly alter the economics of industrial red meat and dairy production without any major changes in consumer preferences. By some estimates, laboratory-grown alternatives to animal products such as insulin, globulin and milk proteins (whey, casein) could potentially be only a decade away from cost competitiveness, with more complex meat products a few years behind, making them a target for the various laboratory-based protein start-ups that have been growing rapidly.[110]

The insect protein market is also becoming established and has now reached an estimated worth of almost $1 billion.[111] The combination of high nutritional value, ease of production, safety attributes (for example, the low risk of transmitting animal diseases to humans) and simple substitution for proteins used to fortify existing food products is contributing to the market's growth. Asia, where many consumers already accept insects as food, is the largest regional market with crickets as the single largest insect protein source. However, growth is accelerating around the world, including in sub-Saharan Africa and the United States.

Near-unlimited production of insects at very low life-cycle costs is possible, but not yet proven. There is some risk that critical know-how, once discovered, will quickly become or remain private intellectual property patented by particular big food brands, similar to new discoveries in the pharmaceutical sector. That would be unfortunate in a world that needs high-quality generic supplies of alternative proteins.

Laboratory-based alternative protein technologies may be potentially the most disruptive. But they face the risk that consumers will reject them, much as they have rejected genetically modified organisms in some markets. This could be a risk even in the out-of-sight business-to-business market.

Priority actions

To a large extent, the diversification of protein supply could be self-scaling. It already attracts venture and corporate capital. There are no insuperable regulatory barriers, although many products will need the equivalent of U.S. Food and Drug Administration (FDA) approval in key markets. Business and consumer users appear to be open to the potential benefits. And as these businesses scale, they are likely to lower their costs, making them naturally competitive with traditional protein sources.

That said, there are a number of measures that could help the entrepreneurs driving this market to achieve faster growth, with all the essential consumer and workforce safeguards in place. To boost the right kind of investment in alternative proteins, governments, the private sector and consumer groups can work on the following priorities.

Increase research and development (R&D) spending for public knowledge

Public sector support for R&D in alternative proteins should increase on condition that the resulting intellectual property remains in the public domain. In principle, alternative proteins could make a significant contribution to equity by lowering the cost of proteins and making them affordable for low-income consumers. But there is a risk that most of the R&D will focus on products targeted at developed economies and higher-income consumers, similar to the pharmaceutical industry. Public support for R&D in this area should focus on the search for alternative proteins that might have large benefits for lower-income consumers.

Build consumer trust

Consumers will have legitimate concerns about the safety and health effects of new food ingredients, especially laboratory-grown and synthetic proteins. These could be a particular challenge to this transition. Governments and the private sector must act to assure consumers that alternative proteins reaching the market are safe and healthy. Developing regulatory standards for this new sector will be key. In parallel, a strategic redirection of public food procurement towards introducing alternative protein products in hospitals, schools, prisons and the armed forces can help to build public confidence in the market. Having long-term public contracts to bid for would help to establish alternative protein businesses as well.

Support the meat industry workforce

According to the North American Meat Institute, the US meat industry directly employs nearly 800,000 people.[112] Many jobs in the meat industry could be at risk from the expansion of a more diversified protein market. Support will be needed for displaced workers in the meat industry to help them move to jobs elsewhere, possibly in the more diversified and expanding local food economies described in critical transition 9.

Investors protect themselves from stranded asset risk

It is not clear to what extent alternative proteins will disrupt the food industry. This market is only just beginning to grow. However, the risk metrics currently used by food investors almost certainly underestimate the potential scale the diversification of protein markets could reach relatively quickly, the number of assets at risk of being stranded and the extent and nature of resistance from incumbents. Investors need to prepare themselves for these dynamics by strengthening their risk analysis and reallocating capital in line with the results if need be.

BOX 30

Commercial development of insects as a source of proteins

Fishmeal is the fish feed ingredient most favoured by aquaculture today. However, as seen in Critical Transition 4, demand for this product has driven overfishing and damage to ocean ecosystems. Soy is the main alternative, but expanding production of soy increases demand for farmland, driving clearance of rainforests.

Insect-derived nutrients can provide a sustainable alternative source of feed for the aquaculture industry.[113] Insect breeding is highly efficient in the following ways:

- **Land use.** Insects require little land area per tonne produced.
- **Water use.** Producing insects requires significantly less water than other livestock rearing.
- **Climate impact.** Insect-breeding emits minimal GHGs.
- **Zero waste.** Besides the nutrients retrieved from insects, by-products such as compost and skins can all be used as raw materials for other industries or as fertiliser. Insects can be fed ingredients produced from food waste and have high feed-conversion efficiency.

Protix is the first company delivering insect-derived proteins reliably and in large enough volumes to serve the fish industry. Having gone from start-up to large-scale producer in ten years, Protix is an example of how quickly alternative proteins might scale.[114]

Indonesia: Food and Land Use

A farmer climbs up a palm sugar tree to collect sap at a forest in Sintang regency, West Kalimantan, Indonesia.

Context

Agriculture and land-based natural resource sectors generate 17 percent of Indonesia's GDP (with GDP growth in the agricultural sector of 3.5 percent in 2017). Among farmers, 93 percent are smallholders. Some 11 million workers and their families depend on the oil palm industry, which generates 20 percent of national export earnings (equivalent to $17.7 billion a year), while 16 million work on other food crops – four million on livestock and three million in horticulture.

The ocean is responsible for eight percent of GDP. As the world's second-largest fish producer, marine-capture fisheries and aquaculture together employ seven million people and generated export earnings of $4.1 billion in 2017. Fish contribute 52 percent of all animal-based protein in the national diet.

Climate change and natural resource degradation are likely to halve potential GDP growth, from seven percent to 3.5 percent, by 2050. The negative economic impact of peat fires in 2015 was estimated at $16 billion. Deforestation, forest and peat fires and land use change are responsible for at least 55 percent of Indonesia's greenhouse gas emissions. Rates of deforestation declined significantly in 2017 and again in 2018 but remain high in absolute terms.

Indonesia has one of the world's highest per capita rates of food loss and waste, including of fish, reaching an estimated 300 kilograms per capita a year. This is the result of a combination of factors, including poor infrastructure and complex value chains between farm (or port) and fork.

High levels of malnutrition – up to one in three children is stunted by malnutrition – when taken together with obesity and diabetes, lead to GDP losses of on average two to three percent a year.

Critical transitions

National government policy in Indonesia addresses each of the ten critical transitions set out in the report. Of these, the following four have the highest priority:

1

Healthy diets. Ensuring a healthy and nutritious diet to reduce stunting and maternal and child mortality is one of the strongest political commitments made by President Jokowi for his second term in government. Particularly critical here will be nationwide policies to promote healthy diets in the first 1,000 days of life, through breastfeeding and qualified complementary feeding, in schools, communities and faith groups; to regulate advertising and marketing of sugary junk food and beverages, especially to children; and to increase investment in universal access to health coverage.

2

Productive and regenerative agriculture. Indonesia's agricultural value chains are characterised by high rates of smallholder poverty, soil erosion and food loss and waste. Innovations in value chains, such as the fast-growing e-commerce and app community, are causing a productivity revolution. Companies such as STOQO are enabling smallholder producers to supply fresh fruit, meat and vegetables directly to urban consumers, ensuring better incomes for producers and reduced loss and waste. Technological advances in oil palm plantations are increasing productivity, meaning that Indonesia can meet its oil palm expansion goals without further encroachment on forests.

3

Protecting and restoring nature. Indonesia has made its moratorium on expansion into primary forest and carbon-rich peatlands permanent, equating to the protection of an area of 66 million hectares, and an over 80 percent reduction in peat conversion in 2017 and 2018. Additionally, it has committed to the One Map policy it has instituted across government, which reconciles competing claims on the land from different sectors. The national government is exploring the establishment of an ecological fiscal transfer mechanism to maintain areas of high forest cover, as well as ongoing policy and financial support for peatland conservation and restoration.

4

Healthy and productive ocean. Indonesia has a national plan for its ocean, including a planned expansion of its marine-protected areas network and a commitment to ensure more sustainable fisheries management. To achieve these commitments will require political will, joined-up government and increased investment.

A farmer walks back to his traditional boiling station after collecting the sap at a forest in Sintang regency, West Kalimantan, Indonesia.

Women community members plant newly matured seedlings at the Cinta Raja Rainforest Restoration Site in Gunung Leuser National Park (GNLP) in Sumatra, Indonesia.

Critical Transition 6.
Reducing Food Loss and Waste

Reducing Food Loss & Waste

Better Futures Additional Investment Requirements 2030 *(USD billions)*	Better Futures Business Opportunity *(USD billions)*	Economic Prize from Hidden Cost Reductions *(USD billions)*	
2030	2030	2030	2050
$30	**$255**	**$455**	**$1,100**

Food loss and waste refers to food and its associated inedible parts that is intended to be consumed by people, but that leaves the supply chain somewhere between being ready for harvest or slaughter and being consumed. It includes food that is not eaten by consumers and is disposed of by them.[115] By weight, approximately one-third of all food produced is lost or wasted. By calories, food loss and waste runs to an estimated 24 percent.[116]

The direct economic losses associated with food loss and waste are estimated at $1.25 trillion.[117] Further to this, lost and wasted food is responsible for an estimated eight percent of greenhouse gas emissions, consumes a quarter of all water used by agriculture, and wastes an area of land the size of China.[118]

Strategies for reducing food loss and waste are central to transforming food and land use systems because of their potential impact. They could reduce greenhouse gas emissions, reduce the pressure on climate, water and land resources, and create financial savings for farmers, companies and households. They could also help to deliver nutrition-sensitive food security. For example, a 35 percent reduction in post-harvest loss of tomatoes in the Kano state of Nigeria, where 42 percent of children are Vitamin A deficient, would result in additional availability of Vitamin A for up to 1.1 million children a day.[119]

SDG12 sets a 2030 target of "halving per capita global food waste at the retail and consumer levels and reducing food losses along production and supply chains, including post-harvest losses".[120] In line with the targets set out in the 2019 World Resources Report, Creating a Sustainable Food Future, this report adopts a lower level of ambition, namely a 25 percent reduction in food loss and waste by 2050. But it is conceivable that technological advances, such as technologies to extend the shelf life of perishable food and climate-smart cold storage, could enable greater reductions.

Goals and benefits

A reduction in food loss and waste would yield the following benefits.

- **Environment.** It would remove pressure to convert natural ecosystems for agriculture, with associated benefits to biodiversity, and would reduce greenhouse gas emissions and freshwater use.
- **Health.** Perishable foods such as fruit and vegetables are particularly prone to loss and waste. More than 40 percent by weight are lost or wasted worldwide. Increased consumption of fruit and vegetables is critical to healthier diets.[121] Reducing food loss and waste would increase the availability of fruit and vegetables for consumption and release resources for more productive uses.
- **Inclusion.** Reducing loss and waste would reduce household expenditure on food.
- **Food security.** Reducing loss and waste would allow us to meet increased demand for food for a growing population without increasing production.

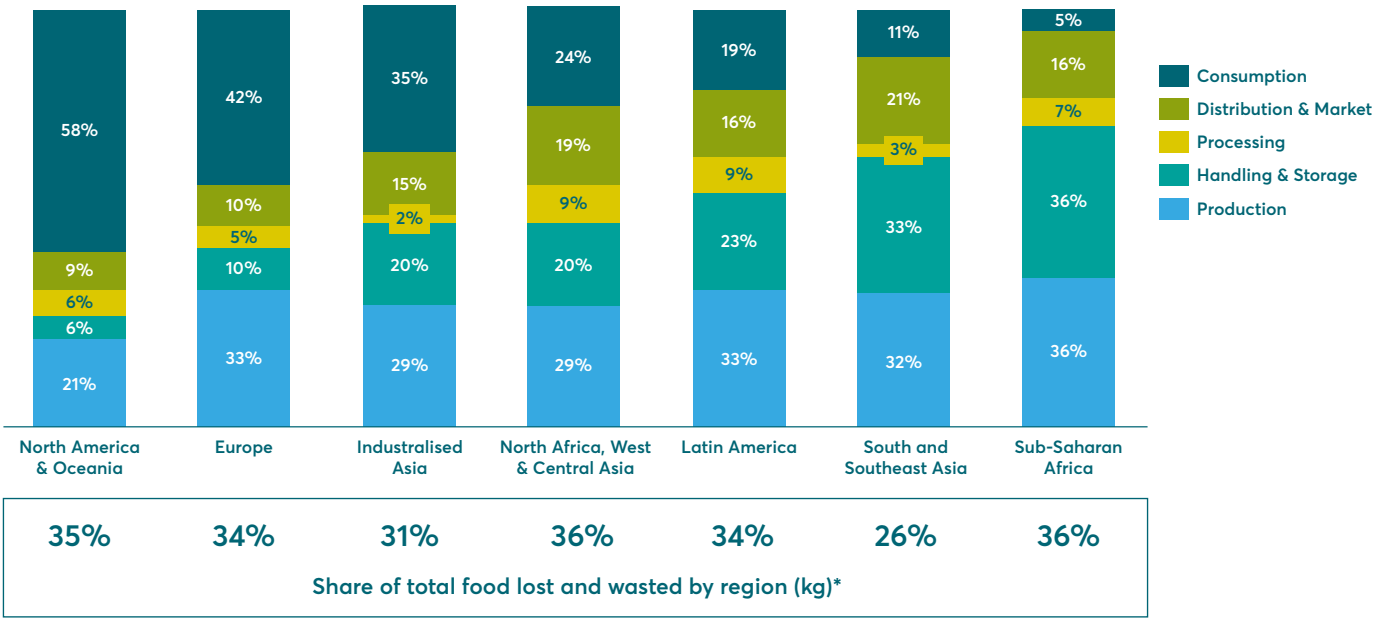
The annual economic gain from this transition is an estimated $460 billion by 2030, and $1.1 trillion by 2050. A reduction in economic costs of $230 billion a year by 2030 would be the biggest driver of the gain.

The nature and scale of food loss and waste varies across geographies (Exhibit 24) and stages of the food value chain (Exhibit 25). High-income regions have a relatively high share of food loss and waste during the consumption stage. Arguably, social norms in these areas are not strong enough to encourage food efficiency, such that high earners tend to buy more food than they need. Low-income regions have a higher share of loss and waste during handling and storage, with a six-fold difference at this stage between sub-Saharan Africa and North America, probably because of poorer logistics infrastructure, especially cold storage.

EXHIBIT 24

Distribution of total global food loss and waste by region and stage across the supply chain

Share of tonnage per region (2007)



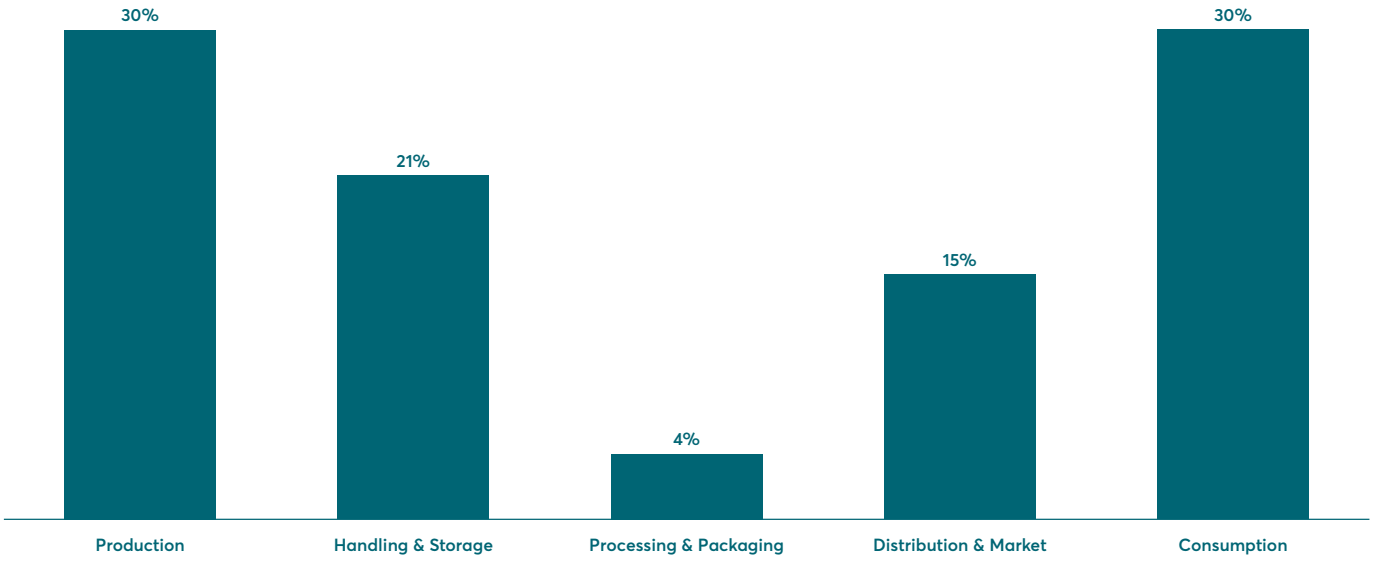
*Values displayed are of food loss and waste as a percentage of food supply, defined here as the sum of the "Food" and "Processing" columns of the FAO Food Balance Sheet
Note: numbers may not sum to 100 due to rounding

Source: WRI analysis based on: 'Global Food Losses and Food Waste: Extent, Causes and Prevention,' Rome: UNFAO, 2011

EXHIBIT 25

Distribution of total global food loss and waste across the supply chain

100% = 1.3 billion tons (2007)



Source: WRI analysis based on: 'Global Food Losses and Food Waste: Extent, Causes and Prevention,' Rome: UN FAO, 2011

Many countries are already making commitments to cut food loss and waste. By early 2019, countries that are home to 49 percent of the world's population had set targets for reducing loss and/or waste in line with SDG target 12.3. A number of countries include these targets in their Nationally Determined Contributions (NDCs) under the Paris Agreement. Côte d'Ivoire, for example, has included in its NDC a target to develop efficient mechanisation of agriculture and improvements in packaging, harvesting and conservation infrastructure. It also aims to develop storage and conservation units that will reduce high post-harvest losses.

Some governments are using "sticks" to encourage corporates to reduce loss and waste. For example, France has banned supermarkets from sending surplus food to landfill and requires stores of a certain size to sign donation contracts with non-profit organisations. Failure can result in fines of up to €75,000- or two-years imprisonment.

Various countries are adjusting their regulations to enable reductions in food loss and waste. Argentina, Ghana, Italy and several states in the United States have passed legislative measures and tax incentive schemes that make redistributing surplus food easier.[122] In 2018, the government of Ghana launched the One District, One Warehouse initiative, under which 50 warehouses will be built with capacity of 1,000 metric tonnes to provide storage for farmers and their produce. Cities are also making commitments to reduce food loss and waste. In 2018, the Pacific Coast Collaborative – comprising British Columbia, California, Oregon and Washington, and the cities of Oakland, Portland, San Francisco, Seattle and Vancouver – committed to halving food waste by 2030.[123]

Momentum to reduce food loss and waste is increasing in the private sector as well. Some 32 of the world's 50 largest food companies (by revenue) across the food supply chain are involved in programmes that have set a food loss and waste reduction target consistent with SDG target 12.3.[124] Most are food retailers and manufacturers with headquarters in Europe or North America. See Box 31 on Olam's successful food loss initiative which resulted in significant savings for rice farmers.

BOX 31

Olam and YieldWise Food Loss initiative

In Nigeria, as part of an outgrower programme around Olam's commercial rice farm and integrated mill, Olam and partners have been working with around 16,700 smallholder rice farms to improve yields for the domestic market and reduce dependence on imports.

In 2018, with research partners Sustainable Food Lab and Wageningen Research Centre, Olam brought together farmers, field coordinators and women's groups to quantify rice losses as part of the Rockefeller YieldWise Food Loss initiative. A key task was to establish a complete picture of where losses occur from farm to mill. At peak harvest time, a pilot study was conducted with field observations, farmer surveys and direct value chain measurements across 80 rice farms in four states.

Average losses were estimated at 35 percent with major hotspots in the initial harvesting stages. For farmers, this equated to an income loss of about $520 per hectare. For Olam Rice Nigeria, it was a major procurement opportunity loss, and for Nigerian consumers it was the equivalent of 97 million servings of rice. The pilot provided a testing ground on how to scale and replicate this approach and apply it to other Olam value chains and externally. During 2018, the Nigeria Rice Outgrower Initiative was recognised by the Financing for Sustainable Development Office of the United Nations as one of three high-impact success stories identified for global recognition by the United Nations Economic and Social Council.

Barriers to progress

Despite these encouraging trends, progress is too slow. There are barriers to overcome. First, food loss and waste is not yet a leadership priority in many countries or companies. Policies, including fiscal incentives and penalties, are not strong enough to drive significant changes in behaviour. In higher-income countries, food is relatively affordable, and the costs of food loss and waste are invisible to consumers. Even the catering and food services sector, which should care because food loss and waste hurt their already low margins, has been slow to tackle waste. One estimate valued food loss and waste in the hospitality and food service sectors in the United Kingdom at £2.5 billion a year.[125]

In many countries, policies on food safety, quality, labelling, packaging, trade and customs, tax incentives, agricultural extension services and the use of unsold food for animal feed or energy have the unintended consequence of encouraging food loss and waste. In addition, lack of data on the volumes, value and environmental and economic consequences of food loss and waste means that governments and companies are often unaware of the scale of the problem or the opportunity it represents. Lack of detailed data means they are also unable to identify hotspots and take targeted action. Moreover, while there are smart, cost-effective solutions, most are not getting enough finance to scale fast. There may be a case for targeting concessional or blended financing at these solutions, especially for upstream and midstream losses in developing countries.

Finally, while consumers do care about food waste, the low cost and ready availability of food in higher-income countries mean that most do not yet care enough to change their behaviour. Wasting food is not yet considered socially unacceptable in the same way as smoking indoors, littering or throwing away single-use plastics.

Priority actions

This transition will be complete when avoiding food loss and waste is the norm at every stage of food value chains in every country. To make progress at the speed and scale needed, governments, business and civil society should work together on the following priorities.

Develop ambitious national strategies

Countries need to develop national strategies with explicit targets to reduce food loss and waste. Since these strategies will be implemented from end to end of food value chains, their development will require collaboration between farmers, food processers, retailers, consumers and civil society organisations. National strategies should be linked to efforts to reduce greenhouse gas emissions as part of the NDCs to the Paris Agreement. Box 32 outlines a number of successful national public-private partnerships.

BOX 32

National-level public-private partnerships to reduce food loss and waste

In 2007, the UK government launched the Courtauld Commitment, a national public-private partnership for reducing food loss and waste. Between 2007 and 2012, the United Kingdom achieved a 21 percent reduction in household food waste. Over the period, the total cost of implementing the initiative was £26 million, while the total financial benefits to the government and citizens arising from it were worth £6.6 billion, a benefit-cost ratio of 250 to 1.[126]

Since then, national public-private partnerships have started in a number of other countries. The United States has the Food Loss and Waste 2030 Champions group.[127] The Netherlands launched the United against Food Waste public-private partnership in 2017, as part of a national agenda to halve food waste by 2030.[128] In 2018, four EU REFRESH pilot countries – Germany, Hungary, Spain and China – launched voluntary partnerships or national platforms.[129] In Indonesia, a coalition of companies, government agencies and non-governmental organisations recently launched the Food Loss and Waste Action Partnership – Indonesia.[130] And in 2018, the Australian government launched the ten-year Fight Food Waste Cooperative Research Centre, a public-private partnership that involves 46 industry and ten research partners to investigate methods for increasing food donation and developing household and business behaviour change programmes.[131]

Require larger companies to report on food loss and waste

Governments can require companies above a given size to report on their food loss and waste in the same way that they require them to report annual greenhouse gas emissions. This requirement should apply particularly to the "big waste" sectors: hospitality, catering, food processing, farming and grocery retailing. Governments should help companies to measure food loss and waste by providing funding to develop open-source data tools. Companies need these to get accurate data and to value the likely return from reducing it, and thus seal the business case for the necessary investment. Companies can lead the way by being transparent about their performance, ideally measuring progress against the targets in their country's NDCs (see action above).

Introduce more policy sticks and carrots

One policy opportunity lies in clarifying the food safety liabilities of supermarkets, restaurants and other food producers when they donate leftover food to charities. Clearer rules will encourage these businesses to contribute more. Governments can also follow France's example and take a tougher policy line. For instance, they should charge businesses significantly more for sending food waste to landfill (partly because of the methane emissions associated with organic landfill waste). These charges could be directly linked to investment in more circular approaches to waste management, ensuring that food that is no longer fit for human consumption goes to the highest-value alternative use, either animal consumption or composting for fertiliser.

Adopt voluntary corporate targets

To drive progress on national strategies, leading businesses, especially in big waste sectors, can commit to voluntary food loss and waste targets across the value chain. One approach is a "10x20x30 campaign". At least ten large downstream corporates commit to food loss and waste targets. They engage their own 20 largest suppliers to do the same, with a shared goal to halve loss and waste by 2030. This approach uses the concentration of large companies in these sectors to advantage, harnessing their scale and market power to drive change up the supply chain and across geographies. Tesco, the United Kingdom's largest supermarket chain, pioneered the approach in 2017 when it encouraged 27 of its major suppliers to establish targets, measurements and actions.[132]

Corporates can also collaborate with peers to roll out food loss initiatives across the supply chain (see Box 33 on the food loss resolution from the Global Agribusiness Alliance).

BOX 33

Food loss resolution from the Global Agribusiness Alliance

The Global Agribusiness Alliance (GAA) comprises leading agricultural companies and aims collectively to tackle the environmental and social challenges facing agricultural supply chains and rural communities. In 2017, GAA members adopted a voluntary resolution to halve their food and agricultural losses by 2030, and to work with suppliers and customers to the same end, a target aligned with SDG target 12.3.

Step up business innovation

As well as meeting corporate responsibilities, business has a strong commercial incentive to innovate. The opportunities arising from reducing loss and waste across the value chain are worth $255 billion a year.[133] One company pursuing them is Royal DSM which has created Pack-Age, a product for the cheese industry that allows cheese to mature without developing a rind that has to be thrown away.[134] Meanwhile, Protix uses food waste to feed insects for high-value protein for animal feed (Box 30 in critical transition 5). It operates in 12 countries and expects to employ over 100 people by the end of 2019.

Technology companies are also interested. Winnow, a UK tech start-up, helps chefs and catering businesses across 40 countries to reduce food waste by using artificial intelligence techniques to guide clients in adjusting menus and correcting portion sizes. The company claims that kitchens using Winnow typically see food waste halve in 12 months, saving its customers $33 million.[135]

Apps too are being used. For example, OLIO, a UK-based tech start-up with over 1.2 million users, connects neighbours with one another and with local businesses so that surplus food can be shared rather than wasted. They report having shared nearly two million portions of food, saving the equivalent of five million car miles of greenhouse gas emissions.[136]

Scale private and philanthropic investment

While there are promising examples of private finance flowing to food loss and waste ventures, the potential to scale investment is enormous. Improving efficiency in value chains in developing countries is one opportunity attracting interest. For example, ARCH Emerging Markets Partners is a private equity organisation currently raising $100 million for an east Africa cold-chain solutions fund. Through this venture, ARCH aims to help prevent fresh produce from perishing, raise rural incomes and enhance regional food security at the same time as making global exports a possibility for its storage clients.

From a commercial perspective, the venture is tapping into rapidly growing food demand and agribusiness activity in the region. Similarly, the World Bank and Fukoku Mutual Life Insurance Company has recently launched a $300 million Sustainable Development Bond focused on reducing food loss and waste.[137] Financial institutions are also using investment roundtables and competitions to boost progress on this transition. For instance, in 2018, Rabobank hosted Food Loss Challenge – Asia, an investment competition for start-up enterprises.[138]

Private philanthropy could greatly increase its grant-making and investment impact from what is currently a very low base. Financing income-sensitive, climate-smart storage technologies could be a priority. The governments of Australia, Canada, the United Kingdom and the United States have partnered with the Bill and Melinda Gates Foundation to establish AgResults, a $145 million initiative that uses pay-for-results prize competitions to encourage

the private sector to invest in high-impact agricultural innovations. The $12 million AgResults Kenya On-Farm Storage Challenge Project, which ran from 2012 to 2018, reached nearly 329,000 smallholder farmers in Kenya and sold over 1 million improved storage devices, resulting in approximately 413,000 metric tonnes of improved storage capacity.[139]

Campaign at the grass roots

Civil society and governments should leverage behavioural science to design grassroots campaigns that engage social media, religious communities and other groups in making wasting food as unacceptable as littering has become in many countries. The aim should be to stimulate a shift in social norms as large and swift as the movement against plastic pollution sparked by the Blue Planet television series.

Civil society movements can build on the distaste for waste that already exists in many cultures. Efforts to reduce food loss and waste in Japan draw on the distinctively Japanese concept of *mottainai* or regret for wasting the intrinsic value of a resource or object. In a number of countries, bottom-up, domestic-led campaigns by civil society organisations, such as Denmark's Feedback and Stop Wasting Food, have raised public awareness of food loss and waste. These campaigns have recruited celebrity chefs and other figures whom the public respects and listens to as their spokespeople to encourage a mass shift in behaviour.[140]

The Nordics: Food and Land Use

Context

The food and land use systems of the Nordic region (Denmark, Finland, Iceland, Norway and Sweden) are complex and diverse. Denmark has the largest agricultural system – covering over 60 percent of its land area and accounting for nearly one-quarter of its export value. In contrast, only three percent of Norway's land is fit for agricultural use, whereas the country is the world's second-largest exporter of seafood. Iceland is limited in its agricultural production by geographic conditions yet uses abundant and renewable geothermal energy to grow a wide variety of fruits and vegetables in greenhouses. Finland is one of the most heavily forested countries of the European Union, with its forestry sector accounting for over 20 percent of the country's export revenue. Land use in Sweden ranges from the heavily forested north to intensive interspersed agriculture and a robust dairy sector.

Across the Nordic region, unhealthy diets contribute to obesity and diet-related chronic diseases that come at a high cost to the individual and public sector. Typical Nordic diets also contribute to high overall environmental impact. Recent research shows that the production of the typical Nordic diet produces 2.5 to three times the greenhouse gas emissions, and uses approximately twice the amount of cropland, as would be considered sustainable if global food system targets were scaled down to an equal per capita scale. Notwithstanding the abundance of water in the region, it also faces important water management issues, including pollution of the Baltic Sea, owing in part to run-off from agricultural inputs. Finally, the Nordic region has high levels of food waste - approximately 120 kilograms per person a year.

Critical transitions

All ten critical transitions in the global report need to be addressed in the Nordic countries. The following five are among the most pressing:

1

Healthy diets. The Nordic Nutrition Recommendations, developed by over 100 scientists, now include sustainability considerations, and feed into a whole-of-government approach intended to ensure better nutrition across the region. A regional "keyhole label" on foods is driving healthier choices, while the Wholegrain Partnership in Denmark promotes greater production and consumption of wholegrain products. Sweden and Finland have strong national programmes to offer healthy, tasty and sustainable food in schools.

2

Protecting and restoring nature. The Nordic countries are committed to the fulfilment of the Aichi biodiversity targets on biodiversity, which will require greater investment in the extent and management of protected areas on land and sea, as well as enhanced biodiversity conservation and management across the economy. The Svalbard Global Seed Vault, housed on the Norwegian island of Spitsbergen, is a globally significant effort to protect and secure the world's biological and seed diversity in perpetuity.

3

Healthy and productive ocean. Ecosystem-based approaches to marine management – including integrated management plans and spatial planning – are being developed and implemented across the region. The Nordic countries are party to the Central Arctic Ocean agreement to prevent unregulated fishing and apply precautionary conservation and management measures in the waters of the Central Arctic. They are exploring the inclusion of explicit spatial protection commitments in their fishery management plans and the adoption of strict purchasing standards governing seafood imports. And they are seeking to pivot to more sustainable aquaculture systems, given ambitious 2050 production goals and the significant environmental impacts currently caused by aquaculture.

4

Food loss and waste. Approximately 3.5 million tonnes of food are wasted each year across the Nordic region. Each country has committed to halving waste by 2030, whether through government-led initiatives, public-private partnerships or voluntary, multi-stakeholder initiatives such as Denmark's national awareness-raising campaign, "Stop Spild Af Mad".

5

Local loops and linkages. Finland's Roadmap to a Circular Economy has prioritised food and land use for action, addressing issues including transport, phosphorus, microbiome management and reductions in single-use plastic packaging. The region is also a global leader in enhancing management of boreal forests to secure greater carbon sequestration, and in the use of engineered wood as a substitute for cement and steel in buildings.

Critical Transition 7.
Building Local Loops and Linkages

	Better Futures Additional Investment Requirements 2030 *(USD billions)*	Better Futures Business Opportunity *(USD billions)*	Economic Prize from Hidden Cost Reductions *(USD billions)*	
	2030	2030	2030	2050
Local Loops & Linkages	$30	$215	$240	$585

By 2050, 68 percent of the global population is expected to live in cities and urban dwellers will eat 80 percent of food consumed.[141] What urban dwellers choose to eat and how their needs are supplied will largely shape food and land use systems. Urban demand for locally grown and seasonal agricultural products is steadily rising across developed markets. In the United States, the number of urban farmers' markets selling local products increased five-fold from 1994 to 2017, to 8,600.[142] There is a similar movement in favour of traceable local food in Japan, where it is not uncommon to see a farmer's photo on the label of fresh supermarket vegetables.[143]

However, local urban food economies remain highly linear and in general highly inefficient (Exhibit 26). Of the 7.1 billion tonnes of global agricultural production that goes into food each year, roughly 2.9 billion tonnes or 40 percent is directed to cities. Of this amount, 500 million tonnes or 17 percent is wasted through distribution and consumption losses. Cities generate 2.8 billion tonnes a year of organic waste which ends up in waterbodies, landfills or potentially hazardous dump sites rather than being mined for nutrients that can be looped back into local food systems.[144] The volume of solid organic waste (food and human) is expected to double between 2016 and 2025, with 70 percent of the increase occurring in emerging economies with limited waste management infrastructure.[145] Today, less than two percent of the valuable nutrients in food by-products and human waste generated in cities is captured and recycled safely and productively.[146]

This critical transition highlights the opportunity to strengthen and scale efficient and sustainable local food economies in towns and cities. Stronger local food economies are a common thread running through all ten critical transitions. Convergence on healthier diets will increase demand in all regions for fresh food products, especially perishable goods (critical transition 1). Urban food retailers of all sizes will seek to meet this demand through local sourcing because shorter supply chains reduce loss and waste when transporting perishable foods (critical transition 6). Productive regenerative farmers will create a market for nutrients recovered from circular urban food production (critical transition 2). Expanding urban and peri-urban supply will open up opportunities for young, skilled rural entrepreneurs (critical transition 9). And intensifying food production using regenerative agricultural practices in peri-urban areas will reduce pressure on forests (critical transition 3).

Goals and benefits

This transition will have multiple benefits.

- **Environment.** Expanding local supply will mean shorter distribution networks. These in turn will reduce transport-related greenhouse gas emissions, food loss and waste, and the use of synthetic fertilisers and pesticides owing to increased nutrient recycling of solid organic waste.

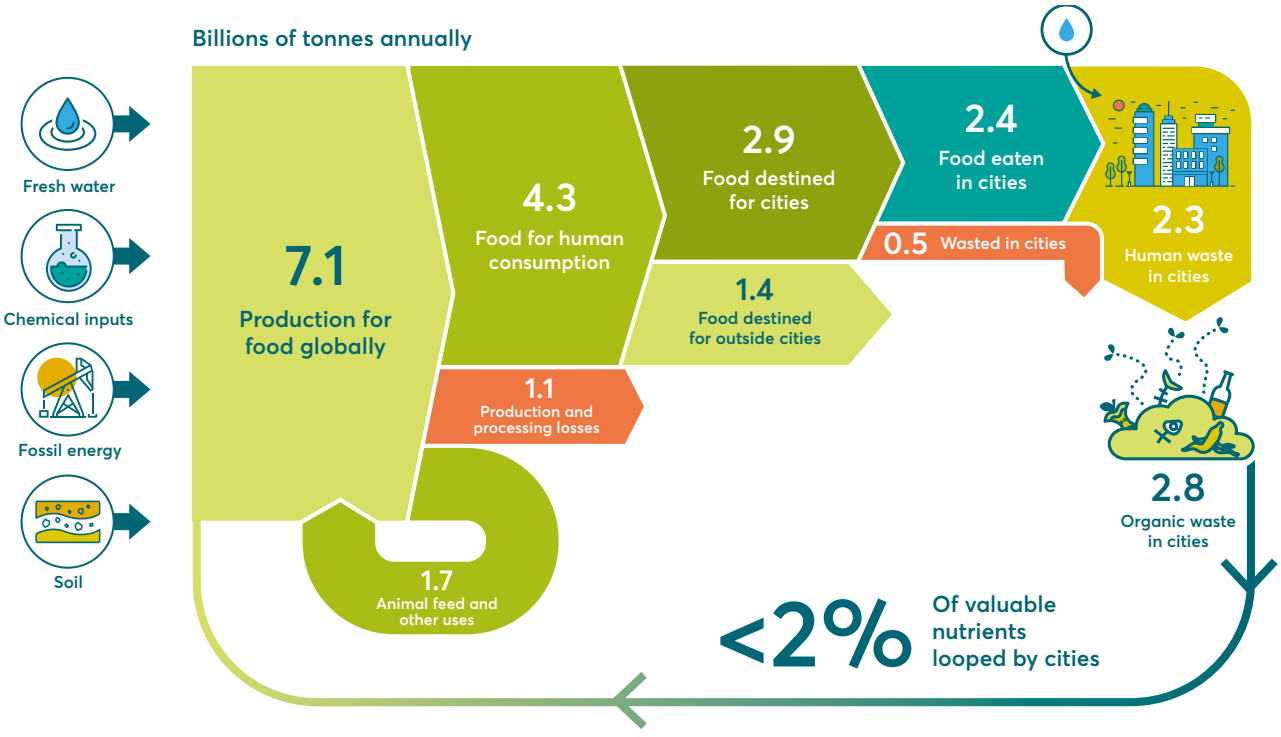
- **Health.** Wider availability of nutritious fresh food in urban and peri-urban environments will help to tackle obesity and under-nutrition.[147]

- **Inclusion.** Economic gains will come from the lower transport costs of shorter supply chains and direct sourcing from local farmers, from higher farm incomes resulting from more direct access to end markets with fewer intermediaries, and from the creation of new jobs through product and service innovation in circular food systems and urban farming.

- **Food security.** Global agricultural production today is focused on a few regions and crops. This genetic and geographical concentration heightens the risk of multiple breadbasket failures resulting in global disruptions to food supplies (see Chapter 2). And at least 80 percent of the population depends on imports for at least part of its food and nutrition security. Expanding local supply to meet local demand will diversify the number of crop varieties grown at a global level, reducing the world's growing vulnerability to staple crop failures. It will also strengthen local food security by reducing local import dependency. That said, long-distance and cross-border trade will remain critical to food security by filling gaps in local supply and helping to smooth spikes in local food prices.

EXHIBIT 26

Efficiency losses in food and land use systems



Source: Ellen MacArthur Foundation. 2019. Cities and Circular Economy for Food.

Left: Farmers from the Kalataima community in Colombia follow an agroecological approach in producing organic coffee, plantain and cacao, as well as vegetables and fruits at times. Here they are transporting their fresh goods sell at an organic food market in Armenia, the provincial capital close to the farm. Right: Homestead Farmer, Tilahun Gelaye, a beneficiary of The Debre Yacob Watershed Learning Restoration Project in Bahir Dar, Ethiopia. He says, "I have been involved with the project for 8 years now. In the past I used to live in a small hut, now I live in a house with corrugated iron roof."

The annual economic gain from this transition is an estimated $240 billion by 2030, and $580 billion by 2050. A reduction in public health costs of $155 billion a year by 2030 would be the biggest driver of the gain.

Significant momentum is gathering already. Entrepreneurs are developing business models that shorten supply chains between farmers and urban consumers. For instance, through its e-commerce platform, agri-tech start up Twiga Foods is connecting farmers to small and medium-sized vendors in Nairobi, giving urban consumers access to fresher products at more affordable prices (see Box 34).

Some companies are seizing opportunities presented by the scale of organic waste available in cities.[148] In London, used coffee grinds from cafés are being used to make high-quality fertiliser for mushroom farms located in the storage rooms of office buildings.[149] The international company AgriProtein is using fly larvae fed on organic waste from food factories, supermarkets, farms and restaurants to create insect-based protein feed.[150] The Nutrient Upcycling Alliance, led by Yara International and Veolia, estimates the potential market for recycled nutrients in fertilisers in Europe at more than $2.2 billion.[151]

Where food waste and nutrients cannot be looped back into the food cycle, they can be repurposed and sold into other systems. Fulcrum Bioenergy, for example, has spent $100 million over the past decade to develop technology which allows it to convert municipal solid waste, including food waste, into low-carbon transport fuels, including jet fuel.[152] UK-based company Bio-bean is also collecting spent coffee grounds from coffee shops, offices, transport hubs and coffee factories and recycling them into sustainable and high-performance conventional fuels and chemicals.[153]

BOX 34

Twiga Foods connects local farmers to urban markets

Agri-tech start-up Twiga Foods is working with 8,000 farmers and over 5,000 vendors to supply fresh fruit and vegetables from Kenyan smallholder farmers to small-and medium-sized vendors, outlets and kiosks in the capital, Nairobi. Through its e-commerce platform, Twiga Foods is connecting local farmers to urban markets. The farmers get higher prices than other buyers offer and a guaranteed market. Vendors get a reliable supply that they can offer to consumers at lower prices because the e-platform lowers transaction costs. Consumers also benefit from accessing fresher products at more affordable prices owing to the more efficient supply chain. By matching demand to supply, the platform is also able to reduce post-harvest losses and waste.[154]

Municipal authorities are recognising the economic opportunity of strengthening local food economies. The city of Amsterdam estimates that by improving the recycling of high-value organic residue streams it could generate $170 million in added value per year, create 1,200 new jobs in the long run and save 600,000 tonnes of carbon dioxide equivalent (tCO_2e) annually.[155] Other cities are experimenting with different models of urban farming to increase supplies of locally sourced food.

Consumer awareness of the downsides of long food supply chains is fuelling demand for circular, traceable, resource-efficient systems. Traceability technology can inform consumers of food sources and support advocates for locally sourced, sustainably produced food.[156]

Barriers to progress

Despite the proliferation of initiatives, there are still major barriers to achieving circular, resource-efficient local food economies. Major retailers rarely have local sourcing strategies. Foods and processed food products are developed to meet standard specifications, so they can be transported in bulk in long global value chains. Public policies on issues ranging from trade to public waste disposal promote standardisation. Foods sourced from small local suppliers are unlikely to meet the standards. Local food economies are also less developed in lower-income countries due to weak local infrastructure. In sub-Saharan Africa, for example, low intra-regional trade, and export-oriented commodity production, leave countries highly dependent on imports of processed foods.[157]

Agricultural inputs derived from converting food waste and recycling nutrients cannot yet compete commercially with products on the long-standing large market for synthetic inputs. A particular barrier here is contamination in urban organic waste. To create a circular nutrient loop, all food by-products generated during the production and consumption of food, from food processing side-streams to human waste, need to be safe to use as inputs for new products in the bioeconomy. This kind of enterprise may need government support to scale, in the way early government support for renewable energy helped that sector to become established. Public investment is also needed to support the market for emerging technologies that can close the local food system loop. China has been giving fiscal support to a pilot initiative for recovering food waste across 100 cities, from collection through to treatment and final disposal.[158]

Competition for the land surrounding cities represents a further barrier. Urban expansion must be managed, since 40 percent of the world's cropland is located within 20 kilometres of cities.[159] In Africa, nearly one-third of the expansion in urban areas between 2000 and 2014 spread on to what was formerly cropland.[160] At the same time, urban food production is still low and in many cases, restricted to informal production for subsistence.

Priority actions

Overcoming these barriers and reaping the benefits of this transition will require cooperation between business, public policymakers and municipal leadership. These actors need to work on the following priority actions:

Commit to increase share of local procurement

Businesses and local and national governments should commit to procuring more food and other biomaterials within cities and peri-urban areas. These commitments should be set out in purchasing guidelines and procurement policies. Larger food companies will need to change their behaviour and negotiate longer-term off-take agreements with local food producers. For example, Heineken, as part of its commitment to increase local sourcing, has signed a three-year partnership agreement in Nigeria that guarantees the purchase of cassava from a local factory that buys from smallholder farmers.[161]

Local government could use the procurement power of schools, hospitals and other municipal bodies to create a market for food entrepreneurs, favouring those that supply healthier food, source it more locally and find better ways to minimise waste and close the nutrient recycling loop. In São Paulo, for example, public procurement alone could generate enough demand for 71,500 hectares of regenerative cropland (equivalent to 73 percent of total peri-urban cropland) if the city were to adopt purchasing guidelines favouring local and regenerative production.[162]

Such commitments to local procurement would increase the availability of indigenous foods, which in turn could help drive consumer demand for them.

Limit competition for land in peri-urban areas from urban encroachment

Municipal zoning and regional spatial and economic planning policies are needed to discourage building on peri-urban farmland and encourage urban and peri-urban food production. There are increasing examples of urban farming systems, including those that combine indoor aquaculture with hydroponic vegetable production in local loops. Singapore, for example, is experimenting with rooftop gardens, hydroponics and vertical farms as part of its commitment to source more food locally.[163]

Invest in local infrastructure to support local loops

National and local governments can support the development of infrastructure for nutrient recycling, especially by redirecting public finance to support new technologies. Emerging economies have a particular opportunity to build organic material collection and separation into the design of waste management infrastructure. This also presents an opportunity for business. Emerging technologies and innovations have an important role to play in closing the food system loop. For example, digital platforms can help in getting organic resources from where they are produced to where they are needed. Organix is a digital marketplace for organic resources, developed by a company called SUEZ, that allows organic producers to find waste management solutions, such as locating anaerobic digestion recovery centres.[164]

Design out pollution and close the loop

All food by-products generated during the production and consumption of food – from food processing side-streams to human waste – should be safe to return to soils as organic fertiliser or as inputs for new products. The European Bioeconomy Strategy, updated in October 2018, supports circular economic activities related to nutrient looping in this way.[165]

Food companies can drive this through the development of recipes and products that replace traditional ingredients with food-processing by-products, helping to ensure that valuable nutrients in by-products do not go to waste. For example, Canvas, a New York City-based company, uses the spent grains (a by-product of the beer making process) from AB InBev's beer brewing to create a high-fibre nutrient-dense beverage.[166] Similarly, International Flavors and Fragrances works with partners to collect spinach which is not harvested due to insufficient quality for sale in the supermarket and to turn it into a nutrient rich powder which can be used in nutritional beverage powders and snack bars (see Box 35).

BOX 35

Drying technology turns otherwise-lost spinach into viable new products

International Flavors and Fragrances (IFF) produces and markets flavors and fragrances that can be used in a range of products from food to personal care. In 2018, IFF launched the EcoEffective+ initiative, where they set a series of environmental goals designed to reduce emissions, eliminate waste sent to landfill and improve water stewardship. As part of this initiative, IFF has a pipeline of pilot projects to explore what can be achieved with regards to food loss and waste. One of these is focused on spinach. A lot of spinach is not harvested because it is of insufficient quality to make it to supermarket shelves. IFF works with its partners to collect this spinach, dry it using PowderPure technology and turn it into a nutrient-rich powder that can be used in its nutritional beverage powders and snack bars.

Farmers generally sell such post-harvest material cheaply or give it away, forgoing the potential revenue opportunities. During IFF's pilot program, 400 metric tonnes of raw spinach were collected, processed and incorporated into various products. This created additional revenues of $1.3 million. IFF is now committed to increasing the number of pilot programmes designed to tackle food loss and waste.

Consumer pressure for more circular and resource-efficient systems will help focus private and public sector attention on delivering them. Civil society can help ensure transparency in supply chains and accelerate the use of technology to support consumer information about local food choices. For example, apps such as Locavore, HarvestMark Traceability and Farmstand all help consumers connect to purchase locally grown, seasonal foods.[167]

The United Kingdom: Food and Land Use

Context

Agriculture in the United Kingdom comprises 70 percent of total land area, employs 1.5 percent of the workforce and contributes 0.6 percent of GDP. Despite high levels of skills and technology, fertile soils and subsidies, farmers' incomes remain comparatively low. These low earnings, as well as high land prices and a shortage of available farmland, have discouraged young people from joining the industry. Agriculture also accounts for 11 percent of greenhouse gas emissions and is the biggest cause of wildlife loss, with a 67 percent decline in the abundance of priority species since 1970 and 13 percent of these now close to extinction.

The United Kingdom's "food production to supply" (or self-sufficiency) ratio is estimated to be 61 percent for all food in 2018 and 75 percent for indigenous types of food. Decades of policy to produce cheaper food have led to environmental degradation and spiralling ill-health. Farm gate prices remain low: of the £121 billion agri-food sector in 2017, only 8.5 percent of this (£10.2 billion) was returned to agriculture, of which about £3 billion came from public subsidy. The United Kingdom has the third-cheapest food among developed countries, but the highest rates of domestic food insecurity in Europe (a function of wealth distribution and the ability of individuals to access healthy food). Meanwhile, issues of how best to use land are often a source of contention and polarisation.

The cost of one diet-related illness – Type 2 diabetes – to the National Health Service (NHS) is nearly £10 billion a year. Costs to the NHS attributable to obesity are projected to reach £9.7 billion a year by 2050, with its wider costs to society estimated to reach £49.9 billion a year.

The case for serious, urgent and systemic reform of food and land use systems is clear. The government's commitment to a net zero greenhouse gas emissions target by 2050, as well as its draft Environment Bill, includes ambitious goals for food and land use (which the National Farmers' Union in England and Wales has accepted and brought forward to 2040). England has commissioned a year-long consultation exercise to establish a National Food Strategy, while Scotland has proposed a Good Food National Bill.

Critical transitions

Each of the ten critical transitions is addressed in diverse national policies in the United Kingdom. Four of the most vital are:

1

Healthy diets. There needs to be an urgent national effort to make UK diets healthier and more sustainable, to make healthier food cheaper and more accessible, and overcome the obesogenic environment. Leeds City administration has achieved a 6.4 percent fall in child obesity by working with pre-school children. Initiatives such as parenting classes that encourage healthy snacking, eating as a family and the importance of cooking meals from scratch have achieved a nine percent reduction in some of the city's most vulnerable neighbourhoods.

2

Productive and regenerative agriculture. The RSA Food, Farming and Countryside Commission sets out a plan for the greater adoption of regenerative farming practices, with some of these approaches also embedded in the government's draft Agriculture and Environment Bills for England. Particularly critical here will be the successful implementation of planned agricultural subsidy reform, linking payments more directly to the adoption of regenerative and environmental practices.

3

Protecting and restoring nature. The target of net zero greenhouse gas emissions by 2050 will require an ambitious effort to plant 1.5 billion more trees and to protect and restore remaining ecosystems (including forests, woodlands and peatlands). The UK Government's Environment Bill and 25 Year Environment Plan include provisions on biodiversity net gain, environmental spatial planning, conservation covenants – encouraging landowners to protect biodiversity on their land – and improved fresh water management.

4

Protected and productive marine waters. The United Kingdom needs to move towards more sustainable management of its marine fisheries and waters, including by ensuring higher levels of protection and the establishment of "no take" zones to allow the recovery of depleted ecosystems, rebuild fertility and enhance resilience. This focus should extend to the Overseas Territories, where the government's commitment to a "blue belt" of marine protected areas needs to be strengthened with finance and enforcement.

Critical Transition 8.
Harnessing the Digital Revolution

	Better Futures Additional Investment Requirements 2030 *(USD billions)*	Better Futures Business Opportunity *(USD billions)*	Economic Prize from Hidden Cost Reductions *(USD billions)*	
 Harnessing the Digital Revolution	2030	2030	2030	2050
	$15	**$240**	**$540**	**$935**

A digital revolution is unfolding across food and land use systems and from end-to-end of their value chains. New technologies make it possible to monitor land use from afar, to trace changes in forest boundaries and to spot deliberate deforestation immediately. Digital precision agriculture tools can lead to significant reductions in input requirements for a given yield by integrating data across whole crop production systems.

The same techniques could be used to scale regenerative farming, which is particularly data-intensive. For example, it requires the farmer to combine variations in soil and weather patterns with the appropriate selection of inputs and outputs for local circumstances – tasks that precision agriculture tools are particularly well suited to perform. In fact, big data, regenerative farming and agrobiodiversity seem made for one another.

Further downstream, digitisation is creating e-commerce routes for farmers to get to market, to offer more specialised products and to capture more of those products' final value. For consumers, access to online data tracing the journey of foods from field to market offers more power to choose products that meet health, ethical and sustainability standards. Meanwhile, activist organisations are enabled to hold companies and governments to account.

Digital technology promises to be a powerful positive multiplier of the other transitions. It can shine a light on existing concentrations of power and the injustices in current food and land use systems. And digital tools themselves can be used by civil society organisations to ensure that digitisation opens up food and land use systems, empowers consumers and smaller producers, enables the sharing of data, and encourages enlightened larger companies to drive positive change.

The potential benefits of digitisation in food and land use systems can be summarised as:

- **Environment.** Digitisation is an input into all ten critical transitions. It enables real-time forest protection and ocean management and regenerative and precision farming. It contributes to improved logistics for reducing food loss and waste and will enable consumers to make conscious purchasing decisions.

- **Health.** Digital tools can help consumers link wellbeing with diet by informing purchasing decisions and enabling them to self-monitor. They can also reduce pollution-related health hazards by enabling more judicious use of chemical inputs.

- **Food security.** Digitisation can make predictions of food security risks more accurate and the distribution of food stocks more transparent, even where governments and companies are not providing all the distribution data.

- **Inclusion.** Digitisation can help small farmers to access key information about weather and the optimal choice of crops and inputs and give more direct access to consumers through e-commerce channels.

The total value of these benefits is hard to quantify but is conservatively estimated at $540 billion by 2030.

The thrust of this transition is not so much about scaling the digital transition. Digitisation is already at scale. There has never been more access to information in food and land use systems. A constellation of new technologies – from open ledger and tracking technologies like blockchain to advances in remote sensing, digital mapping and weather prediction – are combining with mobile phone penetration and rural connectivity. For the first time, the means exist to track and trace trading prices, future demand shifts, weather patterns, greenhouse gas emissions and biodiversity impacts, farming practices, labour conditions and nutrition information from farm to factory to fork and back. It is possible to identify who does what and where, and by whom they are financed.

In addition, there are tools that provide a broadly accepted framework of definitions, norms and consistent guidance around specific commitments, such as the Accountability Framework Initiative, a common set of norms and guidelines for eliminating ecosystem destruction and human exploitation from commodity supply chains.[168]

In principle, therefore, digitisation could lead to more equitable and sustainable food and land use systems by solving many of the problems that have plagued the food industry for decades. However, historic evidence – and trends from other parts of the digital economy – suggest a more complex, disturbing outcome is possible. In the food sector, consolidation has already concentrated market power among a small number of players with entrenched interests. Value chains are optimised for massive economies of scale but often neglect basic standards of care for nature and people.[169] Unequal, asymmetric access to information across long, linear supply chains has exacerbated existing inequalities in market power, allowing the many iniquities they harbour to go unaccounted for. These range from unhealthy products being marketed as a natural choice, to implication in environmental crime and slave labour. It is not unreasonable to assume there is a risk of big data being deliberately used to reinforce these unfortunate tendencies.

Moreover, many small farmers in the developing world cannot access or interpret data. Thus rolling out digital technologies will not by itself improve inclusion. That will depend on training potential users to benefit from the technologies as well, especially those among the world´s poorest producers. Without such support, this population will not be able to compete against producers who can access and use technology to supply a market of well-informed businesses and consumers.

The challenge for this transition is therefore simple to state, and hard to solve: how to digitise food and land use systems in a way that creates transparency and corrects its embedded inequalities and injustices? If the data architecture remains closed and guarded, everything from seed genomes to field micro-topography and consumer micro-segmentation will reinforce monopolies, further weaken the position of small independent producers and artificially engineer consumer choices.

Goals and benefits

If data is opened up, it can empower:

- **Governments** to incorporate appropriate incentives, regulations and enforcement into national agricultural, public health and international trade policies
- **Farmers** and small producers with best practices, natural capital data, market access, pricing information and efficient logistics
- **Consumers** to make better informed, healthier and more environmentally friendly choices
- **Companies** to account for the true value of natural and human capital in their supply chains as well as legal, reputational and security of supply risks
- **The international community** to prepare for and respond to transnational food system challenges such as disease outbreaks, environmental crime and price shocks
- **Civil society** to hold all players in supply chains to account

The annual economic gain from this transition is an estimated $540 billion by 2030, and $935 billion by 2050. A reduction in public health costs of $360 billion a year by 2030 would be the biggest driver of the gain.

Priority actions

To harness the full beneficial potential of the digital transition in food and land use systems, all the system actors above should work on the following priorities.

Governments must walk the walk on digital transparency. They should provide the governance foundations for:

- Open access to public sector data on national land registries, fisheries, agriculture, soil health, water basin systems, land use, subsidies, transportation and extension service curricula
- Redefinition of anti-competitive practices and implementation of stronger anti-trust rules to take account of how big data and artificial intelligence are changing market structures and conduct, upstream and downstream
- Mandatory, holistic product labelling that presents information on food safety, origin, nutrition and environmental and labour rights in a standardised, comparable way for end-consumers. Governments should require the same standards from marketing.
- Minimum standards for chain-of-custody certification for food and land use commodities, and for unprocessed fish, fruit, vegetable and meat products
- Open source communities in key areas of public research, so that information is widely available especially in fields that have high consumer sensitivity. These include research on gene-editing or in areas where there is risk of IP lock-in by a few dominant companies (for example, advanced, climate-resilient seed technologies).

Investors can hasten these positive disruptions if they:

- Follow strict transparency and sustainability guidelines in their investment decisions. Farm Animal Investment Risk and Return (FAIRR), an investor network, is one group providing such guidelines. It advocates for sustainable animal farming backed by 180 fund managers with assets worth $10.5 trillion.[170]
- Support, and help shape, the development of nutritional, social and environmental monitoring, reporting and evaluation standards by WHO, the Rio conventions, and the International Labour Organization
- Support the development of standardised and auditable disclosure standards and parameters for major enterprise risks resulting from unsustainable and unjust operating practices

Food companies and retailers can make digitisation socially productive if they:

- Require suppliers to provide chain-of-custody information that is sufficiently granular to track deforestation, illegal fishing, environmental crime and labour conditions

- Support government efforts to develop food labelling schemes that provide complete nutritional, social and environmental information

- Make better use of consumer data to drive the growth of healthier food categories and to help consumers make healthier purchasing decisions

The international community can better manage transnational risks if:

- Trade regimes include transparency standards. They should encourage countries to cooperate in setting private sector "commodity-neutral" (i.e., covering all relevant commodities) compliance standards on deforestation, legal compliance and human rights, working through the Rio conventions for the environment and the International Labour Organization for labour rights issues.

- NDCs to the UN climate change convention and commitments to the UN convention on biodiversity include improved monitoring, reporting and evaluation standards for food and land use

- Members launch a Global Alliance Against Environmental Crime that combines the capacities of national law enforcement, Interpol and the United Nations Office on Drugs and Crime to crack down on environmental crime and human rights abuses in food and land use systems

- Disaster response planning for disease and food price shocks is convened by international institutions to help governments to plan responses and ensure that national trade policy smoothens rather than exacerbates volatility

Civil society, supported by philanthropy can help encourage transparency throughout food and land use systems by:

- Creating, maintaining and communicating results from real-time platforms for transparency, as is currently done through Global Forest Watch

- Holding governments, business and the private sector firmly to account using real-time information flows on their food and land use system activities

- Driving hard-hitting campaigns against serial offenders, whether governments, businesses or financial institutions

BOX 36

Cocoa Cloud project shares data among cocoa farmers[171]

The cocoa sector, centred on Ghana and Côte d'Ivoire, is particularly sensitive to climate change-related disruption. In Ghana, lack of adaptation is predicted to create income losses to cocoa farmers of up to $410 million a year. Therefore, companies along the value chain have targeted the region for tech-driven, sustainable intensification projects in order to address productivity challenges, deforestation and requirements for better livelihoods and working conditions. A paramount concern is the lack of easily accessible and accurate weather data. An estimated 1.5 million farming households in key growing areas in west Africa cannot make data-driven agricultural management decisions.

The CocoaCloud project, led by the World Business Council for Sustainable Development and Outputs Insights BV, seeks to fill this knowledge gap with a five-year pre-competitive data platform. Data is collected from ground sensors across the region. CocoaCloud sends local weather forecasts and farm management alerts based on agronomic algorithms and location data. The platform also allows exchanges of knowledge and feedback between farmers and extension services. Today, CocoaCloud supports 7,500 cocoa farmers, community members and extension workers in Ghana's Western Region. The target is to make data available for more than 1 million smallholder farmers in Ghana and Cote d'Ivoire by 2024.

Cheklu Fente, Head of Watershed assembly committee and beneficiary of The Debre Yacob Watershed Learning Restoration Project in Bahir Dar, Ethiopia. He says, "I have been the leader of the committee for 6 years now. We do many things from protecting land for grazing to maintaining the flow of water in the gullies."

The Yacan Mi rice farm in the Guangdong Province of China uses ducks as a natural fertiliser and pest control. The ducks are free to roam the rice paddy fields until being sold as organic local produce.

A farmer prepares a medicine called Dashparni Kashayam at his field as a part of Zero Budget Natural Farming.

Critical Transition 9.
Delivering Stronger Rural Livelihoods

	Better Futures Additional Investment Requirements 2030 *(USD billions)*	Better Futures Business Opportunity *(USD billions)*	Economic Prize from Hidden Cost Reductions *(USD billions)*	
 Stronger Rural Livelihoods	2030	2030	2030	2050
	$95 - 110	**$440**	**$300**	**$240**

Underlying all ten critical transitions is a vision of rural areas transformed into places of hope and opportunity, where thriving communities can adapt to new challenges, protect and regenerate natural capital and invest in a better future. Stronger rural livelihoods will be founded on the following elements:

- Better rural jobs created by a dynamic agricultural sector and growing opportunities for diversification in rural economies.
- An improving quality of rural life based on better access to services and digital technology, helping to dim the "city lights" effect that draws young people to urban areas.
- Greater resilience among rural communities owing to their improved access to information, technology, training and well-designed safety nets.
- A wider choice of good livelihoods for rural dwellers, wherever they want to work and in whatever sector, owing to improved infrastructure and education.

This broad-ranging vision acknowledges that most rural inhabitants, especially in the developing world, already have diversified livelihoods. Rural people often combine growing food on farms for their own consumption, or for the market, with small-scale processing of agricultural products, non-agricultural activities and seasonal or longer-term migration.[xv] These findings vary by region.[xvi] But even in areas where people rely more heavily on farming income, such as sub-Saharan Africa, earning income from non-agricultural activities is associated with higher living standards. Climate and geography influence these findings too. Being connected to urban areas and their dynamic markets makes a difference, although the precise influence of this factor varies in different places.

[xv] An estimated 60-70 percent of small farms, for example, mostly produce only to contribute to household consumption.[172]

[xvi] A comparison of African and non-African countries found that in the former 63 percent of households relied on farm-income as their main income source, against 33 percent for countries in other regions. Similarly non-agricultural wage income in SSA countries accounted for only eight percent of household income, against 21 percent in other regions.[173]

This vision also acknowledges that long-term trends are reshaping the context for rural development, presenting opportunities and challenges alike.

- Growing urban populations will need to be fed. Healthier diets everywhere will be rich in highly perishable items such as fresh fruit and vegetables. Urban agriculture will be able to meet some of that demand but producing food for growing urban populations creates market opportunities for all entrepreneurial farmers investing in local value chains.

- At the same time, rural communities will be tested as pressures on scarce resources intensify and the physical impact of climate change increases, while infrastructure and digital connectivity remain weak. Larger commercial interests are likely to increase their control at key points in the value chain, making smaller landholdings untenable.

- Many young people are expected to migrate from the countryside to towns and cities over coming decades.[174] This trend is likely to be marked in sub-Saharan Africa, where rural populations are growing and rural-urban migration has been low.[175] Sub-Saharan Africa as a whole is expected to experience half of projected global population growth to 2050.[176] While migration is an inevitable part of structural economic transformation, it could result in migrants suffering from poverty and vulnerability if they cannot be integrated into urban economies. These trends also imply that rural economies could be drained of the entrepreneurial talent needed to rejuvenate them and produce enough healthy food for growing urban economies.

Many of the opportunities that can support stronger rural livelihoods will come from the other critical transformations. Changes in diet can open up prospects for labour-intensive forms of fruit and vegetable growing, for example. Nature-based solutions can offer sources of income that reward farmers' and forest dwellers' contributions to the provision of public goods. And related support for knowledge-intensive practices can raise returns to rural labour. Moreover, diversified supply sources can boost productivity by reducing food loss and waste and strengthen livelihoods by creating local value chains linking cities and local, peri-urban production areas. Digitisation can help farmers make better production and market decisions, while increasing their productivity by enabling them to access sources of knowledge and financial and risk management products tailored to their circumstances.

Many of the elements needed to effect this transformation lie beyond the rural sphere. They include the substantial investment in education needed to make full use of the creative and productive potential of all. In addition, dense networks of secondary and tertiary towns can provide the services and markets that rural areas need, as long as they do not encroach on productive agricultural land. Above all, it is dynamic urban economies that offer the jobs and opportunities in which young talent can be most productive, relieving the pressure on land to provide livelihoods.

Goals and benefits

The benefits of stronger and more resilient rural livelihoods are hard to overestimate.

- **Environment.** They help to halt some of the practices that contribute most to the degradation of forests and soil, such as converting natural ecosystems to cropland, foraging for wood and burning biomass.
- **Health.** They help prevent nutrient deficiencies and stunting.
- **Inclusion.** They raise productivity in rural and urban areas, diversify income sources and potentially reduce food import dependency.
- **Food Security.** They support greater food security and address the growing inequalities found in many rural and urban areas.

The prize, evaluated as the economic benefits of job creation and health improvements for the rural poor, could be around $300 billion a year by 2030. This is a conservative estimate as it ignores many of the other broader welfare impacts of this transformation on, for example, the health, wellbeing and productive potential of children.

Priority actions

As highlighted above, success in this transition is closely related to what happens in all the others. In addition, delivering stronger rural livelihoods calls for emphasis on developing a cohort of young entrepreneurs and investing in a business environment in which they can create opportunities in farming and food processing, local value addition and new products and services. That environment will provide good living conditions and modern amenities to attract young people, strong property rights to make sure the shift towards more efficient agriculture is fair and inclusive, infrastructure to connect entrepreneurs to markets and livelihood options beyond rural areas, and risk management tools to help them take informed risks.

What can different actors do to promote this shift?

The conventional focus of rural policy has been on improving human capital for farming through expanding agricultural technical colleges and scaling extension services. Policymakers who want to revitalise rural communities and attract younger entrepreneurs need to look further. Much creativity and innovation have gone into strengthening skills through new delivery models, such as demonstration farms that aim to spread innovative practices.[177] PepsiCo has set up demonstration farms to work with local farmers to identify sustainable practices and share them through peer-to-peer learning. But much more such work is needed. Five priorities stand out. They are described below with special reference to sub-Saharan Africa, where the challenges to rural livelihoods are particularly stark, but are also broadly relevant across the world.

Support young people and entrepreneurs to access land, capital and other resources

Rapid population growth has increased demand for land, causing median farm sizes to decline. In response, most rural dwellers combine work on and off the farm but face limited opportunities to make a living. Would-be entrepreneurs have poor access to finance, face high costs of capital and are often perceived as risky. Although potentially just as productive, companies based in rural areas are likely to grow more slowly and generate fewer jobs than those in urban areas. Differences in the quality of infrastructure, access to credit and transportation costs all contribute to this disparity.[178] Young people may therefore find it challenging to create new opportunities for themselves.

Left: Dr Birhanu, Research Directorate Director at Gullele Botantical Gardens, Addis Ababa, Ethiopia. He got his degree in biology in Bahir Dar. He says, "Most people in Ethiopia are very passionate about plants. We aim to preserve, protect and grow plants to sell in the nurseries for the communities."

Evidence suggests that non-farm enterprises led by young people are often less productive and have lower potential than companies run by older adults.[179] These barriers are often even higher for women, who typically lead much smaller and less productive companies than average, given the sectors in which they operate and the small scale of their operations.[180]

Governments and private companies can partner in establishing incubation hubs that provide entrepreneurs with business training, market information, links to investors and a network for sharing knowledge.[xvii] One example is Generation Africa, which aims to strengthen the "agri-preneur" support ecosystem in Africa and unlock the potential of more of the region's young men and women. Governments can also introduce land reform and policies to support young people's access to land. These include opening up rental markets with adequate security of tenure to make it worthwhile for tenant farmers to invest in the land.[181]

The importance to rural reinvigoration of access to land, land rights and land tenure reform is hard to overstate, particularly in the face of a growing risk of large-scale land acquisitions by international and domestic parties.[182] As climate and population pressures make fertile land more valuable, people farming in fertile regions where property rights (both community and private) are not well-established will be particularly vulnerable. Between 2004 and 2009, large-scale land acquisitions in sub-Saharan Africa totalled nearly 2.5 million hectares.[183] Since 2000, international buyers have acquired over ten million hectares of agricultural land in Africa. In some situations, this can lead to a strengthening of productivity, create new and better jobs and improve rural livelihoods. Moreover, the farming sector in many countries needs investment and modernisation. At the same time, however, there is a genuine risk that transactions will take place at the expense of the local population, especially where governance of land title is weak. Land registries need to be developed, allowing major land deals to be monitored by civil society.

[xvii] On the use of networks to address some of the shortcomings of traditional extension services, see Agricultural Technology Adoption Initiative. 2016. Emerging Insights. Sharing Information to Support Smallholder Farmers in South Asia and Sub-Saharan Africa: Evidence from the Agricultural Technology Adoption Initiative. Available online at: https://www.atai-research.org/emerging-insights-sharing-information-to-support-smallholder-farmers/

Address market failures to enable farmers to secure a decent living

Without fair and relatively stable prices, farmers are trapped in poverty and unable to invest in their land. Cocoa farmers in Côte d'Ivoire and Ghana earn between $0.50 and $0.84 a day despite cumulatively producing 60 percent of cocoa for the $50 billion upstream part of the chocolate value chain. Similarly, as we have stated, farmers get less than 1 percent of the value of a cup of coffee sold in London (see Exhibit 11 in Chapter 2).[184] Increasing farmers' share of the final value in food value chains is critical to improving rural incomes. Improvements in farming productivity in such value chains will not make a difference to farmers' incomes unless farmers get a fairer share of the eventual profits.

Governments can try to reduce agri-businesses' power relative to smallholder farmers by having strong institutions in place to ensure price competition and prevent monopolist behaviour, and by enacting appropriate worker protection laws.[185] However, companies also need to show leadership, whether individually or through agreed (and independently monitored) collective bargaining processes. In every commodity (from shrimps to coffee to dairy) and most geographies, there are businesses that have committed to fair and long-term contracts with farmers. For example, the fruit company Blue Skies provides 4,000 farmers with living wages across four countries in sub-Saharan Africa.[186] But these smaller, more purpose-driven companies are the exception rather than the rule. Civil society can and should use its growing capacity to celebrate strong performers while also exposing abuses.

Increase rural infrastructure investment to drive productivity and reduce rural isolation

Rural roads connect people to jobs and markets. When new roads connect remote villages, opportunities for new micro-enterprises or for shifting into more productive crops open up. These effects tend to be more marked for individuals with fewer assets.[187] In addition, when a shock strikes – such as the Ethiopian droughts between 2012 and 2016 – households in villages connected to rural roads are more resilient as they have access to more options.[188]

Access to electricity allows farmers and agri-processers to run their machinery. Yet in rural areas in low-income countries, more than 70 percent of people do not have access to electricity, and those who do often suffer unpredictable power cuts. Small-scale, off-grid solutions are starting to make it possible for rural dwellers at least to charge their phones and electrify some farming tasks. One solar panel, for example, can help incubate up to 200 chicken eggs.[189] To meet larger power needs, mini-grids offer cheaper access than connection to a national grid, especially in sparsely populated areas (Box 37).[190] But despite their growing popularity, access remains spotty.

Finally, connection to broadband is an increasingly essential tool for improving market access for farmers, strengthening rural-urban connections and getting young people to stay in the countryside. As detailed in Critical Transition 8, the future of farming is increasingly digital. Fishers and forestry managers similarly need to be digitally connected to do their jobs, both to protect their resources and to produce more effectively and sustainably for the market. Yet the rural-urban digital divide remains wide, despite fairly high mobile phone penetration in rural areas. In Africa, internet use in rural areas is less than half the level in urban areas.[191]

BOX 37

The role of renewable energy mini-grids

One billion people have no access to power.[192] Communities that lack electricity typically use open fires or inefficient stoves for cooking, using raw biomass such as foraged wood for fuel, often at unsustainable rates. They are also unable to rely on cold storage to preserve crops and store medicine. Solar powered mini-grids could help close this gap, with far-reaching effects on rural agricultural economies.

Renewable energy mini-grids are standalone, decentralised electricity networks that can provide large peak power supply for rural communities, resolving some of the scale limitations of single-unit solar home systems. In Bisanti, Nigeria, 340 local households, some small businesses, a school and a health clinic are powered by a 126-panel solar mini-grid.[193] The International Energy Agency estimates that to achieve universal access to electricity by 2030, 255 million additional people will be connected via solar mini-grid.[194]

Renewable energy mini-grids are highly site specific: the local geography and community structure are critical to their successful operation. In locations where they work, they can make a huge difference, particularly by powering cold storage. Refrigeration reduces food loss and waste (especially of fresh produce) but it is difficult to power agricultural-scale produce from single home solar systems. Rural mini-grids can be powerful enough (typically a minimum of 3kW) to serve communities' cold storage needs and potentially make entire regional agricultural sectors more efficient.

Refrigeration powered by solar energy is transforming fishing in some areas. Around Lake Victoria, 460 million tonnes of fish are caught each year, but significant amounts are wasted. Now Kenyan solar mini-grid operators in Mwena and Kitobo are setting up solar-powered ice production facilities so fishers can preserve their catch and switch from being price-takers to price-setters.

Solar-powered fridges, such as the SunDazer, are being developed to provide portable cooling and are being used in strategically placed locations in Uganda, where 20 to 40 percent of all milk products are wasted because of the heat. The fridges are increasing farmers' incomes by 20 percent.[195]

Solar mini-grids can also provide enough power to make it worthwhile for farmers to invest in their own processing equipment, such as coffee pulping machines. Adding more value on farms improves incomes.[196] Improved rural electrification will also scale digitisation, enabling mobile access to real-time market prices for food.

The scale of rural infrastructure investment needed to connect rural areas through roads and digital investments, and to provide power, is small compared to its transformative potential: about $30-35 billion a year for sub-Saharan Africa. The returns on this investment would be even higher if it were linked to urban planning approaches that created economic multipliers for the surrounding countryside, as is happening in Ethiopia, Uganda and Rwanda. There is a good case for cross-sectoral international partnerships to mobilise the capital for this investment, support project development and drive the growth of higher-value agricultural corridors and sustainable special economic zones.

Right: Homestead Farmer, Tilahun Gelaye, a beneficiary of The Debre Yacob Watershed Learning Restoration Project in Bahir Dar, Ethiopia. He says, "The difference with being involved in the project is huge. Now we are living cleanly and safely. I feel such happiness. In the past there was hunger and starvation but now there is happiness in the area."

Increase opportunities for value-adding activities beyond primary production and processing

Unless they can engage in value-adding activities, people in rural economies are unable to capture a worthwhile share of food value chains. In many developing countries, this restriction applies beyond rural areas to the whole economy, increasing those countries' dependence on imports and reducing the value of their food exports. This challenge is exacerbated by international trading rules that often favour imports of unprocessed or semi-processed commodities from developing countries over more processed agricultural products.

Multinational and domestic companies can invest in value-adding activities in rural areas and developing countries to boost the value of local produce, generate employment and strengthen local supply chains. For example, by opening a vanilla extraction facility in Madagascar's Sava region, the flavours and fragrances producer Symrise has generated 200 jobs and improved local livelihoods.[197] Companies will only take this type of action, however, if national investment policies are sound and, in parallel, international trade rules do not discriminate against processed products. The policy reform agenda recommended in this report as well as the infrastructure investments described above can help to make this happen.

Provide risk management tools to strengthen resilience, including safety nets

Rural livelihoods are defined by risks, for instance the risk that rains might come at the wrong time and be more or less than specific crops need in non-irrigated areas. The ways in which rural households manage their risk exposure and cope with the consequences can be very costly, with long-term implications.[198] All the measures to strengthen rural livelihoods above will go some way to reducing rural people's exposure to some risks, with climate resilient infrastructure likely to play an increasing role. In addition, active risk management tools will remain key to strengthening rural livelihoods.

One such tool is affordable insurance. This can trigger significant investment in agricultural inputs because farmers know they are protected from the possible downsides of such investments. Equally important are well-designed safety net programmes. These can not only support households through short-term emergencies but also build more resilience into rural economies. For example, Ethiopia's Public Safety Net Programme provides millions of households with cash and food payments for building local infrastructure or protecting the environment.[199] This type of intervention works well in synergy with others: with the infrastructure in place, whether in the form of roads or natural capital, extension services have a much greater chance of boosting farmer incomes.

As the risks of weather-related events increase, investing in safety nets that can be easily scaled up is a priority – and public-private solutions can help. Interesting developments in this area include new types of public-private partnership involving international financial institutions or international NGOs.[200] Examples include the Turkish Catastrophe Insurance Pool, the Andhra Pradesh microinsurance programme and an index-based weather derivative for farmers facing drought in Malawi. By putting in place a predictable means of responding if disaster strikes, such interventions make low-income communities more resilient.

In summary, two forms of investment in the next generation of entrepreneurship for stronger rural livelihoods are essential. The first is investment in education, formal training and extension support services. What needs to be taught is well understood, and digitisation can complement high-touch teaching approaches. The need for action is urgent, but the action itself is relatively straightforward. The second essential investment is in the enabling environment for talent – infrastructure, market and resource access mechanisms, fairer land ownership patterns, value chains and safety nets. Here, it is equally well understood where investment is required. The need is equally urgent. But it will take a greater shift in leadership, mindset and resources. Rural communities have been left behind in the rush towards modernity. Supporting stronger livelihoods and the next generation of entrepreneurs is the key to transforming food and land use systems.

BOX 38

Building resilience for 30,000 family farms on Mount Elgon, Kenya[201]

Farming on Mount Elgon, Kenya, has been caught in a vicious cycle of environmental degradation, climate change and poverty. Deforestation, inefficient agricultural practices, uncontrolled grazing and soil erosion are directly damaging biodiversity and soil fertility. They also threaten the watershed and ecosystem of Lake Victoria as a huge quantity of soil sediments are carried into it by rivers. Degrading natural capital contributes to local farmers' very low crop yields and milk production. They also have no sustainable connections to markets.

To break the cycle, the Livelihoods Carbon Fund, an impact investment fund created by private companies, partnered with Vi Agroforestry NGO and Brookside Dairy, a Kenyan dairy processing company, to launch in 2016 the Livelihoods Mount project. This project trains farmers and links them efficiently to Brookside's supply chain. It is reaching out to 30,000 family farms spread over 35,000 hectares.

Farmers learn sustainable agricultural land management practices so they can adapt to the impacts of climate change, reduce their own greenhouse gas emissions and increase farm productivity and food production. Half the farmers trained are women. As Brookside Dairy has committed to buy all milk produced within the project over a period of ten years, farmers have the long-term income security they need to invest in their farms. The project should generate $200 million in the region's dairy sector over that period.

A field worker checks battery level of a camera trap at the Cinta Raja Rainforset Site in Gunung Leuser National Park (GNLP) in Sumatra, Indonesia.

Dr Balakrishna Reddy, Head of Research and Development measuring fruit at a farm which incorporate Jain micro-irrigation techniques at Tandalwadi village in Jalgaon, Maharashtra, India.

A member of the Embera village of Chigorodó, Indigenous Reserves of Yaberaradó and Polines [Pueblo Embera de Chigorodó. Resguardos Indígenas de Yaberaradó y Polines] in Uraba, Colombia, holding a native plant, that has special significance to her.

Critical Transition 10. Improving Gender Equality and Accelerating the Demographic Transition

Gender & Demography

Better Futures Additional Investment Requirements 2030 *(USD billions)*	Better Futures Business Opportunity *(USD billions)*	Economic Prize from Hidden Cost Reductions *(USD billions)*	
2030	2030	2030	2050
$15	n/a[xviii]	$195	$140

Women have a central role in food production and in decisions concerning nutrition, health and population. They have the potential to shape the transformation of food systems, but in most settings they have neither the power nor opportunity fully to exercise this influence. Ensuring women have equal opportunities to participate in and benefit from all the Critical Transitions is therefore a prerequisite for sustainable food and land use systems transformation. Strategies for implementing Critical Transitions need to target gender equity explicitly, given the widespread inequality experienced by women in food and land use systems today.[202]

Women make up 43 percent of the global agricultural workforce.[203] However, female farmers receive only ten percent of total aid for agriculture, forestry and fishing and as little as five percent of all agricultural extension services.[204] Beyond their work in producing, processing and marketing food, women also store, clean, prepare, cook and serve much of the food that is consumed, and care for children. In many households, women make the key decisions for their families related to nutrition and health.[205] These decisions are particularly important during pregnancy and the first two years of a child's life, since the nutrition of babies and children as they develop affects their future health.[206]

[xviii] It would be very hard to quantify the business opportunities specifically related to this critical transition, not least because differences across health systems across the world means that it is hard to generalise on public or private provision and modalities of delivery. One could even argue that access to reproductive and perinatal care falls into fulfilling basic needs, and as such it should not be considered a business opportunity at all.

Goals and benefits

Women's pivotal role in food production and household nutrition means the other transitions recommended in this report can only deliver their full impact if they explicitly promote gender equity in all aspects of their implementation. Consider the ownership and control of productive assets, especially land and water. Clarifying ownership of and access rights to these assets is a critical step towards achieving sustainable intensification of agriculture and reducing poverty. This is because having secure rights over land and water stimulates farmers and others to invest in these resources and related ecosystems (critical transition 3). Recognition of women's control of productive assets has been accompanied by positive outcomes at the household and individual levels.[207]

Improving women's access to knowledge and information is also likely to have a disproportionate impact on the speed and scale of the other transitions. For example, women farmers have so far had fewer opportunities to adopt climate-smart agriculture because most know relatively little about it. Even those who do may have limited access to finance. In some areas, literacy rates among women are low.[208] Moreover, women are often excluded from household and community decisions about changes in production, making it difficult for them to take advantage of new opportunities.

Promoting gender equity in the implementation of all the transitions will contribute to the broader goals of SDG5 (to achieve gender equality and empower all women and girls). It will ensure women have access to the nutritious food they need all year round for their families to enjoy good health, resulting in lower maternal and child mortality. It will reduce reliance on child labour by improving agricultural productivity. It will extend digital connectivity and digital services designed to close the gender access gap. And, most importantly, it will help putting the ingredients of stronger rural livelihoods within the reach of the whole population. These include enhanced access to education, training and finance, new employment opportunities in rural areas, and changes in the design of international food supply chains to support more equitable value-sharing.

Women smallholders will both contribute to and benefit from targeting the other transitions towards gender equity. Success in the other transitions will benefit the ecosystems (soils, water, forests, the ocean and biodiversity) on which women smallholder farmers depend. They will help them to adapt to unpredictable weather and climate change. And they will promote women's access to markets for the crops they produce.

In addition, as more women are able to access education and realise their rights to resources, information and finance, more are likely to seek out reproductive health care and choose to have smaller families. Smaller families, particularly in countries where large families have been the norm, will improve the lives of millions of people. As birth rates fall, for example, families and countries will be able to spend more per child on education and health, making children better prepared to participate in the work force.

There will be environmental benefits too: lower birth rates will reduce pressure on land. From a climate perspective, the larger the population, the greater the impact on global warming even if per capita greenhouse gas emissions fall. The countries most vulnerable to climate change, which already struggle to adapt to its consequences, also have the fastest-growing populations. Expanding populations put pressure on forests and other ecosystems, driving up emissions.[209] Similar chains of cause and effect will accelerate loss of soil health, ecosystems and biodiversity.

By reducing pressure on the climate, biodiversity and ecosystems, ensuring that women benefit from the other transitions recommended by this report will also considerably improve the odds of meeting the SDGs, the Paris Agreement targets and the post-2020 goals on biodiversity hopefully to be agreed in Kunming, China in 2020. The UN projects that by 2050 the world population may be anywhere between 8.1 billion and 10.6 billion people.[210] If it grows beyond ten billion, food security is likely to become impossible to maintain in a sustainable way. The most vulnerable countries and population groups would be hardest hit – but will also be the first to benefit if birth rates fall.

The annual economic gain from this transition is an estimated $195 billion by 2030, and $140 billion by 2050. These reductions are entirely attributable to public health through a reduction in the number of people at risk of malnourishment. There are, as explained above, numerous environmental and economic gains but these are allocated to other critical transitions. This is because the gender equality and the demographic critical transition is considered to be an enabler transition.

Priority actions

Policy makers and investors must commit to making the investments needed for women to benefit from these transitions. Before implementing new policies and programmes, decision makers need to understand gender roles within the economy and society and how women will be affected by the proposed changes to ensure they leave them and their families better off.

Making sure women have equal access to resources such as land, labour and water should be central to policies concerning the transitions. However, they also need full access to other enabling inputs, such as information, credit and other services, to be sure of fully participating in and benefiting from the other critical transitions.

Use policy to ensure the rights and wellbeing of women and girls

Strongly upheld policies and interventions are needed to promote gender equality and expand opportunities for women. These include policies designed to increase access to education for girls, to improve access to finance and extension services for female agricultural workers, to improve maternal and child health and nutrition, and poverty reduction strategies that increase income-earning opportunities for low-income women.

Improve access to reproductive health services

Access to reproductive health services is the means to enable women to exercise their right to decide freely how many children to have and when to have them. Many women still face barriers that prevent them from getting reproductive health services. Governments, donors and civil society organisations can support efforts to improve their access and availability of health care services.

The Need for Comprehensive, Integrated National Reform Agendas

In today's food and land use systems, policies, laws and regulations, (lack of) enforcement, fiscal (dis)incentives and general norms that set the rules of the game are encouraging behaviours that create massive hidden costs, and in aggregate undermine any chance of meeting the SDGs and Paris Agreement targets.

To remedy this, FOLU recommends – through the ten critical transitions – taking a comprehensive, integrated approach to the reform of national food and land use systems, harnessing the combined signalling and system-shaping powers of the whole range of system stakeholders, from heads of government to consumers. To this effect, we are supporting a number of ambitious and committed countries on their journeys (Box 39).

BOX 39

Country efforts to implement food and land use transformations

Supporting the transformation of food and land use systems at the national level is essential to the global effort to bring about a more sustainable food and land use system. A wave of change around the world could be inspired through the growth of a network of national efforts in which countries can learn from one another, accelerate and scale up successful models, and track progress towards national and global goals.

Under the firm leadership of national institutions, FOLU is supporting work in Australia, China, Colombia, Ethiopia, India, Indonesia and the UK, as well as in a regional network in the Nordic countries (Norway, Sweden, Denmark, Finland and Iceland). Each of these countries faces a different set of issues and challenges, and the structure of the work is as diverse as the countries themselves.

FOLU country platforms (described in greater detail in Annex A) are diverse and dynamic. They bring together local actors from government, the private sector, civil society organisations and academic institutions. Their aim is to support the transformation of food and land use systems so that they deliver better outcomes for the environment, health and sustainable development. In countries such as Colombia, Ethiopia and Indonesia, the platforms support existing national government plans. In others, such as Australia, the platform (known as Land Use Futures) operates independently of, but in close consultation with, government, and is supported by philanthropy.

The approach to establishing Country Platforms depends on the unique circumstances of each country. However, a number of characteristics common to each national approach are emerging and are likely to be useful to other countries embarking on the same journey. The emerging Food and Land Use Transformational Approach at the country level comprises:

Long-term targets and policy/investment pathways. Country programmes encourage and support the adoption of explicit, ambitious, measurable targets related to food and land use transformation, as well as the establishment of the policy and investment pathways needed to meet those goals. These targets and pathways should be based on comprehensive stakeholder consultation and informed by national academic institutions.

A compelling, nationally appropriate case for change. The challenges and opportunities for food and land use transformation differ in each country. Country programmes support local partners to build the case for change based upon scientific and economic evidence, business and investment opportunities and political economy analysis. This helps leaders advocate for and explain change within their own domestic constituencies.

BOX 39 - Continued

Integrated, systemic solutions. By encouraging multi-stakeholder and inter-disciplinary approaches, country programmes aim to break down silos between environmental, agricultural, water, health, planning, infrastructure, trade and development interests and to support the development of holistic, integrated policy and investment frameworks. The solutions need to stem from dialogue between multiple actors and communities, from farmers to consumers. These conversations should be weighted towards those voices that are typically under-represented in top-down processes. In food and land use systems, profound change is never purely technical but requires comprehensive integration of social, political and economic factors.

Government leadership of system reform is essential. Governments have to set overall direction, establish tough, binding targets in line with the Paris Agreement and the SDGs, develop and implement integrated resource plans, create effective property rights, set fiscal policy, mobilise public resources to mitigate risks, encourage human capital formation and set the rules for international cooperation.

Leaders at the highest level of government need to drive the changes, working across traditional siloes. This is not a task for civil servants alone. The change programme will be tough. Reviewing each of the ten critical transitions, FOLU concluded that they all face significant implementation challenges in terms of policy, finance, technology and cultural/behavioural barriers (Exhibit 27). Only heads of state and government can convince a sufficiently broad spectrum of political stakeholders that delivering on a country's food and land use agenda is central to achieving key national goals. Political leadership is also critical to building the new coalitions of interest and civil society movements that can transform food and land use systems over the next ten to twenty years.

EXHIBIT 27

Implementation challenges of the ten critical transitions

Scale of challenge Low Medium High	Policy & Regulation	Finance	Tech & Innovation	Behavioural Change	Overall Assessment
Healthy Diets	Medium	Low	Low	High	High
Productive & Regenerative Agriculture	Medium	Medium	Low	Medium	Medium
Protecting & Restoring Nature	High	High	Low	Medium	High
A Healthy & Productive Ocean	Medium	Medium	Low	Medium	Medium
Diversifying Protein Supply	Medium	Low	Medium	Low	Low
Food Loss & Waste	Medium	Low	Low	Medium	Medium
Local Loops & Linkages	Medium	Medium	Low	Medium	Medium
Digital Revolution	Medium	Low	Low	Low	Low
Stronger Rural Livelihoods	Medium	High	Low	High	High
Gender & Demography	Medium	Low	Low	Medium	Medium

Source: Food and Land Use Coalition, 2019

However, political leaders and governments – though they can set the rules of the game – will not be able to carry out the transformation alone. It requires hundreds of millions of people to change what they eat and how they farm. So it must be as much a bottom-up as a top-down exercise. And the top- down part has to start with developing a shared vision of future food and land use and a shared reform agenda through collaboration between government, civil society, the farming community, businesses large and small, finance and researchers.

Critical elements of the vision and reform agenda will be:

1. **Defined goals and pathways.** Individual countries need to develop national goals for the use of key natural resources – land, soil, freshwater, the ocean and biodiversity. They will need to specify their own and science-based pathways towards achieving social and economic development objectives that are consistent with the SDGs and the Paris Agreement targets. These goals and pathways must be compatible with a country's other national commitments and based on the same analysis and priorities. Such national commitments include those made under the UN climate change and biodiversity conventions, and those made on health and development. Planning tools for this work are becoming more available, including those developed through the work of the FABLE consortium (see Box 40). Developing these goals and pathways requires a systematic process that combines science, public health metrics, economics and the insights gained from social dialogue, and includes traditionally marginalised sections of the population such as indigenous peoples.

BOX 40

The FABLE Consortium and new pathway development tools

The Food, Agriculture, Biodiversity, Land Use and Energy (FABLE) Pathways Consortium mobilises experts from leading knowledge institutions in 18 countries, including the European Union. The consortium supports the development of the data and modelling infrastructure needed to produce long-term pathways towards sustainable food and land use systems. It is convened by the Sustainable Development Solutions Network and the International Institute for Applied Systems Analysis, and works closely with EAT, the Potsdam Institute for Climate Impact Research and many other institutions.

The consortium pursues three broad sets of activities. The first is capacity development and sharing of best practice for data management and for modelling FABLE's "three pillars" of sustainable food and land use systems. The three pillars are efficient and resilient agriculture systems, conservation and restoration of biodiversity, and food security and healthy diets. Work for the first pillar consists of providing simplified assessments of land use and food systems for stakeholder engagement, integrating data to support policymaking, and integrated, geospatially explicit modelling with trade analyses. Work for the second pillar comprises the development of national pathways to the mid-century resting on consistent trade assumptions that can collectively achieve shared global targets. Work for the third pillar is the analysis of national policy options to enable governments and their stakeholders to test the impact of proposed policies across all three pillars.

The FABLE Consortium published its first report outlining its initial findings in July 2019. Albeit preliminary, the report represents the first coordinated effort by researchers from most G20 countries and other nations to chart long-term pathways towards sustainable land use and food systems. It presents a shared approach towards framing and analysing integrated strategies for land use and food systems, an initial set of global targets to be achieved by mid-century and 18 preliminary country pathways for achieving these targets.

As part of FOLU, FABLE is working with interested governments to improve policies and develop long-term transformation strategies, including the low-emission development strategies required under the Paris Agreement. FABLE's work shows that these strategies need to target a range of objectives, including net-zero greenhouse gas emissions and protecting and restoring biodiversity. FABLE plans to issue a second global report in 2020 in the run-up to the Conference of the Parties of the Convention on Biological Diversity in China, and the Conference of the Parties of the UN Framework Convention on Climate Change.

2. **Aligned natural resource regulation.** The goals and pathways should inform legal and regulatory frameworks for national land use, water and fisheries planning and resource allocation as well as enforcement mechanisms. Aligning laws, regulations and enforcement mechanisms with the goals and pathways should ensure efficient use of these resources from the combined perspectives of ecosystems protection and restoration, nutritional benefits, agricultural production, rural livelihoods and other uses of land (infrastructure, urban areas, fibre crops, timber).

BOX 41

Using maps for sustainable food and land use[211]

Most of the challenges and solutions described in this report are location specific. This is because only certain areas are suitable for high-productivity agriculture, biodiversity and high natural carbon stocks are often confined to small areas, and companies' environmental footprints depend on where they source commodities. In addition, cities often depend on nearby watersheds for sustainable water supply, and climate change will affect parts of a country differently. Strategies towards sustainable food and land use therefore require geographic analyses and place-based solutions. Put simply, governments, businesses and civil society need to develop maps.

Yet few countries systematically use maps for the diagnosis of challenges facing their food and land use systems and the design of solutions. One interesting example is China, where maps are used extensively. Starting with large-scale restoration programmes covering an area the size of Australia, the country has mapped agriculture, biodiversity, ecosystem services and risks from natural disasters to identify areas that require protection, restoration and sustainable management practices. Using these maps, China has instituted an ambitious set of spatial zoning regimes (referred to as "red lines" in Chinese) that cover water, agriculture and ecological conservation. In each case, the government identifies areas that require protection and sustainable management to ensure long-term food security, water availability, biodiversity conservation and protection from natural disasters. A range of policy tools – principally zoning and economic incentives, including the world's largest system of payments for ecosystem services to secure Beijing's water supply – are used to achieve long-term goals in economic policymaking.

Other examples of the use of maps for the design of land use policies include Brazil's Forest Code, the European Union's Mapping and Assessment of Ecosystems and their Services, Australia's National Outlook, and land zoning in Namibia and South Africa. Yet despite the urgent need for spatial analyses and policy tools, most countries' climate and biodiversity strategies make little use of maps. Hardly any NDCs under the Paris Agreement and only a small sub-set of national biodiversity strategies under the Convention on Biological Diversity include maps. But without high-resolution maps countries will struggle to identify and manage competing uses of land, including for food production, biodiversity conservation, urbanisation and industrial development. They need maps to design strategies for meeting the SDGs related to food and land use systems.

Fortunately, recent years have seen an explosion in the availability of spatial data and analysis tools to support sustainable land use. For example, high-resolution satellite data from the Landsat and many other programmes is freely available to monitor land use and environmental change. Global Forest Watch (see Box 22) tracks deforestation and other changes in forest cover. The Transparent Supply Chains for Sustainable Economies program (TRASE, see Box 23) combines spatial data to track the sustainability of international agricultural supply chains. And the recently launched Nature Map integrates high-resolution data on biodiversity, ecosystem services and natural carbon stocks to develop a decision-support tool allowing countries to "spatially operationalise" their objectives to halt and reverse the loss of nature.

The Paris Agreement calls on countries to submit long-term, low greenhouse gas emission development strategies by 2020. In addition to mitigating emissions from energy, the strategies must chart a course towards sustainable food and land use systems. Successful long-term climate strategies will therefore require extensive use of maps and place-based economic and regulatory policy mechanisms.

3. **Aligned fiscal incentives and public spending.** Policies and fiscal incentives should send clear signals to markets, helping to direct production and consumption activities in line with national priorities. Tailoring public procurement, fiscal transfers and agricultural support, as well as using pricing (through carbon or sugar taxes), to drive environmental, health and livelihood outcomes are measures with great promise for bringing about positive change.

    - **Increased investment in human capital.** Developing human capital is essential for nations to be able to take advantage of new technologies, develop new business models and create innovative policies, products and partnerships that meet national needs. But today, food and land use systems across the world suffer from systematic under-investment in technical colleges, extension services (digital and physical) and R&D. Public and private R&D resources for food and land use systems together account for 0.1 percent of global GDP.[212] The majority of private sector R&D is in incremental product development. It has barely begun to translate the hidden environmental and health costs into major new market opportunities. There are some incubators of risk capital, but on nothing like the scale in other sectors.

    - **Strong risk management.** The capacity of governments, communities, businesses and the financial community to assess and manage different risks, strengthen resilience and build safety nets is likely to become even more critical as severe weather events become more frequent. The deep complexity of food and land use systems is a further challenge to that capacity.

Business leadership is a necessary complement to political and government leadership. Lasting, large-scale change will only happen when progressive business and finance actors also step up to the plate. They can drive the transformation by endorsing national policy reform agendas, and by aligning their own businesses and investment portfolios with national policy goals and pathways. Some parts of the business community are now moving faster than policymakers, recognising the potential scale of new market opportunities linked to the ten critical transitions (see Chapter 4 for more details). But change at speed and scale will only occur if progressive private sector leaders embrace and support politicians and governments in putting new rules and policies in place. Business and finance leadership need to come out and advocate collectively for reforms that fix what's wrong in food and land use systems, just as they are advocating for reforms that fix climate change, human rights and modern slavery.

International cooperation is also needed to support national responses to the challenges and opportunities. Individual countries' room for manoeuvre is defined by international trade rules, including tariffs, quotas and subsidies. Changing patterns of global demand translate into local environmental and economic impacts over which individual countries have little control. And multinational branded companies have a disproportionate impact on how tastes evolve across the world.

Over coming years, the need for international cooperation is likely to rise. Radical, even interventionist international action may be required to address key risks, such as pests and diseases or catastrophic disruptions of food supplies. It will also be needed to coordinate the design and operation of international financing instruments that underpin several critical transitions, such as efficient global markets for ecosystem services.

The ten critical transitions are all part of one interdependent, mutually reinforcing transformation programme. For example, all depend on a successful forest transition. The forest transition itself depends on the more efficient use of land, driven, among other things, by dietary shifts, increased productivity of regenerative agriculture, greater supply chain transparency, reduced food loss and waste and so on. Better diets play a critical role in enabling many of the other shifts, whether through freeing up natural resources or by improving health and so unleashing human potential. Note that one child in five is stunted due to under-nutrition, creating lifetime damage to their wellbeing and potential. At the same time, better diets depend on an expanding supply of nutritious, affordable food, making the success of the transitions relating to a sustainable ocean, alternative proteins and circular local economies particularly important.

In other words, this is not a menu from which to pick and choose. Wholehearted commitment to all ten critical transitions is needed. Countries that make the commitment will reap massive gains for the local and global environment, for the nutrition and health of their citizens and for the livelihoods of their rural populations. The better food and land use future is truly a prize worth having. The following chapter expands on this theme.

Transforming food and land use systems

From a system where...

Food and land use systems have large hidden costs greater than the market value

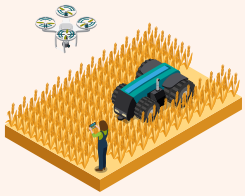
Rising hidden costs

Food and land use systems generate $12 trillion annually in hidden costs ($2 trillion more than their market value) through their contribution to climate change and environmental degradation, malnutrition, other public health costs and widespread rural poverty.

Tinkering at the edges

Focus on marginal improvements

Focus on small adjustments and celebration of marginal improvements in a dysfunctional system where the rules of the game encourage non-sustainable practices.



Focus on system maintenance

Public subsidy and support mechanisms decoupled from public goods but help to maintain status quo. Low levels of public and philanthropic capital (e.g. less than 3% of climate finance) are deployed to de-risk investments without addressing flaws in the current enabling environment or targeting scale-able investment areas.

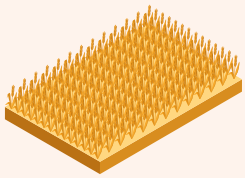
Concentration

Geographic concentration

Just a few countries provide the bulk of the world's calories: Argentina, Brazil, China, India and the United States, and within them relatively limited areas like the Midwest in the United States. In the face of unavoidable climate change and weather variability, this massively increases risk to food security across the world.

Food type concentration

30 crops and animals provide 95 percent of human food energy needs and just four – rice, wheat, maize and potatoes – provide more than 60 percent. Four varieties of apple dominate global markets today, compared with the over 7000 that existed at the beginning of the 20th century. This concentration reduces resilience, increases risk and leads to less nutritious diets.



Company concentration

From 1994 to 2004 the market share held by only four companies in four key food and land use value-chain nodes increased by around 150% (from just over 20% to just under 60%). This consolidation increases numerous systemic risks, particularly when these companies have high levels of influence on governments.

To a system which is...

Food and land use systems are net positive; costs are visible and largely paid by the responsible actor

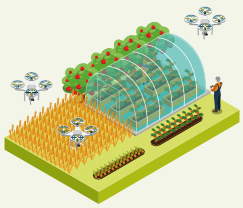
Visible and decreasing costs

Hidden costs are reduced by $5.7 trillion by 2030 relative to current trends scenario. Market value is at least $5 trillion more than the hidden costs. Costs increasingly born by those responsible for their generation.

Redesigning the system

System redesign

System designed to encourage sustainable practices – through pricing externalities and "public bads", protecting and restoring nature, using public finances and regulations to drive sustainability and better health.



Focus on opportunities

Public and philanthropic funding allocations to food and land use systems are scaled and deployed to drive innovative, high-impact sustainable investments (e.g. capacity building and market development in key geographies) in a reform-enabling environment, rapidly driving down risk perceptions and mobilising private capital at speed and scale.

Diversity

Geographic variation

More localised food production, with local circular loops ensuring more efficient use of resources as well as greater variety and respect for local culinary traditions. Sustainable trade is, however, still essential to ensure healthy diets, diversify local production risk and reduce environmental footprints of food and land use systems, especially in areas of high biodiversity value.

Higher agrobiodiversity

The world would draw systematically – including through fiscal incentives and active use of extension services/seed banks – far more heavily on the great variety of food varieties available from nature, thus increasing both nutritional value and resilience of food and land use systems.

Digital innovation and transparency disrupt markets and increase diversity

Governments use investments, research and development (R&D) and regulatory measures to reduce information asymmetries in supply chains, strengthening the hand of smaller actors. Cross-governmental cooperation is established to reduce market concentration and develop open platform protocols that are essential for retaining and fostering competition, innovation and equity.

From a system where...

To a system which is...

Linear, inefficient and long supply chains

Circular, efficient and often local supply chains

Linear

Nutrients are mined, used and wasted. Only 15-20% of the nitrogen and phosphorus applied to crops in fertiliser actually reaches consumers' plates. In cities, less than 2% of valuable nutrients from organic waste gets looped back to productive use.

Circular

Nutrients are captured after use and recycled in circular loops of value creation.

Inefficient

Land, water and chemicals are inefficiently deployed. Livestock uses 62% of agricultural land while delivering 17% of calories and 33% of proteins. Current irrigation efficiencies are often below 50%, with large losses occurring in the water transport system or through inefficient application to plants.

Efficient

Land, freshwater and nutrient use are driven towards efficiency through protection, regulation and pricing.

Long

There is nothing intrinsically wrong with long food supply chains, but the lack of pricing/regulation of externalities and "public bads" leads to far higher level of long-distance trade of products (including food) than would happen if those elements were properly priced into the transactions.

Often local

Urban and particularly peri-urban farming plays an increasingly important role in creating a symbiotic relationship with rural and urban populations. There is strong connection between movement towards local and circular supply chains respectively, strengthening both trends. Trade is still essential for nutrition, food security and sustainability, but with environmental rules applied to avoid unsustainable outcomes.

Opacity and impunity

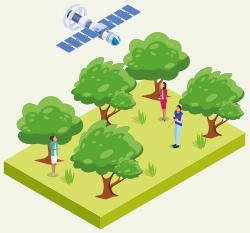
Transparency and accountability

Opacity

Despite progress over the last decade, the ability of systems actors to operate illegally and/or unethically in the shadows of international food and land use systems is significant, reinforcing and perpetuating low levels of accountability and high levels of impunity.

Transparency

The public sector drives transparency throughout supply chains through leading by example, implementing and enforcing regulatory measures, investing in free, publicly available satellite data, and financing and processing information sharing platforms to ensure full accessibility of information on all key elements of food and land use systems.



Impunity

Food and land use systems are characterised by high tolerance of crime – both from public and private sectors – and thus high levels of impunity, even for murder. Natural resources worth between $90 and $260 billion are being stolen each year. Environmental crime grows at 2-3 times the rate of the global economy.

Accountability

National governments and international cooperation put an end to impunity in food and land use systems, unlocking massive value creation potential while also ensuring a just transition and greater levels of equity. This is, in part, driven by a Global Alliance against Environmental Crime.

Casey Harris, CEO of Odonata, a not-for-profit entity supporting biodiversity impact solutions,on the land of Tiverton farm in Victoria, Australia. Tiverton farm is the first remnant-vegetation-only farm to operate sheep grazing in a comprehensive and master-planned model on Volcanic Plains Grassland.

R&D technicians at work in the Jain Irrigation's Jalgoan facility in Jalgaon, Maharashtra, India.

Women work on tissue cultured banana saplings at the Jain Irrigation facility in Jalgoan, India.

Chapter 4: A Better Food and Land Use Future

"You cannot get through a single day without having an impact on the world around you. What you do makes a difference and you have to decide what kind of a difference you want to make."

Jane Goodall

Chapter 2 laid out the case for transforming food and land use systems. It showed how existing systems have done an impressive job in producing affordable food with ample calories in recent decades, but how they also harbour multiple inefficiencies and incur huge hidden costs for the environment, health and inclusion. And because of their contribution to climate change and biodiversity loss, coupled with increasing concentration patterns, today's food systems might also be undermining food security.

Chapter 3 described the transformation programme identified by the Food and Land Use Coalition, made up of ten critical transitions. These could drive a turnaround for the environment, human health and inclusion, while also strengthening food security, if implemented together as a comprehensive package of reforms.

This chapter is structured as follows:

- **Section 4.1** summarises the modelling and the differences in outcomes between implementing the transformation programme and allowing current trends to continue. The different outcomes are captured in two scenarios based on the modelling. The "Current Trends" scenario shows our likely future if current trends continue. The "Better Futures" scenario shows, in effect, the expected outcomes of implementing the ten critical transitions worldwide.

- **Section 4.2** provides further detail of the outcomes of the different scenarios in terms of the environment, public health and inclusion, explaining how the differences arise.

- **Section 4.3** estimates the investment needed for the transformation programme and explains how it can be financed.

The modelling helps to understand the trade-offs and impacts of global drivers of change. As it is a simplification of reality, however, it has limitations. For instance, the Current Trends scenario understates the scale of downside risks arising from climate change, as climate models in themselves do not capture increased variability. And by providing snapshots at different points in time, the Better Futures scenario misses the messiness of the transition, with its risks of temporary setbacks and reversals. Finally, by focusing on what can be measured, the model does not explicitly account for resilience achieved through diversity (of crops, production modes and nature), which is arguably as important as productivity trends in shaping the future we want. Yet despite these methodological limitations, the scenarios do demonstrate what is possible, highlight crucial levers for change and quantify the broad environmental, health and inclusion consequences of different potential futures.

4.1 Summary of outcomes of the transformation programme

The main modelling for this report has been produced by the International Institute of Applied Systems Analysis' (IIASA) Global Biosphere Management Model (GLOBIOM), informed by in-depth analytical work on specific sectoral issues. The model provides a link between agricultural production choices and their impact on the planet. Complementary modelling was done by the University of Washington on diets and health; in addition, we run scenarios on income and employment using the World Bank Shockwave model. A more detailed exposition on the modelling can be found in the technical annex (Annex B).

The aim of the modelling is to offer broad insights into developments under two different scenarios.

The baseline scenario, Current Trends, was designed to deliver a picture of a future grounded in historical trends. This future would see considerable progress and innovation (for example with regards to agricultural productivity) within the framework of the current system. Current Trends mainly relies on the standardised set of assumptions that has informed the analysis of the Intergovernmental Panel on Climate Change's 5th Assessment Report (IPCC AR5), coupled with the matching set of climate assumptions.[i] Under this scenario the world gets nowhere close to meeting the SDGs or the Paris Agreement targets.

The reform scenario, Better Futures, is based on ten assumptions of fundamental change, derived from the ten critical transitions. Strong (but not perfect) implementation of the ten critical transitions would be the key to achieving the outcomes described in this report.[ii] The key assumptions are:

1. Aggregate average agricultural productivity continues to increase following historic trends at a rate of 0.9 percent a year under Current Trends. The Better Futures scenario assumes an additional 12 percent increase in productivity by 2050 due to technological advancements, i.e., an annual rate of increase of 1.1 percent overall. This reflects renewed efforts in R&D and technological diffusion, and large investments in infrastructure, which would help raise yield and reduce the yield gap between more productive and less productive producers.

2. By 2050, food loss and waste could be reduced by 25 percent.[iii]

[i] Our Current Trends scenario is defined by the Shared Socio-Economic Pathway 2[1] and by the climate assumptions of the Representative Concentration Pathway 6.0.[2]

[ii] A number of the key institutional features introduced in the critical transitions, such as structural changes that would lead to shorter supply chains, could not be modelled with the tools available. Their impacts are therefore described in more qualitative terms. These challenges were particularly strong when constructing socio-economic scenarios, given the limited number of variables that could be used to depict changes to livelihoods.

[iii] Note that the Sustainable Development Goal target is to reduce per capita global food waste at the retail and consumer levels by 50 percent, and to achieve a reduction in food losses along production and supply chains, including post-harvest losses by 2030. Recent analysis, however, demonstrate that achieving this goal is only achievable with breakthrough technologies and behavioural change. To avoid unrealistic assumptions, a 25 percent reduction has been modelled for this report.

3. Negligible conversion of forests and other natural ecosystems from 2020 onwards is possible.

    - This assumption is based on what exogenous climate modelling finds necessary to limit global warming to 1.5-degrees Celsius. It thus describes the necessary level of ambition. This report recognises that ending deforestation next year is unrealistic under any assumptions. However, the essential point to take away from the modelling is that the reform agenda to halt deforestation needs to be put in place without delay. The reform agenda described in this report aims to achieve the desired result as soon as possible, realistically between 2025 and 2030 (this has a knock-on effect for biodiversity, as well, where the model has recovery starting in 2020, but realistically that would happen gradually between 2025 and 2030, as deforestation is gradually halted).

4. Systematic measures to increase energy efficiency globally can achieve a reduction in energy demand by 40 percent relative to current demand – this would help the planet stay within a 1.5-degrees Celsius pathway without deployment of bioenergy with carbon capture and storage technologies (BECCS).[iv]

    - Though achievable, this is an ambitious assumption. For this reason, and because a number of other 1.5-degrees Celsius assumptions are also ambitious, an option is maintained to deforest, starting around 2040, some of the newly reforested land and use the biomass for BECCs, if such a solution becomes imperative to avoid runaway climate change and if further analysis demonstrates the relative merits of such an option relative to relevant alternatives.[3] Note that if the BECCS alternative is implemented, there will be significant negative consequences for biodiversity from 2040 onwards (see Box 25 on bioenergy in Chapter 3).

5. Enough food will be produced in 2030 to deliver on the ambitions of SDG2 (to end hunger, achieve food security and improved nutrition and promote sustainable agriculture), making it possible to eliminate food insecurity by 2030.

6. The world would converge towards "human and planetary health" diets by 2050 (see Box 7), with significant progress in that direction by 2030. This would include a global convergence in calorie intake and average level and composition of protein consumption.

7. The ocean would deliver 40 percent more sustainable proteins over the next 30 years.

    - Note that the potential is far larger, as Chapter 3 demonstrates, but a number of uncertainties makes a conservative assumption more realistic.

8. Significant investments in human capital, technology diffusion and the digital revolution would support the emergence of a new generation of young rural entrepreneurs who can take advantage of the opportunities offered by the transformation of food and land use systems and create decent jobs in agriculture and in the processing of agricultural products.

9. Increased investment in rural infrastructure (e.g. roads, clean electrification) and connectivity would be the key to overall income growth, helping to drive off-farm value added and the creation of non-agricultural jobs.

10. The combination of investments in rural assets and the design of new productive safety nets increases the resilience of the rural population in the face of possible dislocations caused by the transformation of food and land use systems and increasingly likely weather shocks.

[iv] Grubler et al (2018) illustrates how such a low energy demand scenario is possible based on rapid social and institutional changes in how energy services are provided and consumed, in addition to technological innovation. Trends in this direction are already observable (e.g. digitalisation and device convergence reduce energy demand, with a smartphone providing a single integrated digital platform which potentially replaces over 15 different end-use devices).[4]

These assumptions were tested by conducting sensitivity analysis around variable specifications. The narrative accounts for key uncertainties – such as the potential negative impact of climate change and the potential positive impacts of technology – on agricultural yields. In sum, the assumptions provide a realistic basis for the Better Futures scenario, though, again, that scenario depends on the full implementation of the ten critical transitions laid out in this report.

The implication of recent reports from the IPCC is that limiting global warming to as close to 1.5-degrees Celsius as possible is essential to avoid the risk of runaway climate change and to minimise the consequences of unavoidable climate change. Following the precautionary principle, the modelling underpinning this report therefore takes the need for the world to get on to a 1.5-degrees Celsius pathway as an ongoing assumption. Success depends on fundamental changes not only in food and land use systems but also in other key systems, notably energy. None of these systems are advancing fast enough today. Implementing the report's framework of reforms can get the world's food and land use systems on the right track fast. However, success in transforming food and land use systems depends on other sectors stepping up the pace of change with the same degree of urgency (and vice versa).

The main outcomes of the modelling include:

1. Higher productivity, reduced food loss and waste and dietary shifts yield the opportunity to shift more than 1.5 billion hectares of land away from agriculture compared to the Current Trends, meaning that:

    - Greenhouse gas (GHG) emissions are reduced in a way that is consistent with the 1.5-degrees Celsius pathway recommended by science. At a conservative estimate of the social cost of carbon, the differential in emissions between the Better Futures and Current Trends scenarios can be estimated at around $1.3 trillion annually, mainly achieved by protecting and restoring tropical forests.

    - The Biodiversity Intactness Index (BII) in the Better Futures scenario decreases by one percent between 2010 and 2020, which represents around one third of the losses experienced over the past 40 years. It however starts to recover after 2020, a sign of halting and reversal of biodiversity declines. In contrast, under the Current Trends scenario, biodiversity continues a steady decline towards the "sixth extinction" at a speed similar to that of the last 40 years, reaching 3.2 percent loss in BII between 2010 and 2050.

    - As demand and production methods change, the advantages of high intensity agriculture erode, reducing overuse of fertilisers and herbicides/pesticides.

    - By 2030, sufficient food is produced to feed everybody on the planet nutritious diets, while protecting affordability. A number of actions, such as ongoing agricultural productivity gains, reductions in food loss and waste and shifts in diet towards less-resource intensive foods, contribute to making this food affordable and accessible to the full global population. This could yield dramatic gains in the battle against poverty.

    - Shifting to healthier diets has the potential to reduce significantly by 2050 the number of people dying prematurely due to diet-related non-communicable diseases caused by high body mass index, from over ten million to less than 6 million.

2. The economic gains to society from reducing the current "hidden costs" of food and land use systems would sum up to $5.7 trillion annually by 2030 and $10.5 trillion annually by 2050. These numbers are almost certainly under-estimates, since they do not properly price in the benefits of reducing tail risks.

3. Rural incomes grow twice as fast over Current Trends and over 120 million more decent jobs are created in the countryside.

Financing the food and land use transformation agenda requires significant reallocation of capital to new assets across the food and land use system, combined with an estimated annual $300 – $350 billion increase in total capital investment – less than 0.3 percent of global GDP during the period. The world needs to invest more wisely, reducing systemic inefficiencies and redeploying capital in line with a more honest account of risk-adjusted returns.

The scale and extent of these results are impressive. They may even seem over optimistic. However, the modelling of the Better Futures scenario has incorporated a large degree of caution and flexibility. In particular, the assumptions are based on the scaling-up of existing technologies, while in many areas there are signs that entirely disruptive change is within reach.

Thus, while some aspects of the recommended transformation are likely to turn out less positively than modelled, others might be more positive, for example;

- Mariculture production of seafood is primarily constrained by the availability of feed in the form of fish meal and fish oil. If it were possible to remove this constraint by sourcing these proteins from molluscs, the productive potential of oceanic aquaculture would become almost unlimited. If such a technological breakthrough were achieved, consumption of poultry and pork could be replaced by consumption of farmed carnivorous fish such as salmon, and about 200 million hectares of cropland would be saved in the process.

- The model allows for significant reforestation over 800 million hectares, but the theoretical potential under the hypothesis of agricultural intensification is more than twice as large. Even if only half of the additional potential were leveraged, almost four additional gigatonnes of carbon dioxide equivalent would be removed from the atmosphere annually by 2050, for a value to society of $400 billion.

- Scientific consensus indicates that a range of five to 13 gigatonnes a year of additional carbon sequestration from forests could be achieved, depending on tree species' growth differences and what happens to the timber afterwards. However, these differences cannot currently be captured by the model in its calculations.

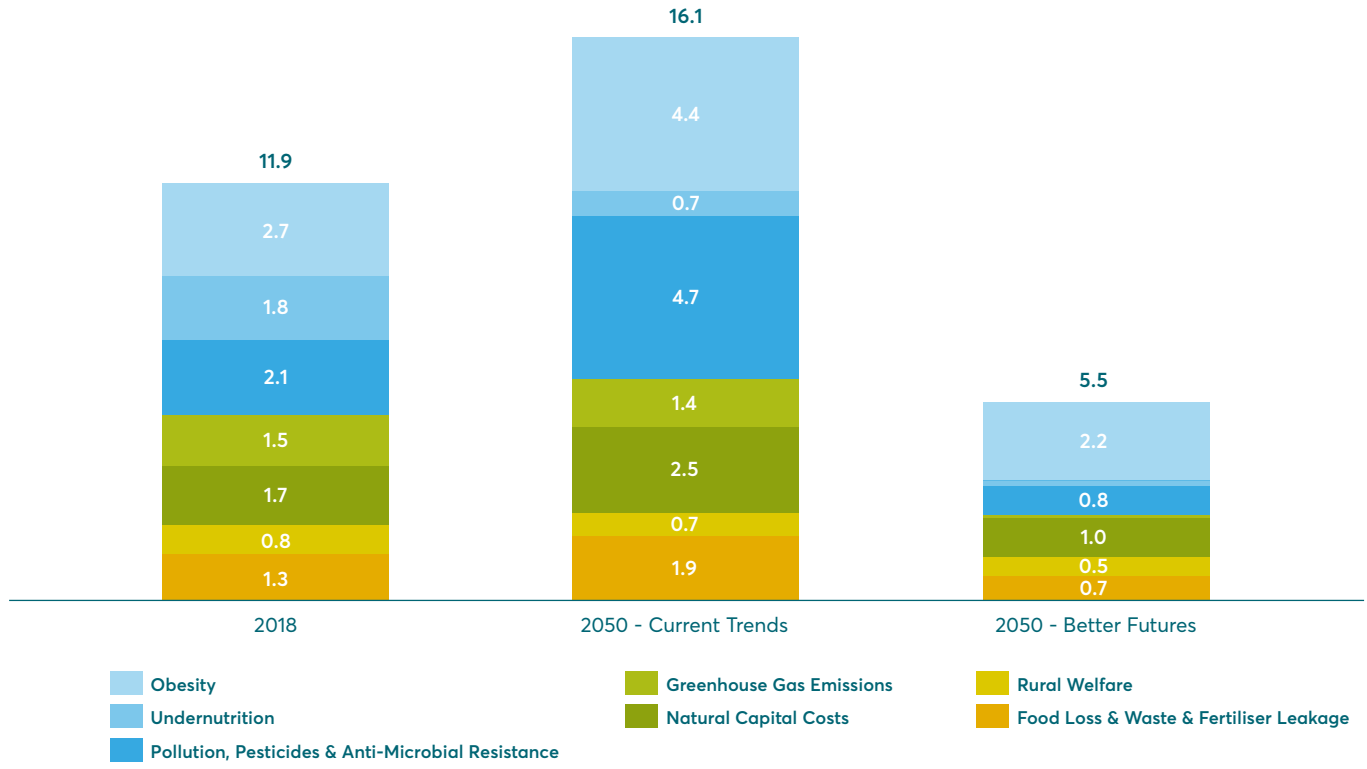
- Assuming that the appropriate measures were put in place by governments to support such activity, re-wetting deforested peatlands could result in a two thirds reduction of ongoing emissions from deforested land from 2025 onwards, resulting in a net negative emissions from the pre-farmgate food and land use sector by 2050 (up to one $GtCO_2e$ per year). That seems, for now, a likely scenario, given the impressive progress the Government of Indonesia is currently making in this area.

- While modelling for this report assumes a 25 percent reduction in food loss and waste, the potential is clearly larger if sufficient capital, regulatory action and innovation is targeted at the problem, yielding the potential for additional economic gains and reductions in greenhouse gas emissions as well as in biodiversity and ecosystem loss.

In other words, there is significant potential upside in the Better Futures scenario beyond the encouraging outcomes described above, if the ten critical transitions are fully implemented. As so often, the essential variable is political will.

EXHIBIT 29

The hidden costs of global food and land use systems in alternative 2050 scenarios versus today



Source: SYSTEMIQ, Food and Land Use Coalition, 2019 (see online technical annex for methodology).

4.2 Detailing the Outcomes of the Better Futures Scenario

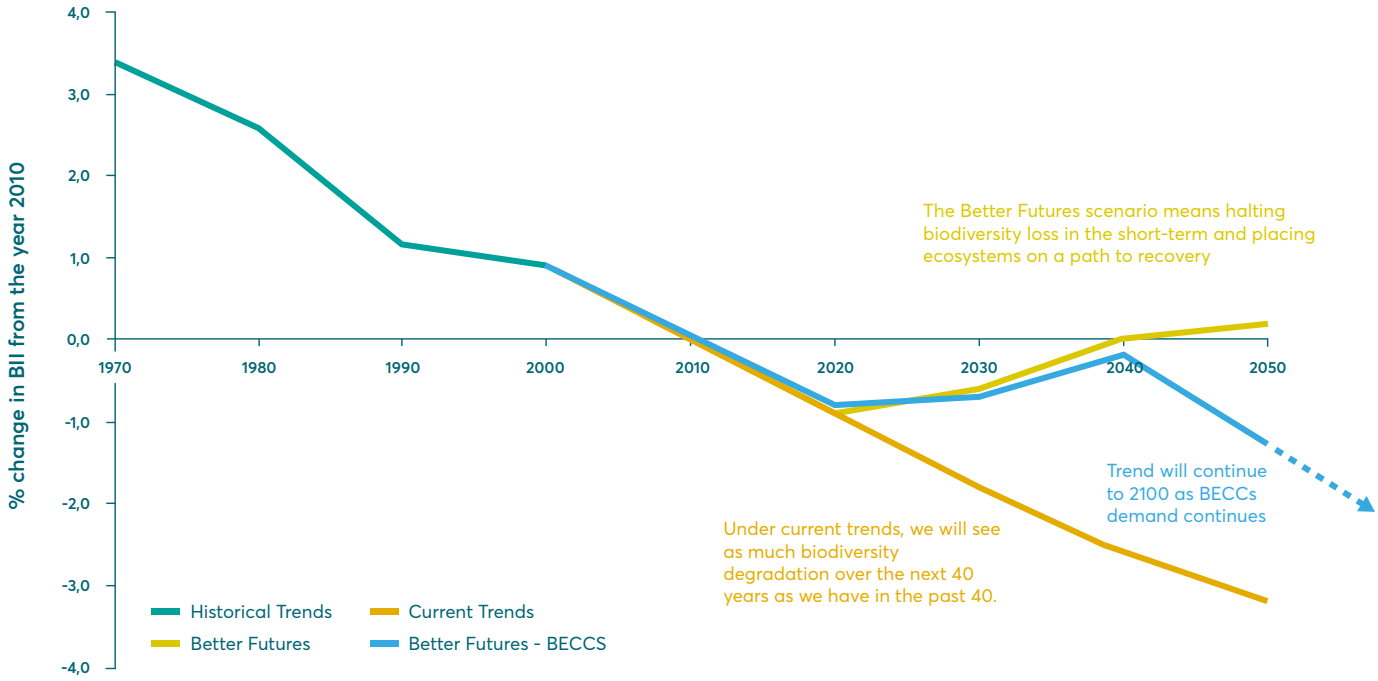
This sub-chapter details the key results of Better Futures in terms of environment, health and inclusion.

Better environment

Better Futures sees much less pressure on land, water and other natural resources than would occur under Current Trends. The combination of increased resource productivity, widespread deployment of regenerative farming practices, reduced food loss and waste and dietary shifts towards less resource-intensive proteins has the potential to transform the environmental impact of food systems. When combined with proper protection of and payment for key natural resources such as forests, the ocean and healthy soils, food systems could be a major driver of environmental protection and regeneration.

A BECCs scenario will reverse gains on biodiversity recovery and continue this downwards trend through to 2100

Biodiversity Intactness Index (BII): evaluates impacts on local biodiversity in terrestrial ecosystems



Source: IIASA GLOBIOM 2019; Leclère et al., "Towards Pathways Bending the Curve Terrestrial Biodiversity Trends within the 21st Century," 2018, for historical reconstruction

All environmental indicators are far more positive in Better Futures than in Current Trends. For example, Current Trends shows the world heading for a loss of biodiversity between 2010 and 2050 approximately equal to that between 1970 and 2010, during which loss of biodiversity and habitat was such that scientists began to warn of a "sixth extinction". In contrast, Better Futures entails a reversal of this negative biodiversity trend due to habitat loss, and even a slight recovery by 2050 (See Exhibit 30).[v] However, this reversal could not be sustained unless we avoid the use of bioenergy with carbon capture and sequestration for climate mitigation. To reverse biodiversity declines without giving up on climate mitigation ambition, Better Futures instead assumes a low-energy demand future (see Technical annex), that depends on achieving energy-efficient economic growth. This demonstrates the linkages between energy and land use, and the importance of achieving transformation in both sectors.[vi]

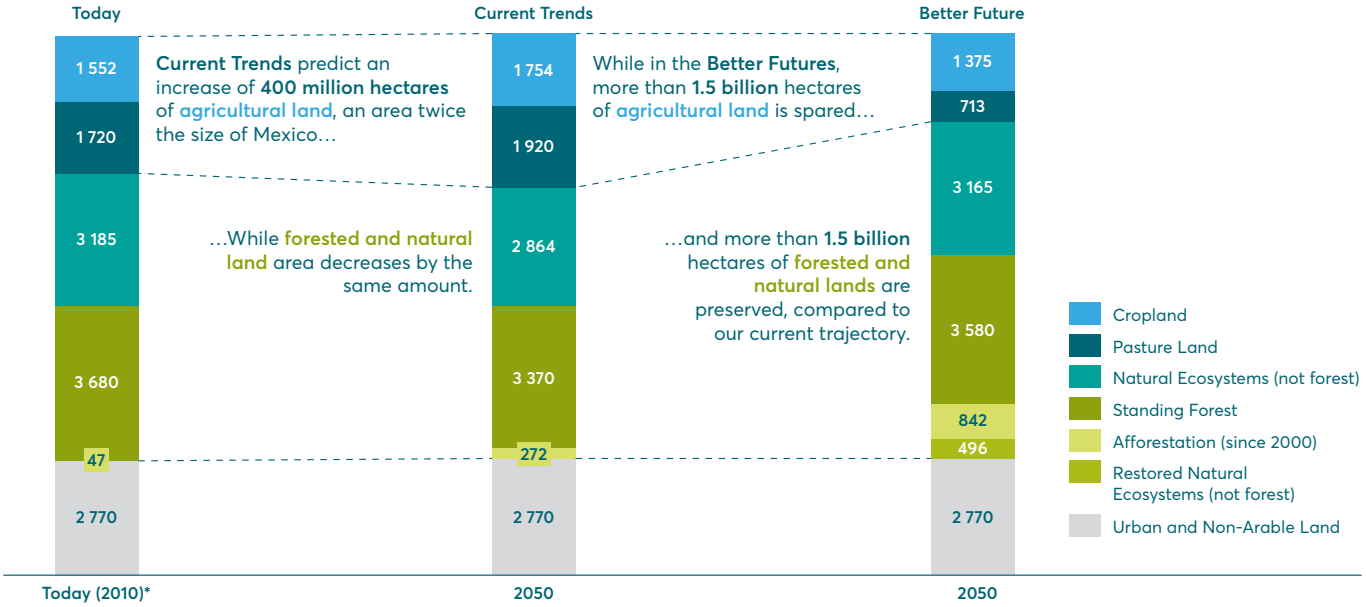
The biggest impact of Better Futures is on demand for agricultural land. In Current Trends, demand for agricultural land grows by an additional 300 million hectares from 2020 to 2050 – roughly a nine percent increase over today's total agricultural land requirement. In Better Futures, demand for agricultural land shrinks by well over one billion hectares over the period, with most of the reduction in demand for land seen in the Global South. A gradual shift out of land-intensive proteins, combined with faster productivity growth, lower food loss and waste and more efficient livestock management, reduces the need for grazing land and cuts requirements for land for feed crops, such as soy.

[v] The Biodiversity Intactness Index (BII) estimates how much the intactness of a region's originally present biodiversity has been degraded, relative to if the region were still covered with primary vegetation and facing no human pressures. BII is able to measure potential biodiversity recovery as it assesses ecosystem condition based on species diversity and relative abundance across originally present species.

[vi] If large-scale bioenergy with carbon capture and storage (BECCS) becomes necessary from 2040 onwards due to lower than assumed progress on energy efficiency, see the technical annex for assumptions, the land-sparing gain will be partially reversed due to land (an additional 225 million hectares) required for biomass harvesting. While BECCS at scale could potentially allow the system to stay on track for 1.5-degrees Celsius, it would do so at the expense of biodiversity recovery. Land use, biodiversity, climate and energy systems are tightly coupled and delivery failures in one system (e.g. missing energy efficiency targets) has major negative spill-over effects. Since the losses of biodiversity caused by large scale BECCS would have disastrous effects, delivering on the energy side of the equation is essential.

In the Better Futures scenario, 1.2 billion hectares of land which is currently used for agriculture will be freed up for restoration of natural ecosystems by 2050. Conversely, in the Current Trends scenario, a further 400 million hectares of natural ecosystem will be converted for agriculture

Total Surface Land Use: million hectares



*** Baseline data forecast from 2000**
Source: IIASA GLOBIOM 2019

Note: According to IIASA estimates, parts of the permanent pastures, as defined in the IPCC 2019 Special Report on Climate Change and Land report, are pastures without significant contribution to total livestock production and thus, are included in the land use classification 'Natural Ecosystems Land'. The 'Pasture' land use classification includes only grassland utilised for agricultural production.

Removing the need to expand agricultural land under Better Futures allows additional space for forests and other natural ecosystems to grow. In this scenario, gross tropical deforestation falls significantly from 2020 and is more or less eliminated by 2030. In addition, there is significant afforestation over the next three decades. By 2050, more than 1.3 billion hectares of land is in the process of returning to forest, woodland and other natural ecosystems, relative to today.[viii]

Greenhouse gas emissions from food and land use systems are dramatically reduced over the period. Today,[ix] these systems are responsible for over 13 gigatonnes carbon dioxide equivalent a year, taking into account direct agricultural emissions, emissions from land use change, shifts in forest cover, and emissions from other agricultural activities such as clear-burning of savannah and from crop residues[x]. Under Better Futures, food and land use systems become a net zero greenhouse gas contributor by 2050, absorbing over four gigatonnes carbon dioxide equivalent a year to make up for remaining agricultural emissions. This makes them critical in tackling the climate emergency. Food and land use systems thus deliver a level of climate change mitigation – a total positive mitigation swing of about 13 gigatonnes carbon dioxide equivalent – with a remarkable degree of efficiency and effectiveness.

[vii] This slide shows shifts between land use categories. As such it does not capture the restoration of cropland that occurs through regenerative agricultural practices and does not lead to a reclassification of land across categories.

[viii] A small amount of deforestation continues per year in 2050, therefore overall change in natural land area (forests and other natural ecosystems) is 1.2 billion between 2010 and 2050.

[ix] 2020.

[x] The GLOBIOM emissions estimate is in the range of 12-13 gigatonnes of carbon dioxide equivalent ($GtCO_2e$) per year, which is slightly higher than Intergovernmental Panel on Climate Change (IPCC) estimates of 10-12 $GtCO_2e$ per year. When GLOBIOM's deforestation data are calibrated with FAO data they are in accordance with the IPCC findings. For this report, however, GLOBIOM deforestation data were calibrated with the Hansen et al (2013) dataset, which uses geospatially explicit data analysis to report forest cover, resulting in higher deforestation and lower afforestation estimates than those reported to FAO, allowing for a more conservative analysis.

The key measures needed to reduce pressure on land and enable large-scale protection and restoration of forests, along with the related climate mitigation, are all "win-win" from environmental and economic perspectives. Reductions in food loss and waste provide a net benefit to the economy – they require investments but create value. Similarly, changes in diets and farming practices to increase resource productivity and improve soil health are all net positives for society and individuals. So too are changes in the management of ocean resources, which have the potential to provide an almost limitless supply of carbon-neutral proteins, provided they are properly governed and operated.

Better Futures is as positive for biodiversity as for climate, partly because reducing the need to expand agricultural land will also reduce pressure on natural ecosystems including biodiversity hotspots. However, the policies for protecting and restoring tropical forests and other natural ecosystems recommended in Critical Transition 3 (on protecting and restoring nature) are essential to gaining the full biodiversity benefit.

In addition, biodiversity benefits from lower requirements for agro-chemical inputs (fertilisers, pesticides, herbicides and fungicides). While these effects have not yet been included in the modelling, precision farming combined with regenerative farming practices and large investments in R&D have the potential to significantly cut such inputs without compromising yields. Shorter, more circular supply chains could also lead to greater nutrient recycling and lower food loss and waste.[5] The shift in dietary patterns, combined with growing transparency along value chains, is likely to expand markets for more natural food. New bio-based technologies that mimic nature and are less chemically toxic are likely to emerge rapidly as substitutes for traditional agro-chemical inputs. Based on our modelling, it would not be a surprise if demand for standard agro-chemical inputs into farming peaked by 2030.

Better public health

In Better Futures, consumers have the opportunity to make healthier, more nutritious choices that improve quality of life without compromising convenience. This yields major gains in relation to the incidence and costs of both under-nutrition and over-nutrition. These are two distinct challenges requiring different remedies. Today, both are faced simultaneously by a growing number of countries. The combination of dietary shifts, reduced poverty (especially in the countryside) and increased availability of low-cost, more nutritious food has the potential to deliver benefits to billions of people over the next three decades.

One extremely encouraging gain seen in Better Futures relates to under-nutrition. Under Current Trends, the number of chronically food-insecure people is forecast to decline to around 240 million by 2050, largely as a result of growth in per capita income (especially in South Asia and sub-Saharan Africa, where the majority of these people will live). However, if the frequency of shocks – owing to conflict or climate factors – increases, much higher numbers of people will be exposed to food insecurity. Such risks are likely to increase even more sharply after 2050 if, as in Current Trends, the world is on a pathway towards a 3-degrees Celsius scenario.

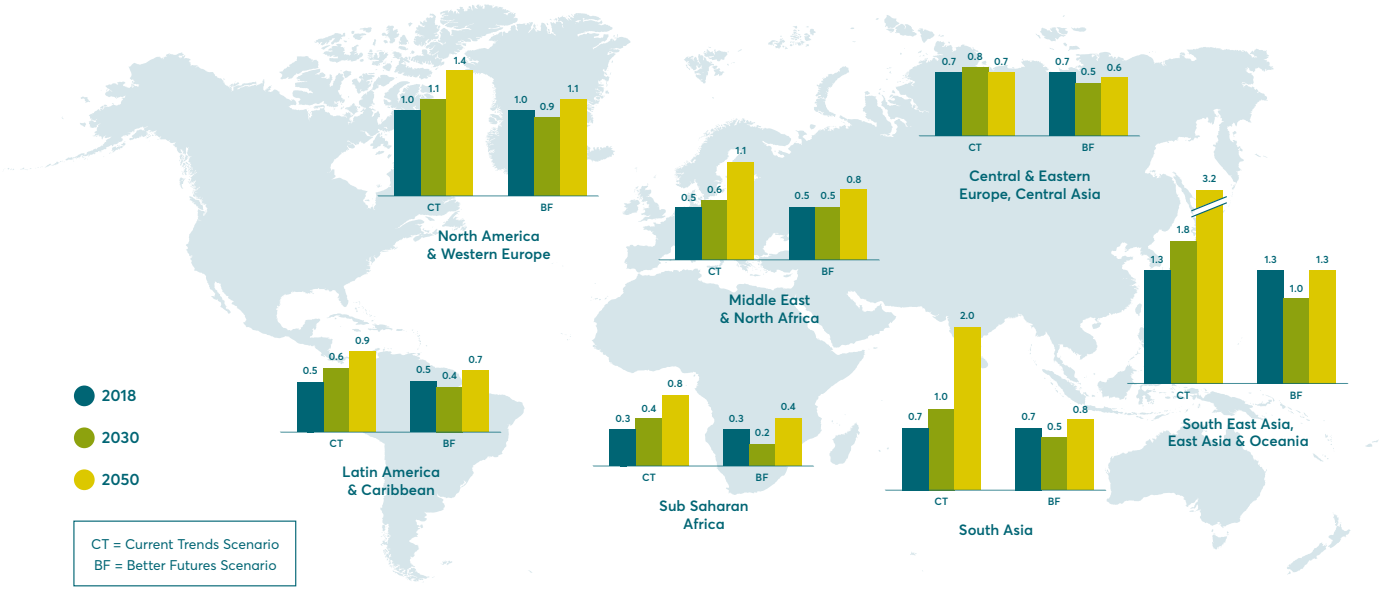
Under Better Futures, by 2030 sufficient food to feed everyone on the planet affordably is produced. Structural improvements that will help bring this about include measures to boost incomes in the countryside, where much under-nutrition remains even in food-exporting regions; expansion in supply of food containing the vitamins, minerals and amino acids essential for healthy growth; and the targeting of public support towards the most vulnerable communities and households through well-designed safety nets.

Note that the effective distribution of under-nutrition in both scenarios is uncertain, since it largely relates to people living in fragile states or regions, or in areas of climate stress, where factors exogenous to the food system – internal conflicts, supply chain disruptions or regional instability – could alter prospects fundamentally. Owing to falling greenhouse gas emissions and ecosystem loss, however, downside risks would be significantly lower under Better Futures than Current Trends.

Better Futures also has an impact on the rapidly growing public health challenge of over-nutrition. The direct costs of obesity, largely related to diabetes, heart disease and stroke, are already greater than the costs of under-nutrition on some measures. In Current Trends, the number of people dying prematurely each year as a result of high body mass index is expected to rise to more than ten million by 2050. In Better Futures, this number is reduced to around 5.6 million, with a 17 percent reduction in deaths from obesity as soon as 2030. Dietary shifts are key to that improvement. As Exhibit 32 shows, this outcome will look different in different parts of the world.

EXHIBIT 32

Annual deaths from high body-mass-index by region (millions)



Source: University of Washington, Institute for Health Metrics and Evaluation, Global Burden of Disease Model 2019

More inclusive development

Under Better Futures, inclusion is improved through investment in human capital, physical capital (roads, digital connectivity, irrigation systems and renewable energy) and natural capital (water management, soil health and forests). Faster income growth owing to higher productivity and new opportunities for agricultural and non-agricultural jobs bring benefits for people in the countryside, particularly those at the bottom of the distribution. The gap between rural incomes and urban incomes narrows from 50 percent under Current Trends to 40 percent. More diversified employment opportunities (especially in agro-processing activities) and the greater resilience gained from renewing human, physical and natural capital benefit rural people directly. Urban populations gain too from lower – though still significant – rates of rural-urban migration and increased local supply of nutritious, affordable food. These benefits come on top of average growth in rural incomes of two percent a year under Current Trends.

Better Futures also sees greater resilience in all elements of food and land use systems, from soils to food supplies. The importance of system resilience, given climate risks, has been highlighted in a recent World Bank report, which estimated that by 2030 up to 100 million more people, mostly in rural areas, could be in poverty because of climate change.[6]

BOX 42

Inclusion gains around the world

The ten critical transitions will reconfigure the rural economy and the livelihoods of those who depend on it, leading to an acceleration of rural income growth.

The scenario modelling on income and employment conducted using the World Bank's Shockwave model helps give a sense of how different elements of the critical transitions might combine in bringing about more inclusive development.

The middle-of-the-road socioeconomic development pathway assumptions (see the technical annex in Annex B) reflected in Current Trends already incorporate a relatively benign view of rural livelihoods, with the income of those in the bottom quintile increasing by over $100 Purchasing Power Parity (PPP 2011) by 2030 (roughly a two percent a year growth rate), and significant growth in job creation, particularly in services and manufacturing.

Better Futures factors in a number of developments that would accelerate that growth and create a larger number of "decent jobs".[xi] The dietary shift is expected to raise demand for more labour-intensive goods such as fruits and vegetables, where high-input farming has less competitive advantage. Combined with higher productivity growth and the diffusion of new ideas and practices, smaller and lower-input farmers can be expected to flourish. Incomes of the bottom 20 percent in rural areas are likely to grow about 20 percent faster over the baseline in Current Trends, boosted by payment for ecosystem services for communities on the forest frontier.

In addition, investments in rural infrastructure, human capital and entrepreneurship can support farming and the non-agricultural economy through the creation of more decent jobs than under Current Trends. Under this scenario, up to 120 million new decent jobs providing a living wage could be created across rural and urban areas. These estimates only indicate the potential of Better Futures to generate stronger livelihoods, as they depend on assumptions that are hard to identify at the global level.

Synergies across different trends seen in Better Futures can reinforce income growth, especially for the poor. For example, improvements in nutrition can lead to small but significant improvements in productivity for the poorest agricultural workers. In addition, productivity in low- input agriculture will gain from local regeneration of forests. Such specific benefits will compound the gains from including more fresh fruit and vegetables in diets, shortening value chains and increasing domestic value addition.

In comparison, Current Trends assumes that the rural economy worldwide grows significantly over the next 30 years, with little structural change in how it operates in developed countries. In developing countries urbanisation accelerates, especially in sub-Saharan Africa, driven by natural urban growth, internal migration and land reclassification as more rural settlements become built up.

[xi] As discussed in the technical annex (Annex B), as our scenarios are built using household survey data of the World Bank Global Monitoring Database, they cannot benefit from detailed individual level wage or earning information for a large part of the sample. We have therefore to resort to proxying those earning a living wage with those working and living in households above the poverty line.

Better Futures paints a picture of a more vibrant rural future. Investment in labour-intensive forms of agriculture (such as regenerative farming) combined with greater opportunities for off-farm employment in businesses set up by a new cohort of young entrepreneurs (for example, in peri-urban local food supplies) create more than ten million more good jobs a year in food and land use systems. Incomes are higher as a result of greater productivity. Farmers are better able to capture a fair share of the value through increased transparency, digitisation and better market access. However, the microeconomics of how value chains actually work – and how farmers obtain a fair share – remain critical, especially if downward pressures on food prices are sustained. Finally, payments for ecosystem services will potentially generate up to $30 billion a year by 2030, enhancing incomes for rural people including forest-dwelling communities.[xii]

Local market linkages will be important in shaping the relation between urban and rural areas, with locally produced (urban and peri-urban) food stabilising or increasing its share of urban demand. However, long distance and cross-border trade will continue to be vital to food security, leveraging comparative advantages and helping to neutralise local food price shocks (See Box 43). In sub-Saharan Africa, trade will help to increase value added, owing to economies of scale afforded by greater regional integration. Rural-urban migration will continue to shape local linkages too, with small towns playing a greater role than larger conurbations.

As well as bringing benefits, the Better Futures scenario poses certain transition challenges to the rural economy, for example through limiting growth of the livestock sector and redeploying land to nature-based solutions. Public action will be needed to explicitly address some of the transition costs. Restructuring public support can be helpful here, especially if subsidies can be linked to the provision of environmental services (See Box 44), and to investment in productive safety nets which also help to manage natural capital.

BOX 43

Trade policy in support of food security, inclusion and the environment[xiii]

Over the past 20 years, trade in agricultural products has more than tripled to reach $1.33 trillion, driven primarily by demand growth in large emerging economies and greater south-south trade, which now accounts for roughly a quarter of total agricultural trade flows.[xiv]Because of this increase, today at least 80 percent of the population depends on imports for at least part of its food and nutrition security, enjoying benefits in terms of variety (seasonal trade flows that enrich diets, for example) and prices.

While trade offers a more diversified basis for acquiring food and maintaining food security, many of the features of today's trading and investment system do not contribute to environmental, health and inclusion objectives, and may even undermine food security itself.

Countries with a comparative advantage in agriculture have captured a greater share of the world market over recent decades. This is leading production to focus on just a few regions and crops, with geographical and genetic concentration heightening the risk that multiple breadbasket failures could cause global disruptions to food supplies. Current trade arrangements, which reflect wrong incentives (by not reflecting externalities), are reinforcing the bias towards unsustainable intensification, the export of water from water-

[xii] This is based on the assumption that 60 percent of total REDD+ payments of $50 billion reach rural communities on the forest frontier or forest dwelling communities. This assumption can clearly be discussed, and countries will deal with this differently.

[xiii] This box draws heavily Bellmann, C., Hepburn, J., Lee, B. 2019. Impacts, Barriers and Opportunities: Where can international trade hinder or help deliver a sustainable food and land use system? Hoffman Centre for Sustainable Resource Economy. Additional sources are quoted separately.

[xiv] Excluding intra-EU flows.

scarce countries, soil degradation and biodiversity loss. By bypassing the potential of local markets to support more traditional diets, trade is contributing to greater greenhouse gas emissions from transport and storage of agricultural goods, while reducing local variation in diets and contributing to the reliance on ultra-processed foods, with convenience benefits but also potential adverse consequences for health.

In addition, the benefits of agricultural trade are not shared equally, with different groups affected by growth according to their consumption patterns and sources of income. Opportunities for poorer farmers, for example, are limited by the nature of the trading system. In terms of staple and fresh foods such as tubers and local cereals, trade flows are constrained by the fact that these foods tend to be consumed locally, while processed products are driven by globalised, commercial production networks and subject to food safety standards and regulations.

To participate equitably in international trade opportunities, therefore, small, poorer farmers need improved infrastructure, technical support on product quality, training in the use of digital tools to stay connected with markets, the provision of risk management instruments and support from producer organisations.

Trade policy, directly or indirectly, can exacerbate challenges to food security in certain markets. As barriers to trade result in "thin" markets, volatility is high. Even in the case of cereals, the largest category of exported products by volume, trade represents only 15 percent of world production. Policy reactions (such as the trade bans imposed during the 2007-08 global food crisis) have often exacerbated such volatility and resulted in a lasting erosion of trust in international markets.[7]

Addressing skewed incentives in agricultural production, as outlined in this report, is a first step towards addressing the challenges that trade can present to food security. In addition, multilateral coordination around policy responses at times of crisis is crucial. For example, following the rice price spikes of 2007-08, the Association of Southeast Asian Nations (ASEAN) started building the institutions for attaining rice security and avoiding extreme price volatility by focusing on rice trade facilitation (the ASEAN Rice Trade Forum), market information (ASEAN Food Security Information System project) and rice stocks (the ASEAN Plus Three Emergency Rice Reserve).

This type of multilateral arrangement is likely to become increasingly necessary in order to face higher frequency climate-related events. Other priorities include establishing international cooperation to tackle the environmental externalities of trade, removing perverse subsidies while providing targeted support for small-scale producers to stimulate sustainable production, and taking much stronger action on international environmental crime, much of which is linked to illegal deforestation and fishing.

The FABLE Consortium (see Box 40), with the support of the Gordon and Betty Moore Foundation, is leading a study to assess the sustainability of China's projected trade in agriculture and forestry products, drawing on national analyses from China's major bilateral trading partners. Initial findings will be available towards the end of 2019 with a final policy report due out by early 2020.

BOX 44

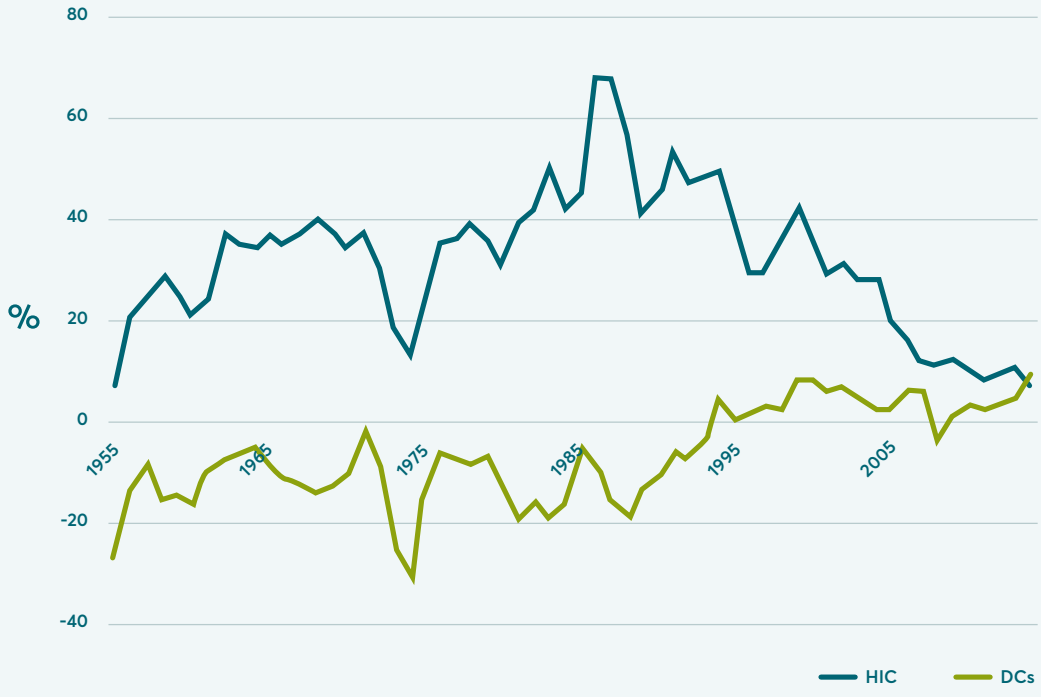
Public funds for public goods[xv]

Agricultural support, estimated at $700 billion a year,[8] is a key tool for governments to shape the economic environment for farming land. Support for agriculture comes in many forms and can be broadly divided into market price support, implemented through barriers to trade which alter domestic prices relative to world prices; coupled subsidies, such as subsidies on inputs or that are linked to outputs, that increase returns to producers and hence their incentives to produce specific goods; and decoupled subsidies that are not linked to current output (but to production in an historical period, for example) and remove the link between support and output levels.

The traditional pattern of agricultural support involved substantial support to farmers in high-income countries, while low-income countries, on balance, used to tax agriculture. This pattern has changed over the past decades, leading to convergence in nominal protection rates (Exhibit 33). In wealthy nations, average rates have fallen and there has been a move away from trade measures and towards decoupled protection. This seeks to avoid pushing for higher agricultural production and reducing the market access opportunities of other countries. In developing countries, meanwhile, agricultural support has shifted from net taxation to net assistance on average.[xvi] Nowadays, most support is provided through border measures that generate revenues, such as tariffs, rather than subsidies paid by governments.

EXHIBIT 33

Agricultural subsidy support to farmers is converging



Source: Mamun, A., Martin, W. and Tokgoz, S. 2019. Reforming Agricultural Subsidies for Improved Environmental Outcomes. International Food Policy Research Institute (IFPRI)

[xv] Unless otherwise acknowledged this box draws from Abdullah Mamun, Will Martin, Simla Tokgoz (2019) Reforming Agricultural Subsidies for Improved Environmental Outcomes, International Food Policy Research Institute, often verbatim. That paper used the latest data available at the time of writing, that is those of OECD based on 51 countries between 2015-2017.[9]

[xvi] Notable exceptions of countries still taxing agriculture include Argentina and India.[10]

BOX 44 - Continued

In addition to agricultural support, governments also intervene to improve the enabling environment for agriculture, providing goods that would otherwise be under-provided, such as R&D and rural infrastructure. [xvii] Support through provision of public goods has been estimated at 12 percent of total subsidies in OECD countries, and 16 percent in non-OECD countries.

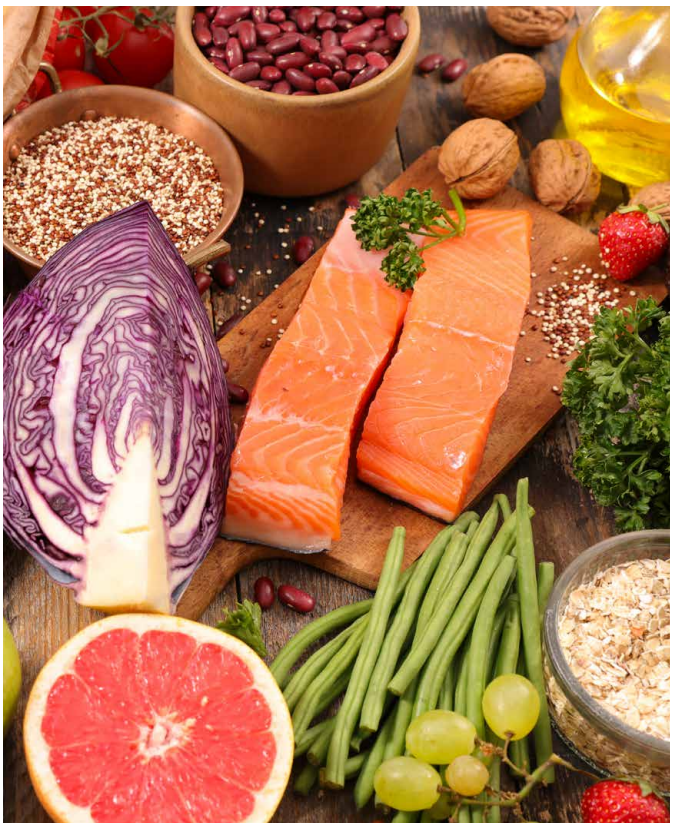
With agricultural production and land use change contributing up to one-third of global emissions, spending on subsidies has potentially wide implications for environmental and climate impacts, given current technology. Recent analysis by IFPRI suggests that only around 20 percent of agricultural support directly includes environmental conditionality or cross conditionality.[11] The evidence shows that many of the measures aimed at supporting better environmental practices often have little impact if subsidies support behaviours that would be chosen anyway (lack of additionality) or that allow farmers to minimise changes to their ideal behaviour. An example of this is slippage, whereby farmers who receive payments to set aside land choose to set aside their least productive land.

Research commissioned for this report has highlighted how subsidies contribute to emissions. First, subsidies that target the production of emission-intensive commodities such as meat, dairy and rice, or that reduce production in more efficient countries through tariff barriers, result in higher levels of emissions.

Second, subsidies that support adverse land use changes, as in the case of meat, soy and palm oil, thereby resulting in greater deforestation, contribute to higher emissions. IFPRI analysis conducted for this report suggests that there is huge potential – worth over $220 billion – to redirect agricultural support away from emission-intensive goods.

This report recommends that countries investigate the potential to redesign their agricultural support regimes to improve environmental outcomes as well as production of more nutritious food. In so doing, they should draw upon lessons from successful schemes for payments for ecosystem services and take care to target incentives directly at the desired outcome in relation to soil carbon. Public support mechanisms, whether through fiscal subsidies or trade regimes, should provide incentives for farmers to produce healthy food in ways that regenerate nature and strengthen resilience – in short, public funding for public goods.

[xvii] Other interventions that indirectly affect agriculture but are outside the scope of support as conventionally defined, are mandates for use of biofuels and improving access of poor people to food through social safety net programs.



Feeding a growing population in a Better Futures scenario

Standard forecasts typically estimate a 70 percent increase in food production demand by 2050, with consequent pressures on food prices, land and water requirements, and the environment.[12] Coupled with climate change and population growth, the picture painted is one of growing food security risk, especially in parts of the Global South, and massive pressure on land. Current Trends tends in the same direction.

The message from Better Futures is that if the ten critical transitions are implemented with conviction and urgency, a very different future is possible.

First, and perhaps most importantly, the scenario forecasts growth in food production demand to be closer to 25 percent than 70 percent by 2050. There are two main reasons: the shift towards healthier diets, which translates into significantly lower requirements for animal feed, and a 25 percent reduction in food loss and waste compared to 2010 levels. In addition, GLOBIOM modelling uses more conservative population predictions than those published by the UN. The population projection data estimates a global population of 9.3 billion[13] by 2030 under Better Futures, compared with United Nations (UN) estimates of 9.8 billion.[14] The lower figure contributes to lower production demand, and the number of people who are undernourished also falls sharply compared to the current trend.

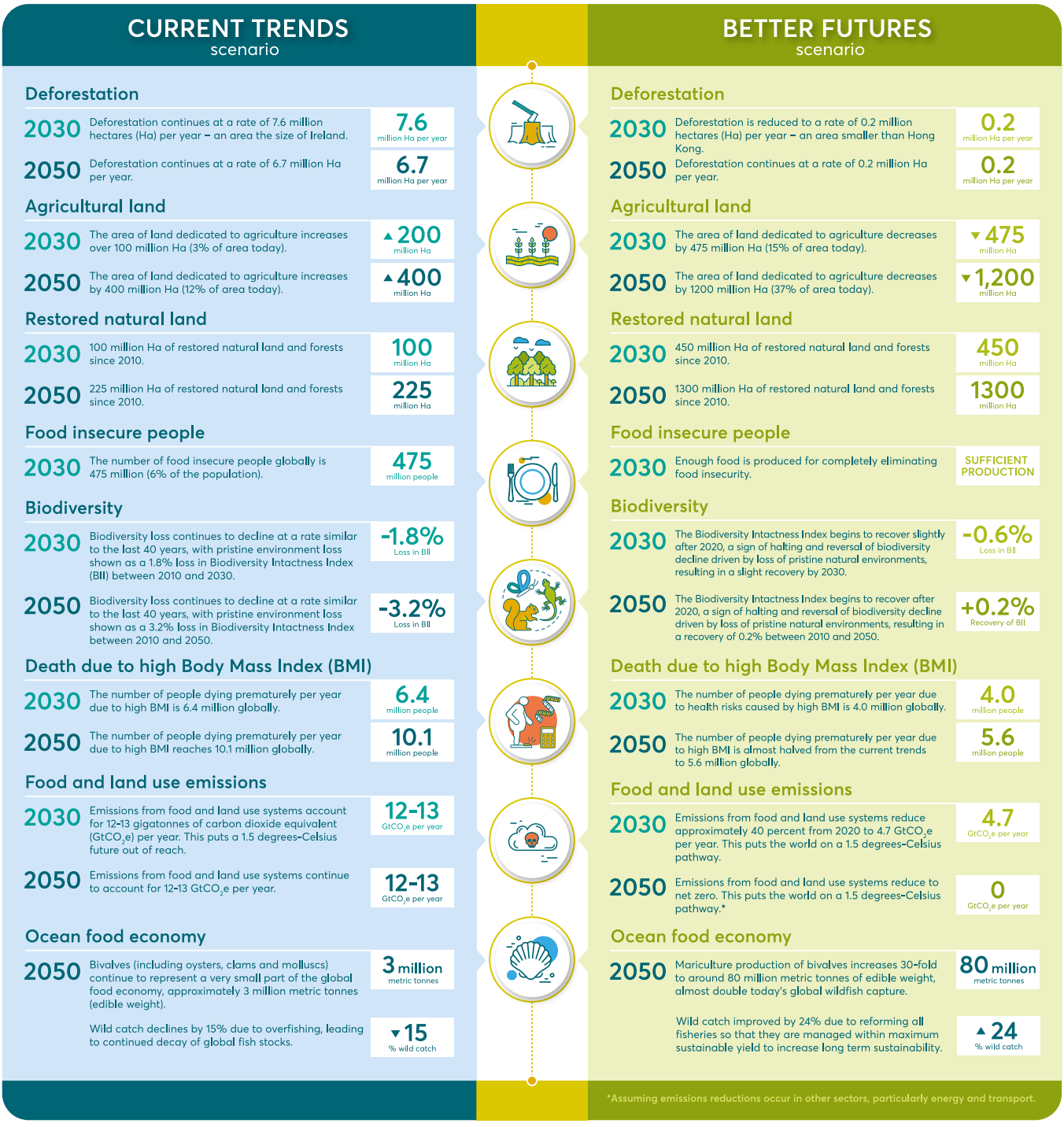
Second, Better Futures includes a significant shift in the pattern of food consumption. While most forecasts assume that the rest of the world will move towards current northern and western developed-country diets, this scenario envisages a convergence towards a human and planetary health diet. This would mean significant changes in all countries, whether developed, developing or emerging economies. There are signs that diets have already moved some way in this direction in some developed countries.

Third, under Better Futures, agricultural supply continues to expand across the world, with faster productivity growth in most of the Global South. Productivity differentials across different farming systems remain, however, suggesting that further improvements are possible if progress is faster than assumed due to, inter alia, higher resources committed.

As a consequence of these three developments, food security worldwide has the potential to improve. Better Futures sees enough food being produced to eliminate food insecurity by 2030, compared with more than 240 million people experiencing food insecurity by 2050 under Current Trends. Moreover, the modelling indicates a significant downward pressure on food prices relative to today, which will improve food security by increasing affordability.

EXHIBIT 34

Comparing the Current Trends scenario with the Better Futures scenario



The combination of the income growth built into the baseline scenario (the middle-of-the-road socioeconomic modelling pathway (see Technical Annex)), and the developmental impact of implementing the ten critical transitions, means that rural incomes could rise by almost 50 percent by 2030 in the Global South. The social and economic benefits of this trend are hard to overstate, provided they are accompanied by shifts into healthier diets.

Trade is critical to national food security under Better Futures, but with some important differences from today. The scenario sees the share of trade in global food supply decreasing slightly over the period. Its regional and product composition changes more significantly. As diets diversify, so the range of high-volume traded commodities expands to include crops better adapted to regional realities. For instance, West Africa could become a net exporter of beans, cacao, fonio and millet, East Africa of enset, coffee and sorghum.

The changes in the composition of trade happen in parallel to efforts to make transport carbon-neutral and refrigeration sustainable. In the south, local investments in improved logistics allow greater demand for fresh fruits and vegetables from urban areas to translate into greater demand for high labour-intensive smallholder production, especially in peri-urban areas. In contrast, many of the countries in the north remain dependent on trade to access fresh fruits and vegetables off-season.

Trade will be indispensable in a world heading for food security with lower greenhouse gas emissions, greater biodiversity protection and nutritious diets for all. However, the food system could experience a growing number of shocks from a higher frequency of extreme weather events, prudent policymakers will want to continue sourcing from a range of countries. Diversified sourcing will need to be combined with mechanisms that build transparency into global supply chains and links between consumers, producers and the landscapes in which they operate.

4.3 Financing the Food and Land Use Transformation

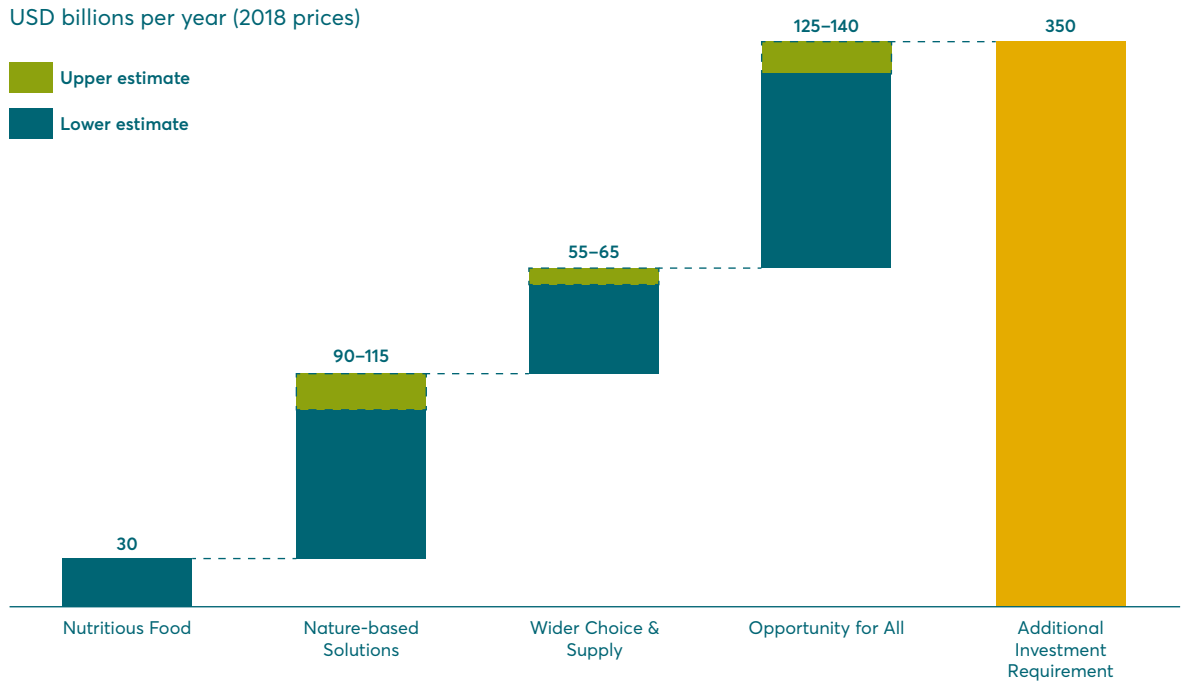
Delivering the ten critical transitions of the Better Futures pathway will require a fundamental shift in what gets financed: from capital-intensive, externality-generating, high-input assets in linear value chains to knowledge-based, regenerative and circular business models that are driven by value rather than volume and are more resilient, human-scale, diversified and in balance with nature. It will also require a systemic shift in *how* food and land use systems are financed – away from short-term investment practices that fail to price in climate-related financial, social and environmental risk, and into long-term investment solutions that put a price on nature and account for the trillions of dollars of hidden costs relating to climate, biodiversity, human health and livelihoods.

To realise this vision, capital will need to be reallocated from the "old" food and land use economy into the new one. New investment will also be needed – to the tune of $300 to $350 billion each year to 2030 (see Exhibit 35). This is not insignificant – especially as more than half will need to be deployed in developing markets as these regions will see the most significant growth in food demand and have the greatest potential for productivity gains.

However, put in context, the additional investment needed to deliver the Better Futures scenario is only a fraction of what is currently invested in the global food and land use system.[xviii] It also amounts to less than six percent of the $6 trillion annual SDG funding requirement, Yet it could deliver around a third of the required carbon savings alongside huge benefits for biodiversity, human health, livelihoods and inclusion. The economic gains from this investment are estimated at $5.7 trillion by 2030, delivering a return to society of more than 15:1.

EXHIBIT 35

The annual investment requirements associated with the ten critical transitions are between $300 and $350 billion (2018 - 2030)



Source: SYSTEMIQ, Blended Finance Taskforce, 2019 (see online technical annex for methodology).

[xviii] In 2016, public investments in infrastructure amounted to ~$620 billion including government expenditure and development flows while total credit from private/commercial banking sector to producers in agriculture and, forestry and fisheries accounted for ~$560 billion. Including investments from other value chain actors would bring the share of additional investment requirements further down. See https://www.un.org/pga/71/wp-content/uploads/sites/40/2017/02/New-Climate-Economy-Report-2016-Executive-Summary.pdf

Investment requirements for the new food and land use economy

Exhibit 35 lays out the investment requirement for each of the four categories of the Better Futures Transformation Pyramid. Investment in "opportunity for all" and "nature-based solutions" forming the bulk of the capital requirements.

Financing opportunity for all

Unsurprisingly, almost half of the investment (or just under $150 billion a year) is needed for the "opportunity for all" layer of the Transformation Pyramid, which captures investment in rural infrastructure, extension services, financing smallholders, education for girls and family planning.

The lion's share is needed in sub-Saharan Africa and other regions without adequate roads and energy systems. This kind of infrastructure investment will provide savings by reducing the overall cost of food production and dramatically lowering food loss and waste. Expanding irrigation and improving irrigation efficiency are also critical areas for investment, given their potential to increase yields and reduce uncertainty for farmers, especially as climate-related risks grow.[15]

Such investments have high upfront capital costs and often require "patient" public capital and effective management. Financing solutions suited to rural infrastructure therefore include public-private partnerships and blended finance vehicles, which use development capital to mitigate investor risks. Innovative mobile payment solutions and shared infrastructure, such as solar-powered pay-per-use cold storage units or solar-powered water pumps (Box 45), can lower the estimated financing needs.[16]

BOX 45

Blended finance for rural infrastructure

CDC – the UK development finance institution – is championing a blended finance solution to mobilise capital for rural infrastructure in the new food and land use economy through its investment in SunCulture. This is a solar irrigation company providing smallholder farmers who grow high-value fruit and vegetables in Kenya with products for spray and mist irrigation, drip irrigation and solar pumping. SunCulture has launched a solar-powered water pump called the RainMaker. Smallholders who are not able to buy a pump because of their high borrowing costs and limited access to working capital can access a pay-as-you-go financing scheme.

Rainmaker users report an increase in yields of an average of 300 percent a year. They also significantly reduce costs by saving the energy they used to spend on collecting water and the money they used to spend on fuel for electric pumps.[17]

Financing nature-based solutions

Financing nature-based solutions is the other major investment category in the Transformation Pyramid. Approximately $100 billion new investment will be needed each year in regenerative agriculture practices, to support a healthy and productive ocean and to restore forests and other critical ecosystems. Scaling up payments for ecosystem services and business models that integrate a "produce and protect" approach will help mobilise capital for nature-based solutions. Financing solutions that incorporate conservation into traditional commodity production will be critical to start shifting the obligation to protect and restore nature on to the beneficiaries of ecosystem services.

Financing forest protection and restoration (with restoration costing anywhere between $30 to $50 billion a year) is particularly important as it forms the majority of the nature-based solutions investment requirement, and holds massive future benefits for climate, ecosystems, biodiversity, and water. On average around $14 billion a year would go to forest protection to achieve the lower deforestation rate targeted by the Better Futures scenario, reaching the targeted REDD+ (Reducing Deforestation and Forest Degradation in Developing Countries, Box 26) costs of $50 billion a year in 2030 (if deforestation reduction results are achieved). Around $1 billion would go to additional forest management costs. Even at $65 billion a year, the cost is modest, given the huge benefits derived from forest ecosystem services. The social benefit of the forest related "mitigation gap" in 2030 between Better Futures and Current Trends is conservatively estimated at around six gigatonnes of carbon dioxide equivalent, i.e. a social cost of $600 billion, meaning a nine to one rate of return on investment.

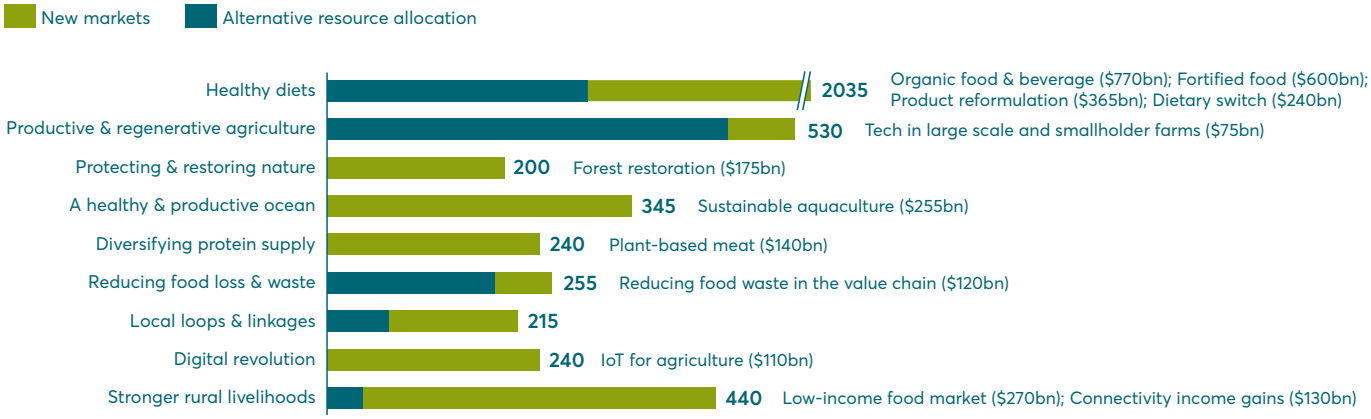
The Better Futures business opportunity

New analysis for this report suggests that Better Futures represents an economic prize of around $4.5 trillion by 2030 (Exhibit 36 and the technical annex – Annex B). This includes revenues from new markets and products across the ten critical transitions – for example, the market for sustainable aquaculture and bivalves which together could be worth over $300 billion a year by 2030. It also includes system savings derived from a reduction in land use, less food loss and waste and a range of other efficiency gains in the system – essentially freeing up capital to be reallocated for assets in the new food and land use economy that are not associated with trillions of dollars of negative externalities (see Exhibit 15 in Chapter 3 on hidden costs).

EXHIBIT 36

There is an annual business opportunity of $4.5 trillion associated with the ten critical transitions in 2030

USD billions (2018 prices), 2030 estimates, examples of opportunities >$100bn



Source: SYSTEMIQ, Blended Finance Taskforce, 2019 (see online technical annex for methodology).

Redirecting capital into low-carbon, regenerative, circular models of food production and consumption should drive higher-quality, lower-risk economic growth in developed and emerging markets and open up entirely new business opportunities and efficiency gains. This is not a new concept. When the Business and Sustainable Development Commission originally estimated the value of the new food and land use economy in 2017, it projected an economic prize of up to $2.3 trillion a year through investment in a more knowledge-intensive, resource-efficient, nature-based system.[18]

Analysis for this report has confirmed that this figure was relatively conservative, and that there may be over $2 trillion extra a year in business opportunities on top of the original projections by the Business Commission. Either way, the projected market for Better Futures assets is only expected to grow, which is likely to be confirmed by the World Business Council for Sustainable Development (WBCSD) in its forthcoming paper, "CEO Guide to Food System Transformation" which will be published on 16th October 2019 on World Food Day.

The business models and assets of the new food and land use economy will often have lower capital requirements, use fewer inputs and capture widespread efficiencies from natural capital solutions. For example, the growing alternative proteins sector (embracing sustainable aquaculture and multitrophic farming, plant-based meat substitutes or lab-grown meat) is more "infra-light" than livestock production. Beef and dairy production in particular have major capital expenditure requirements for abattoirs, milking machines and other processing infrastructure, and require much more land to deliver the same protein count. Similarly, more regenerative, resource-efficient agriculture should reduce the need for inputs such as inorganic fertilisers and pesticides.

While more traditional investment in rural infrastructure may have higher upfront capital costs, it will improve productivity and supply chain management, thus lowering future food production costs. A 15 percent reduction in food loss and waste results in almost $200 billion a year of recouped market value. There is also a significant social benefit from reducing externality costs related to health and climate by scaling these new industries. This makes their value proposition even more appealing to policymakers by avoiding hidden costs and negative externalities (Exhibit 15 on hidden costs).

Of course, capital that is "saved" from shrinking sectors such as beef, dairy and agro-chemicals will not automatically be redeployed for the Better Futures critical transitions. It is especially difficult to shift investment from capital-intensive physical assets into recurring operational expenditure costs of human and natural capital development. Putting in place the right policy framework, including regulations, incentive structures and subsidies, and improving information sharing, risk mitigation and mechanisms for scaling innovation are essential. So too is mandating the disclosures recommended by the Task Force on Climate-related Financial Disclosures (TCFD) for the main agri-businesses, and expanding the disclosure categories to include nature, water, biodiversity and public health. A corresponding shift in the use of public and development funds to mobilise private capital for the new food and land use economy will also be critical.

Financial innovations that will drive the transition

The Better Futures business opportunities, potential system-savings and wide-ranging positive externalities for people and planet from the Better Futures scenario are hard to ignore. Capturing them will depend on creating the right financial instruments and innovative partnerships, as well as expanding the pipeline of bankable opportunities to accelerate investment. These measures will help investor "agility" to move capital into the new food and land use economy. Of course, this financial transition will also need to overcome existing macro, regulatory, technical and commercial risks, as well as pipeline constraints.

The catalytic use of development and philanthropic capital will be crucial in overcoming various risks (both real and perceived) and constraints to attract private investment into assets in the new food and land use system.

These assets typically share five characteristics:

- **Higher perception of risks**, especially to finance smallholders who typically have limited or no credit history, credit rating or collateral, and high debt burdens
- **New business models** such as conservation or integrated landscape approaches that combine multiple revenue streams
- **Innovative technology and practices with unfamiliar risk profiles**, for example in regenerative agriculture and alternative proteins
- **Riskier geographies**, since many assets in the new food and land use economy will be located in emerging markets where political risk, weak legal systems (especially relating to land titles), lack of local currency financing, hedging costs and weak institutional and physical infrastructure are all barriers to investment
- **Long-term finance requirements** typically needed for investments in irrigation, improving soil quality, forest and ecosystem protection, nature-inclusive agriculture, new farm equipment and farmer training. Most banks perceive these investments to be too risky, or lack access to the funding they need to provide long-term lending. They may also find that the required loan tenors make it difficult to comply with increasingly stringent banking regulations such as Basel III.

The pipeline of investment opportunities will be supported by the reforms outlined in Chapter 3 as they should strengthen the enabling environment and make it more attractive to play in the new food and land use economy. However, many of the most significant investment opportunities will still have the characteristics listed above. Mobilising the additional $300 to $350 billion a year needed to transform food and land use systems will therefore depend on rapidly scaling innovative financing solutions which can mitigate these risks and attract more private capital, until investment in Better Futures assets becomes mainstream.

Innovative financing solutions

A range of financial products and structures are already on or coming to the market and could help mobilise capital for new food and land use assets across the Transformation Pyramid to deliver the Better Futures scenario (see Exhibit 37).

EXHIBIT 37

Financial Innovation Matrix: 10 financing innovations / solutions for the Food and Land Use Transformation

	Financing solution									
Transformation	**Paying for nature** (PES, carbon credits, debt swaps)	**Bonds** (green, blue, SDG, sustainability, resilience)	**Blended finance** (first loss, g'tees, hedging)	**Securitisation**	**Impact investing**	**Sustainability linked loans & financial products**	**Contractual** (vendor / supply chain finance)	**Insurance** (parametric, weather-indexed)	**Technical assistance / project development**	**Shared services (fintech / mobile)**
1. Nutritious food		✓	✓	✓	✓	✓	✓		✓	✓
2. Nature-based solutions	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
3. Wider choice & supply		✓	✓		✓	✓	✓	✓		
4. Opportunity for all			✓		✓	✓		✓		✓

Source: Blended Finance Taskforce, Food and Land Use Coalition, 2019

Financing solutions which help mobilise capital for the Better Futures scenario

	Instrument	Description	Examples
Financing new business models	**Paying for nature**	Payments to incentivise the protection and management of nature by attaching a value to the services it provides like climate change mitigation, oxygen, flood management or temperature regulation. Includes payments for ecosystem services (often through outcome based / pay for performance models), conservation finance models like carbon and resilience credits, debt for nature swaps, and tourism user fees etc.	• Norway's REDD+ programme (critical transition #3 on protecting and restoring nature) ($2.3 billion disbursed) • Blue Ventures' payment for mangrove ecosystem services • Greening Australia's carbon and reef credits • $22 billion Seychelles debt swap for the marine protected areas • South Pole carbon offset schemes with cocoa producers • Vietnam's Payment for Forest Ecosystem Services funded by domestic hydropower companies and subsidised by USAID ($150 million)
	Contractual innovation (new forms of vendor / supply chain finance)	Contractual arrangements between supply chain actors to incentivise sustainability performance, lock in offtake, or redirect capital to conservation	• Walmart's Sustainability Index Program with HSBC (global suppliers get improved financing rates tied to their sustainability performance) • Danone milk contracts to drive regenerative ag and performance improvements
	Innovative insurance	Insurance provides protection by promising to compensate for a specified loss or damage in return for payment of a specified premium. Includes parametric or weather index insurance (does not indemnify the pure loss, but makes a payment based on a triggering event like a hurricane) and microinsurance (protection of low-income people against specific risks like natural disasters)	• SwissRe / TNC parametric insurance for the Mesoamerican coral reef • UNDP's microinsurance programme for coastal fisheries in Fiji • Kilimo Salama weather-indexed insurance
Longer-term financing with capital markets	**Green/ Sustainable Bonds**	Debt instrument issued by governments, development banks, companies to raise capital to finance new food and land use economy assets. Includes green, blue, SDG, impact and sustainability bonds plus resilience bonds which are designed to fund both proactive risk reduction projects and reactive disaster recovery actions	• TLFF's $95 million sustainable land use bond which benefits from a partial development guarantee from USAID
	Green / Sustainable Securitisation	Securitisation refers to the process of transforming a pool of illiquid assets into tradable financial instruments (securities)	• Agricultural financing securitised through notes traded on the Colombian National Agricultural and Livestock Exchange • Green agricultural receivable credits in Brazil (R$1 billion or $294 million)

	Instrument	Description	Examples
Risk mitigation	**Blended finance vehicles and instruments**	The use of development capital (public or philanthropic) to mitigate particular investment risks (including offtake, access to capital, credit, technical, demand and currency risk), thereby mobilising commercial capital. Includes first loss or subordinate capital in a fund; development guarantees; hedging; political risk insurance etc.	• &Green Fund with catalytic capital from Norway ($100 million) and Unilever ($23.5 million); targeting $400 million • $1 billion Rabobank / UN AGRI3 sustainable land fund • $20 million Meloy Fund for sustainable fisheries with catalytic capital from the GEF • Food Securities Fund which benefits from a partial development guarantee of $37.5 million from USAID • Africa Agriculture and Trade Investment Fund (AATIF) with first loss capital from the German government (losses have to exceed 50 percent of the AATIF's net asset value before senior investors suffer any harm) • GEF non-grant initiatives ($91.2 million disbursed; $136 million available) providing guarantees for blue bonds (e.g. $5 million for the first-of-its-kind Seychelles blue bond), equity in sustainable fisheries (Meloy Fund) and guarantees and subordinated debt for land restoration • IFC Global Agriculture and Food Safety Programme Private sector window ($310 million deployed) providing blended finance solutions to early-stage agribusiness projects
	Technical assistance	Grants for technical assistance, project preparation, incubation and research to bring a project to bankability. These can be critical for pipeline development, especially in less mature sectors and riskier geographies, mobilising significant (if often hard to measure) amounts of private capital	• AgDevCo invests, develops and provides training for sustainable smallholder agriculture in Africa ($128 million portfolio size with 40 investments) • DFID's Partnerships 4 Forests incubator • Gordon & Betty Moore Foundation's $90 million Oceans and Seafood Markets Initiative which is developing the business case for sustainable shrimp farms • GEF Good Growth Partnership develops the capacity of banks and institutions to assess and manage deforestation-related risks
	Mobile & fin tech	Digital solutions to increase the ability for investor to finance sustainable food and land use assets e.g. tech-enabled mobile phones for payments (pay as you go / pay as you use), GPS to gather data on land and productivity, and creation of digital credit history	• FaaS platform collecting data on productivity and sharing information about inputs and weather • Digitisation of payments to create credit history for farmers

	Instrument	Description	Examples
Creating markets and incentives	**Impact investing**	Investments made in companies, organisations, and funds with the intention of generating a measurable, beneficial social or environmental impact alongside a financial return	• Althelia Climate Fund I (€100 million) • SLM fund for regenerative farming systems in Australia (AUD 200 million) providing blended finance solutions to early-stage agribusiness projects
	Sustainability-linked loans and other financial products	Loans and other financial instruments which are contingent on or incentivise the borrower / policy-holder's achievement of predetermined sustainability practices. May be linked to the crop-cycle / harvest	• ING / Olam $500 million sustainability-linked loans for agricultural investments in Asia • COFCO $2.1 billion sustainability-linked credit facility • F3 Life's Climate Smart Lending Platform • BNDES ABC agri-credit
	Shared services	Turns fixed costs into variable ones to make them more affordable, reduces the total amount of infrastructure needed. Often involves digital solutions (see above)	• Hello Tractor shared farmer infrastructure services • Aavishkaar communal warehousing solutions for farmers
	Market infrastructure	Dedicated market platforms to connect sustainable producers and investors	• BV Rio's Responsible Commodities Facility (raising a $300-375 million bond) • Lestari Capital's Sustainable Commodities Conservation Mechanism (first investment from Cargill)

New financing solutions at work

Many of the innovative financing solutions described in Table 2 above involve new forms of risk sharing, including "blended" vehicles and instruments that use development capital to crowd in private capital. This happens by mitigating specific investor risks that currently prevent mainstream capital from flowing into new food and land use assets.

Two examples are the Rabobank AGRI3 Fund (a partnership between the UN and FMO, the Dutch development finance institution) and the &Green Fund (set up in partnership between the Norwegian government Norway, IDH and Unilever). Both aim to use concessional capital to invest in sustainable, deforestation-free commodities and supply chains. AGRI3 provides de-risking financial instruments and tailor-made technical assistance, while &Green provides flexible forms of concessional/first-loss capital to finance commodity supply chain projects in jurisdictions with progressive forest and peatland protection policies.

Financial instruments are also being created to address specific funding gaps. For example, Clarmondial's Food Securities Fund provides loans to value chain actors that engage with smallholders who implement best in class environmental and social practices, but struggle to get access to working capital because they are too small or lack collateral. The Food Securities Fund offers a simple fixed-income product to investors looking to gain exposure to climate-smart smallholder agriculture, while offering access to growth markets. The Food Securities Fund will create a more efficient, scalable credit channel between qualified investors and emerging market agricultural companies. It benefits from a partial guarantee from USAID's Development Credit Authority.

This blended finance structure reduces risk for the commercial partners, while partnerships with leading international companies provide access to an extensive pipeline at low transaction costs. This structure allows the fund to address the gap in season-long loans for agriculture production in emerging markets and to promote climate-smart agriculture and responsible, deforestation-free supply chains.

On the credit side, digitisation of payments is helping to fill the credit gap in several countries by creating credit histories for farmers. Access to mobile money is also improving financial resilience and increasing occupational choices for women. In Kenya, access to M-Pesa had a pronounced impact on female-headed households, where women moved out of agriculture and into business.[19] Better risk-sharing arrangements, better partnerships and better data collection throughout the value chain are necessary to tackle credit gaps and attract more private capital to the new food and land use economy.

New financial products that shift payment incentives also encourage critical changes in behaviour. Sustainability-linked loans are one example. For instance, Olam, a global agri-business, has secured a three-year, $500 million sustainability-linked revolving credit facility from ING for its Asian agriculture operations. The interest rate on the facility will be reduced as the company meets its ESG targets. COFCO – another food and agriculture giant – has agreed a $2.1 billion sustainability-linked loan with a consortium of 20 banks. It is one of the largest sustainability-linked loans by a commodity trader, with the interest rate tied to the company's sustainability performance. Targets include year-on-year improvement of ESG performance and increasing traceability of agriculture commodities, particularly directly sourced soy in Brazil. If it meets the agreed targets, COFCO will invest the discounts in improving the sustainability of its supply chain, enhancing health and safety measures and supporting local communities.

Innovation is also making it easier to insure a more sustainable food and land use economy. In Kenya, Kilimo Salama (now ACRE) is a micro-insurance programme that uses technology and scale to reduce the cost of insuring smallholders (on-farm monitoring costs the same for one acre as it does for 1,000) through distribution networks and shared weather data infrastructure. Some 50,000 smallholder farmers are insured by the company. It uses automated weather stations to estimate crop losses and automatically settles payments through a mobile payments channel, eliminating the claims process. Crop insurance products or land financing linked to land fertility are still to be developed, reflecting the constraints and challenges of measuring soil health, but offer considerable promise for the future.

Projects are also starting to take a more integrated investment approach, combining multiple revenue models, financial structures and outcomes. One example is financing "produce/protect" business models that build an element of environmental conservation or "payment for nature" into farming a traditional crop or commodity. For instance, Selva Shrimp raises black tiger prawns naturally in the mangrove forests of south-east Asia. The prawns depend on intact mangroves, which provide all the nutrients they need without external inputs. They are then sold at a premium as they have been produced without chemicals and in a natural environment. The shrimp farmers are thus incentivised to maintain the mangrove forests through this proxy payment for the mangrove ecosystem services.

The Tropical Landscape Finance Facility (TLFF) is another example where integrating conservation has become an important part of financing the underlying commodity – in this case rubber in Indonesia. The TLFF's inaugural transaction was a landmark $95 million sustainable land use bond that helps finance 34,000 hectares of rubber in two heavily degraded landscapes in Indonesia's Jambi and East Kalimantan provinces. In Jambi, the plantation will function as a critical buffer zone to stop further land speculation and encroachment in the biodiverse 143,000 hectare Bukit Tigapuluh National Park, one of the last places in Indonesia where Sumatran elephants, tigers and orang-utans are found. Conditions of the loan require the plantation to comply with a clearly defined environmental and social action plan which includes social benefits for the local community and requires leaving almost half of the 88,000 hectare rubber concession area untouched for conservation and community development. This is tracked by a publicly available Landscape Protection Plan as required by the latest investor into the project, the &Green Fund, which has purchased the 15-year subordinate notes, critical to catalyse commercial investors. The transaction benefits from a partial credit guarantee from USAID, which contributed to the "Aaa" rating by Moody's for senior notes, helping provide investor confidence in the transaction and attract mainstream capital.

Finally, fintech and shared-services platforms are helping accelerate the Better Futures pathway by enabling business model innovation for new food and land use assets. One example is Indian start-up Farming-as-a-Service (FaaS). FaaS offers services including equipment rental for tractors and warehouse storage on a "pay-per-use" basis through its digital platform. The platform also includes data collection, analytics and information sharing among farmers, market agents, government agencies and financial institutions, as well as the opportunity for farmers to connect with suppliers of seeds, fertilisers and other inputs. Total investor funding for FaaS was over $100 million in 2018.[20] Hello Tractor in Kenya also enables farmers to share equipment through a mobile app and mobile payments. Usually, equipment costs are fixed. By turning them into variable costs, smallholders are given access to productivity-enhancing equipment that would otherwise be beyond their means.

Clearly a new generation of Better Futures assets is emerging. Businesses and investors position themselves for comparative advantage if they can develop and implement the investment solutions required to finance the new food and land use economy. However, these solutions and their early adopters are still marginal in the world of finance. It will take time for experiments by a handful of companies and investors to become economically viable at scale and move into the mainstream. This will not only shift 4-degrees Celsius portfolios into <1.5-degrees Celsius assets but also attract new pools of capital. Systematically implemented and rapidly scaled, these solutions could revolutionise the food and agricultural sector.

Accelerating investment in the new food and land use economy

Making the new food and land use economy "investable" relies on the right real economy settings – from regulatory frameworks and a track record of enforcement, to policy signals, investor coalitions, hubs for pipeline development, repurposing of agricultural subsidies, active use of public procurement, pricing of externalities and "public bads" and clear disclosure requirements.

To spur investment in the Better Futures pathway, the financial sector will need to develop a more rigorous approach to assessing and managing risks in its existing food and land use portfolios. These portfolios are currently carbon-heavy and exposed to risks arising from changes in:

- **Regulation and subsidies.** Farmer borrowers who rely on inefficient subsidies will be exposed if regulators reform subsidy regimes, affecting their credit profiles and exposing investors

- **Consumer preferences.** Investors that finance the agro-foods industry are potentially exposed to widespread shifts in consumer diets arising from growing concerns about nutrition, deforestation, the impact of meat consumption and the use of chemicals

- **Technologies and business models.** Investors in incumbent industries and companies face disruption from the rapid penetration of new technologies, processes and business models

Given these trends, better data and risk assessments should eventually lead to a divestment out of 4-degree food and land use assets, and the reallocation of capital into new food and land use systems. Several investors are already moving in this direction. This is evident from the increase in venture capital for circular food innovation, recent mega-IPOs for alternative proteins companies, the launch of new "healthy" lines in major supermarkets and fast food chains, the booming organics market (predicted to be worth $730 billion in 2030, up from $145 billion in 2018), and significant oversubscription figures for green bonds and other debt instruments for sustainable land use.

Five actions could accelerate these trends and reset the financial system to deliver the Better Futures pathway:

1. **Integrate natural capital accounting.** Governments and companies could swiftly adopt natural capital accounting policies (such as the OECD's System of Environmental-Economic Accounting or SEEA).

   Natural capital would then be included in government budget documents, allowing national leaders to monitor and manage their environment for economic purposes. This would also allow the financial sector to price the risk of natural capital depletion. This should be reflected on the balance sheets of companies in the same way that international oil companies have to declare their reserves (which form a large part of the basis for corporate valuations).

   Several companies are already following the Climate Disclosure Standards Board for the reporting of environmental information, natural capital and associated business impacts. However, these disclosures need to be fully integrated into financial accounts and valuations rather than being carried out as separate, disconnected activities as they are now. The Economics of Ecosystems and Biodiversity (TEEB, see Box 6 in Chapter 2), a global initiative focused on "making nature's values visible", is driving this agenda through a structured approach to valuing natural capital. This should provide useful tools for decision-makers to recognise the benefits of and reliance on natural ecosystems and biodiversity, as well as demonstrate their value in economic terms to build into investment decisions.

2. **Mandate TCFD for nature.** The Task Force on Climate-related Financial Disclosures (TCFD) has developed recommendations for corporates to disclose climate-related risks. Agriculture, food and forest products are one of the TCFD's target sectors. However, fewer than half of agriculture, food and forest companies disclose climate-related metrics and emissions as recommended by the TCFD. And only 20 percent report board-level oversight of climate-related risks.[21] Corporate impact on ecosystems and biodiversity – and public health – is largely ignored.

   Developing the scenario analysis for this sector, as recommended by TCFD, can help financiers get a better grasp of risks inherent in the current systems, redirect capital towards investments that support the Better Futures scenario, and create more resilient systems with lower risk exposure. As a first step, financial institutions should voluntarily implement TCFD recommendations across their agriculture and food portfolios as regulators develop mandatory disclosure rules. This will give the financial sector time to develop methodologies to assess such risks and gather data. Both activities will help regulators to implement further supportive policies, such as capital discounts and access to discount liquidity windows, and lower haircuts for sustainable food and land use assets.

   The recently released reporting guidelines from the European Commission and the supporting taxonomy are welcome steps in the right direction. If a number of leading banks ran a pilot TCFD implementation programme for nature and biodiversity, that would send a powerful market signal. Environmental degradation and natural capital loss are also material risks that can create systemic challenges to global financial systems and threaten their stability. They could start with disclosure of land use change and progress to full disclosure of the impact on biodiversity and ecosystems. Banks could work with businesses that also want to implement science-based targets for biodiversity.

3. **Review the impact of financial regulation.** More than half of the investment required to deliver the ten critical transitions of the Better Futures scenario will be needed in developing countries. Yet international financial regulations often create barriers to investing in these markets. For instance, Basel III imposes high capital requirements for financial institutions in certain circumstances to reflect the potential higher risk of some investments.

Basel III has been identified as one of the key causes of a sharp decline in cross-border lending after the 2007-08 financial crisis (alongside deleveraging processes and tougher standards for anti-money laundering)[22] and is often cited as a disincentive to investing in emerging markets. The same rules can also make it challenging to invest in asset classes such as agriculture and rural infrastructure (both critical for a sustainable food and land use system), owing to biases that favour corporate bond issuance over infrastructure finance.

In the energy sector, this has provided an advantage for incumbent fossil fuel companies over clean energy developers as Basel III provisions have made the debt of large liquid fossil fuel corporates much cheaper than that of smaller and younger renewable energy companies. Although the regulation was implemented with the intention of creating a more stable financial system, banks and regulators should identify a balance that would enable prudent investment in the new food and land use economy.

4. **Increase development capital allocations to food and land use systems.** Governments and development finance institutions, especially multilateral development banks (MDBs), need to rapidly scale up their financial support for the new food and land use economy. Allocations are worryingly low. Governments have allocated less than two percent of their budgets to agriculture over the past ten years, and less than six to eight percent of overseas development assistance (ODA) was allocated to agriculture between 2001 and 2017.[23] Of all global public climate finance, only three percent goes to making food and land use systems resilient.[24] MDB exposure to agriculture accounts for less than ten percent of total climate finance portfolios (both mitigation and adaptation). These allocations need to at least double by the early 2020s.

   Development capital providers should focus on the highest-impact underinvested areas, such as land and forest restoration or development of irrigation infrastructure. Optimising the use of catalytic instruments such as guarantees will be equally important. Guarantees currently make up fewer than four percent of MDB climate finance transactions despite being one of the most catalytic instruments for mobilising private capital. Finally, ODA and donor capital could also be linked to specific reforms and implementation, such as the Global Environment Facility's $500 million Food Systems, Land Use and Restoration Impact Programme. Working through country projects around the globe, this donor funding is expected to catalyse up to $2 billion in co-financing investment.

5. **Ensure development capital is focused on capacity and market building.** Financing intermediaries, including development finance institutions such as AgDevCo that have a strong presence on the ground, microfinance institutions and value chain actors, can build and connect local capacity, access unfamiliar markets, and have an outsized impact – especially on increasing access to capital for smallholders. Several high-impact financing schemes in other sectors have operated this way, using and expanding local lending infrastructure while being able to raise funds in international markets. Lendable, which improves access to finance through alternative lenders, and WaterCredit, which offers water and sanitation loans through microfinance institutions, are examples.

BOX 46

Coalition to develop principles for investing in the food and land use system

A coalition of leading commercial and development banks could join forces to develop a set of "Equator principles" for financing food and land use assets. These principles would address the natural capital risk exposure of their food and land use portfolios and potentially explore their public health and social impacts in light of growing litigation risk (see Chapter 2).

Just like the Green Bond Principles and the upcoming Principles for Responsible Banking, such an initiative would send a powerful signal to the market and could provide the momentum and guidance needed to shift capital out of high-carbon assets – which expose investors and society to huge hidden costs related to climate, biodiversity, nutrition and livelihoods – and accelerate investment in the new food and land use economy. It would also help finance institutions to standardise their lending approach by following key principles on common goals, credit risk assessment and incorporation of mobile technology to gather data. This would also streamline the participation of public and private players in different transactions.

The principles could work with, or build on, the United Nations Environment Programme Finance Initiative (UNEP FI) Natural Capital Credit Risk Assessment in Agricultural Lending framework, the World Bank/Food and Agriculture Organization (FAO) Principles for Responsible Agriculture Investment and the Principles for Responsible Investment (PRI).

The principles could include:

- Financing production of lower-carbon and more nutritious food
- Promoting resource efficiency and regenerative farming methods
- Conserving and restoring natural capital
- Contributing to development and poverty reduction
- Transforming sustainable and transparent food value chains
- Providing improved risk scores to companies that have strong science-based targets – especially for biodiversity – and that integrate climate resilience, nutrition and health outcomes and inclusion into their corporate strategies
- Zero deforestation supply chains
- Zero tolerance for environmental crime
- Zero tolerance for land grabbing or exploitation

BOX 47

Capital market oversight – civil society's role in developing financial markets for the Better Futures food and land use systems

Numerous new capital market oversight mechanisms are shedding light on risks in current supply chains. They are designed to enable more effective disclosure by bringing transparency to the hidden liabilities on companies' balance sheets, helping to build trust between consumers, civil society, business and investors.

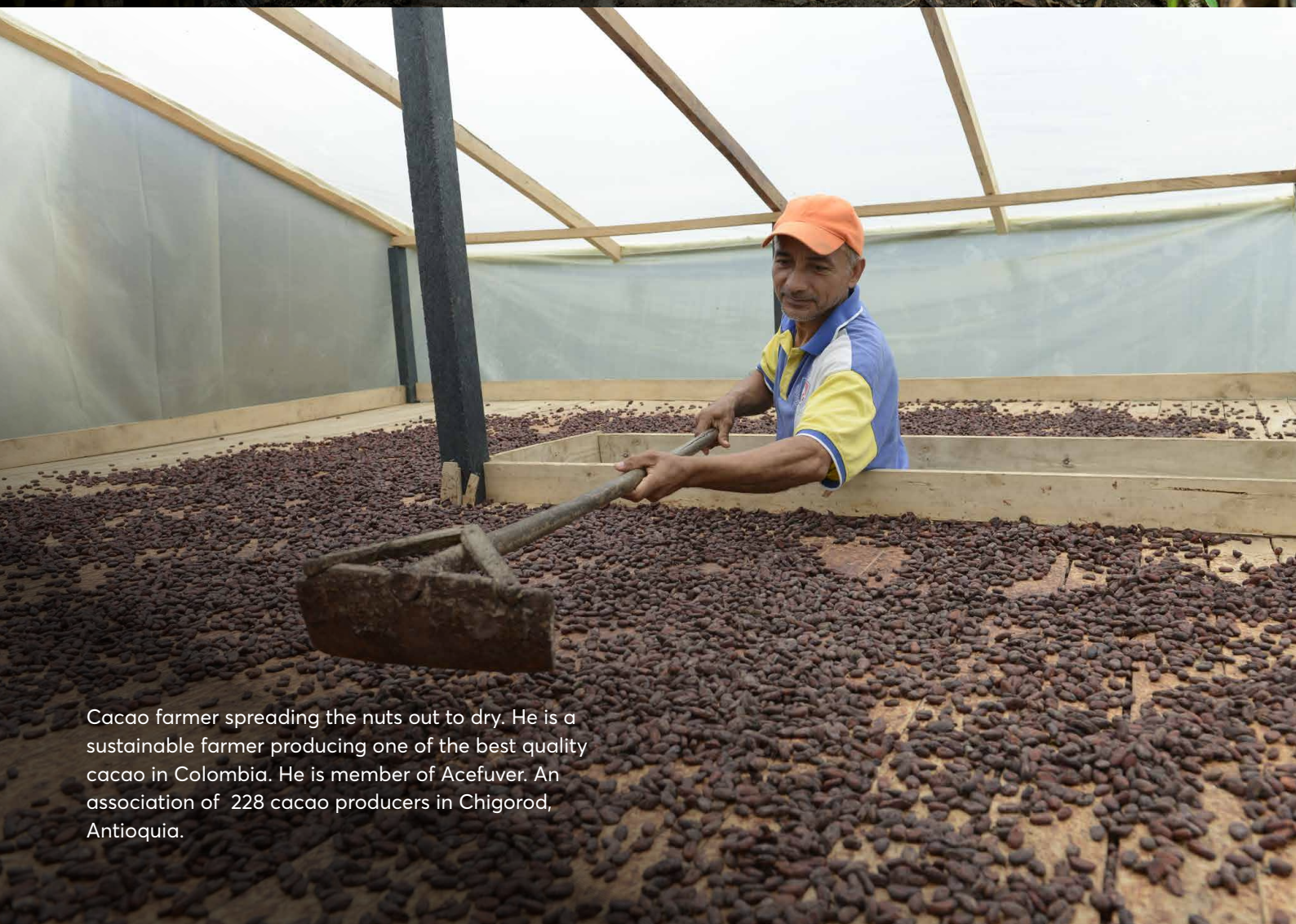
Farm Animal Investment Risk and Return (FAIRR) is one example. An investor network that advocates for sustainable animal farming, it is backed by 180 fund managers with assets worth $10.5 trillion. Planet Tracker is another. This not-for-profit financial think tank provides data and market intelligence to identify, quantify and rectify the disconnect between financial markets and planetary limits. Its Trase for Finance tool, to be launched in March 2020, aims to map more than 70 percent of global trade in major forest risk commodities, promoting supply chain sustainability.

Initiatives such as the Science-Based Targets initiative (SBTi) can also help companies and financial institutions align their activities with a 1.5-degrees Celsius world. The newly launched Science Based Target Network is developing sector methodologies for land use and biodiversity to achieve SBTs within planetary boundaries. The True Cost of Food initiative from the World Business Council for Sustainable Development and FreSH bring together 70 agri-food companies on issues such as climate-smart agriculture, food loss and waste, positive nutrition and protein diversification and improvement. They aim to reform business on the ground and at board level. In addition, ESG screening and SDG analysis (including initiatives like Aviva's World Benchmarking Alliance) are all beginning to work as powerful forms of informal regulation that show how capital markets are part of the solution to environmental challenges.

Ultimately, the financing required to realise the Better Futures scenario is within reach. The financial innovation needed to mobilise capital for new food and land use assets is available but needs to be rapidly scaled from one-off examples to mainstream and cost-effective solutions with the support of donors and providers of development capital. Adopting "whole balance sheet" approaches that start from mainstream principles and govern decision-making for mainstream banks and investors will be critical.

The real challenge lies in replicating and scaling proven financing solutions and mobilising the right leadership at every point of the investment value chain. Rising to these challenges will make sure finance is a powerful enabler of the new food and land use economy, an accelerator rather than an anchor.

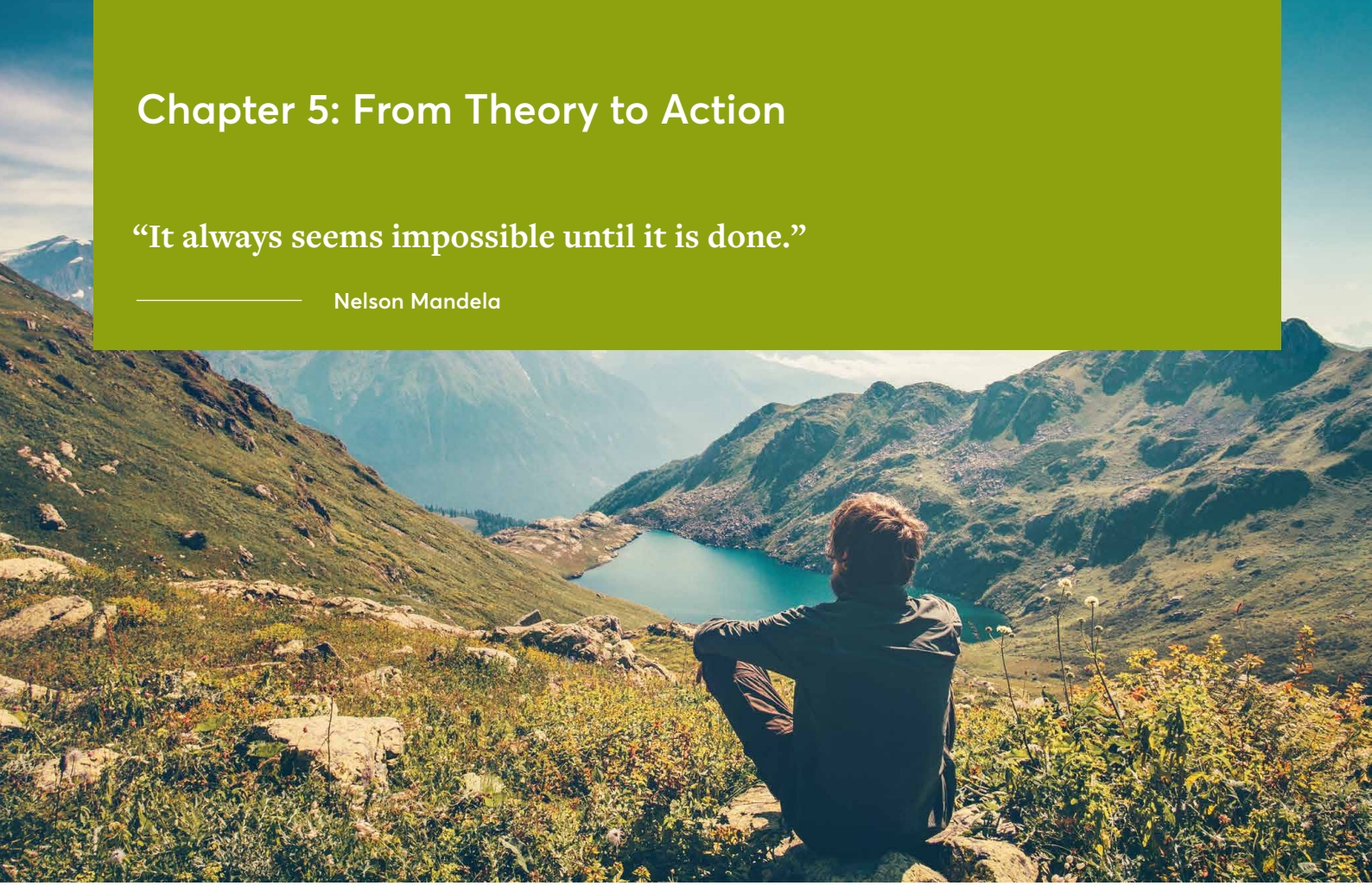
Workers harvesting Bananas in the fields at Tandalwadi village in Jalgoan, India.



Cacao farmer spreading the nuts out to dry. He is a sustainable farmer producing one of the best quality cacao in Colombia. He is member of Acefuver. An association of 228 cacao producers in Chigorod, Antioquia.

Fresh organic cherries from God's Grace Farm being sold at Beijing Farmer's Market.

Chapter 5: From Theory to Action



> "It always seems impossible until it is done."
>
> Nelson Mandela

This report has shown there is a sizeable prize to be won from transforming food and land use systems. It takes the shape of exceptional environmental, health and inclusion benefits. The ten critical transitions set out in Chapter 3 together can deliver the transformation necessary to ensure this better future at local, national and international levels. Crucially, compared with such gains, the global investment needed is minor.

The process of implementing the critical transitions will not be easy, of course. Each faces barriers: policy and regulatory, financial, technological and behavioural. Current food and land use systems are fragmented and vested interests are defending their turf, even when that turf is clearly unsustainable.

Nonetheless, practical examples of all ten transitions are already up and running across the world, initiated by entrepreneurs in farming, politics, business and communities, as well as social entrepreneurs. These front-runners are creating waves of change, some driving legal and regulatory reform at federal government level, some pushing to rid multilateral company supply chains of deforestation. Many start from the ground up in local communities. What they have begun has the same potential to surge as the renewable energy movement, with new social norms and disruptive technologies – such as satellite surveillance, precision farming, agro-genomics, digital traceability systems and large-scale platforms for alternative protein and algae production – ushering in a fourth agricultural revolution.

But for such remarkable change to happen, the rules of the game must change, and there is no time to lose. Unless food and land use systems are turned around in the next ten years, the compounding risks of their current trajectory will be unmanageable.

For inspiration, what would it look like if leaders across public, private and civil society sectors – and not least farmers themselves – were to make food and land use systems an urgent priority, grasping the scale of the opportunity as well as the risks of inaction? What would it mean if they were to push this transformation to the top of their short-term priority list rather than allowing the tyranny of the urgent to crowd out the important?

This chapter tries to answer these questions by outlining the near-term actions needed to set the ten critical transitions in motion from five groups: governments, business and farmers, investors and financial institutions, participants in multilateral processes and multi-stakeholder partnerships, and civil society. These actions are highlighted for their potential systemic impact on changing the rules of the game, for the strong signals they will send to markets that a new food and land use economy is coming, and because all of them can and should ideally be taken during the next one to two years – in the context of sharpening countries' ambitions under the UN biodiversity and climate change conferences in the fall of 2020, as well as pushing a stronger integrated perspective on the world food systems at the Sustainable and Inclusive Food Systems Summit in September 2021 – if the world is to have reasonable odds of staying on course for the outcomes set out in the Better Futures scenario.

1. Actions for Governments

National government action is essential to the transformation because governments set the rules and create the norms that shape how food and land use systems operate. They make the policies, laws and regulations and enforce them. They determine the use of public resources, financial and human, and operate coordination mechanisms. The threats posed by and to current food and land use systems mean several national governments are already making their transformation a top priority. More should join them. Reforms to food and land use policy deserve close attention from all heads of state and heads of government and a permanent place on the agenda of every international summit meeting.

Government leaders must work with all key stakeholders to develop national food and land use pathways rooted in science and consistent with the SDGs and the Paris Agreement. National and sub-national governments can create the integrated policy frameworks that will drive rapid system change by taking the following actions:

1. **Put in place a framework of goals, processes and capacity to enable reforms**

   - **Conduct transparent, inclusive, multi-stakeholder consultations to shape a compelling vision for food and land use systems.** The process of consultation can build trust and knowledge among those who are critical to implementation and affected by change: the private sector, cities, towns and rural areas, civil society organisations, farmers' organisations, trade unions and community leaders.

   - **Set clear, ambitious 2030 and 2050 system targets and decide delivery strategies centred on the ten critical transitions.** Vision, targets and strategies should be fully aligned with the SDGs and Paris Agreement goals. In line with the Paris Agreement, governments should commit to ambitious Nationally Determined Contributions and expand them every five years, starting in 2020. They should also incorporate the global biodiversity goals that will be established at the 15th Conference of the Parties of the Convention on Biological Diversity in Kunming, China, in 2020, and the aims of the United Nations (UN) Convention to Combat Desertification.[1]

   - **Prioritise and strengthen land use and water planning for the public good.** Efficient use of national land and water resources depends on holistic resource planning. Spatial planning helps to identify the optimal allocation of land for agriculture (based on yield, natural capital and soil health), the allocation of natural ecosystems for legal protection and large-scale restoration, and geographical boundaries of urban growth and infrastructure. Freshwater planning ensures optimal use of scarce water resources and proper management of climate-related water risks. Use of marine resources should be planned and enforced in the same way as use of land resources.

- **Strengthen institutional capacity and cross-government frameworks.** Government in silos is ill-suited to driving change in food and land use systems. Cross-ministerial cooperation is essential. The highest level of political focus can be ensured if accountability mechanisms for the relevant targets are integrated into national budget processes.

- **Increase transparency and data availability.** Readily accessible public sector data will help civil society to play its role in strengthening the governance of food and land use systems, including holding powerful players to account, and also set the standard for private sector transparency.

2. **Encourage the transition to healthy diets** by issuing strong, clear guidelines for healthy consumption and promoting them vigorously through the education system and public health system. Governments would use public procurement to scale the market for healthy foods. They would deploy fiscal instruments (taxes, subsidies, market support) to reward producers of healthy food (making it more affordable for lower-income households) and penalise producers of unhealthy foods. They would align regulations with the nutrition guidelines, require clear food health labelling, restrict marketing of unhealthy food and use city-zoning to favour healthy food distribution over unhealthy food distribution.

3. **Support farmers with the transition to regenerative agriculture** through incentives for sharing knowledge, tools and equipment. This could include seed banks for more diverse crop rotations and cover crops, equipment for preparing land without tillage, and mechanical weeders or crimpers that reduce the need for herbicides. Separating the provision of inputs from agronomic advice (as France is doing) strengthens the incentive for agronomists and extension agents to recommend practices that reduce farmers' input costs and promote agrobiodiversity.

4. **Protect and value critical ecosystems through stronger policy and enforcement:**

   - Place an immediate and comprehensive moratorium on conversion of forests and other natural ecosystems to any other land use.
   - Launch a strictly timetabled process to translate the conversion moratorium into appropriate forms of robustly enforced permanent protection and sustainable use.
   - Grant secure tenure over traditional territories to indigenous peoples and other forest-dwelling communities and provide the support to enforce it.
   - Phase out policies that intensify competition for land, such as public support that drives agricultural or urban expansion, or biofuels mandates that directly or indirectly promote deforestation or other ecosystem conversion.
   - Establish the legal basis for domestic ecosystem payment mechanisms. This action should enable the flow of funds to rural and forest-based communities to pay them for verified results in protecting and restoring ecosystems and soils, strengthening their livelihoods and their resilience to climate-related shocks at the same time.
   - Formalise large-scale, predictable payments for ecosystem services in developed countries and some emerging economies, including introducing regulated REDD+ (Reducing Deforestation and Forest Degradation in Developing Countries) payments for private companies (increasing up to $50 billion by 2030, depending on reductions in tropical deforestation).

5. **Introduce carbon pricing,** starting at the World Bank shadow price of $40 per tonne of carbon dioxide equivalent (tCO_2e) and rising significantly and predictably, to ensure the externalities of greenhouse gas emissions are internalised in market transactions throughout food and land use systems, and, potentially, to recycle the funds in ways that support nature-based solutions. In water-stressed areas, mechanisms to ensure more efficient, fairer water allocation, including forms of pricing where appropriate, could be introduced.

6. **Repurpose agricultural subsidies and market support mechanisms** to encourage farmers to deliver a diversity of nutritious food and environmental benefits. Increase the share of these incentives that flow to smaller farmers to promote inclusion.

7. **Increase investment in sustainable innovation to expand choice**, including a 100 percent increase in public R&D spending over the next decade. Focus would be both on regenerative agriculture, helping mitigate climate-related impacts on production, and on the designed use of nature to push value creation and ecosystem services – integrating fully functioning ecosystems with cash crops, for example. Government R&D investment should promote open source innovation to make it easier for smaller new businesses to participate in field trials, access public R&D resources and scientific expertise, and identify funding for their early commercial growth.

8. **Catalyse more productive, local food systems** through local government use of zoning and public procurement. The aim would be to encourage urban and peri-urban farming and drive down food loss and waste. This would require greater transparency and ambitious targets from larger companies.

9. **Reduce the gap between rural and urban standards of living** by improving rural infrastructure (especially roads, clean electrification and connectivity), strengthening the rights of rural communities to protect their land and other natural resources, attracting young entrepreneurs back to the countryside, and funding safety nets to protect rural households from increasingly likely climate-related shocks (with the support of international donors). This report recommends a global push to establish solar energy electrification in low- and medium-income rural economies. The benefits for the environment, agriculture, food value chains and off-farm employment would be massive.

10. **Ensure a just transition** by establishing safety nets for vulnerable groups and using public resources to reinvigorate "stranded" communities.

11. **Promote the transformation through leadership on the international stage.** International cooperation on food and land use systems is often the remit of relatively weak ministries and mid-level civil servants. Heads of state and government should use international forums to ensure it becomes an international as well as a national priority. Transforming food and land use systems should be on the agenda at every international summit, including the G7 and G20 meetings.

2. Actions for Business and Farmers

Farmers are the original food and land use systems entrepreneurs. They are CEOs of the most critical set of businesses in these systems. Today, however, farmers everywhere face ever more pressure and risks: growing weather uncertainty as a result of climate change, stringent customer demands, shifting, complicated public policies and support regimes, and new banking terms and conditions. This, indeed, is the main reason we put such emphasis on changing the rules of the game and shaping it in ways that pay farmers fairly to produce the right food in the right way. This means allocating risk (market, weather, production) so that farmers do not carry most of it while receiving the least of the returns, protecting their tenure and giving them confidence to make longer-term investments, improving opportunities for women and younger farmers, and respecting their experience in land stewardship and food production. Farmers are natural entrepreneurs – and they will play a critical role in any successful transformation of food and land use systems.

Beyond the farming community, responsible business leadership requires CEOs in the corporate food and agriculture sectors to understand and act on the inefficiencies, hidden costs, risks and opportunities in food and land use systems. Business leaders – including farmers of various categories – would thus publicly support government transformation programmes and work with government and civil society to accelerate the critical transitions. In October 2019, the World Business Council for Sustainable Development, a core partner of the Food and Land Use Coalition, will release a guide for CEOs based on further consultation.

There are huge opportunities – worth up to $4.5 trillion a year by 2030 – for those farmers and companies that can translate today's hidden costs into tomorrow's new markets and purpose-driven strategies. But seizing these opportunities, many of which require new business models that emphasise value over volume-based economics, might require a generational shift in mindsets and leadership.

To help jump-start food and land use systems' transformations, businesses can:

1. **Establish science-based targets** to make their strategies compatible with the SDGs, the Paris Agreement goals and global targets on ecosystems and biodiversity. They can put in place plans to reshape supply chains that can be easily monitored, product development and marketing strategies in line with "healthier diets", and "nature-based solutions", "wider choice and supply" and "opportunity for all". The Science-Based Targets Network provides approaches to these actions for businesses to follow. Targets embracing health, nutrition and inclusion factors and environmental goals will ensure companies' faster strategic adaptation to the rapidly changing social, economic and physical environment.

2. **Shift R&D and marketing resources into healthier food options**, building on the pre-competitive work of coalitions such as Food Reform for Sustainability and Health (FreSH) hosted by the World Business Council for Sustainable Development. This action can turn the enormous hidden costs of malnutrition into a major growth driver for the sector and create a measurable improvement in the overall health performance of the food industry.

3. **Establish full transparency and ban deforestation and other ecosystem conversion, crime, land grabs and exploitation throughout supply chains.** Businesses can require adherence to the same standards from all business partners and cut ties with suppliers that transgress.

4. **Shift commodity procurement strategy from buying on the spot market to investing in long-term sustainable supply from equitable partnerships.** Companies need to show leadership to address inequalities in their value chains, whether individually or through agreed (and independently monitored) collective bargaining processes. They can commit to fair, transparent and long-term contracts with farmers and other workers in the value chain, including a living wage. They can adapt procurement strategies to invest in helping farmers with the costs of

meeting standards and training. They can also incentivise farmers to invest in sustainable practices themselves by lengthening procurement contracts that include guaranteed offtake – that is, guaranteeing farmers that they will have buyers for the results of their investments. To encourage environmental performance, they can also source as much as possible from countries and sub-national jurisdictions that protect ecosystems and promote regenerative agriculture principles.

5. **Commit to voluntary food loss and waste targets across the value chain** and engage their own 20 largest suppliers to do the same, with a shared goal of halving the amount by 2030.

6. **Support governments in adopting a comprehensive food and land use reform agenda.** To this end, companies can join or create pre-competitive business coalitions and public-private coalitions that advocate for the policies recommended in this report. Business for Nature and One Planet Business for Biodiversity are examples.

7. **Pilot true cost accounting for food** using for example methodologies developed by True Cost of Food Accounting or the approaches recommended by TEEBAgriFoods. These enable companies to include the real value of natural and human capital in internal and published accounts. Piloting these methodologies can both encourage the development of new measurement norms and inspire innovative business models with strong growth potential in the new economy, helping to safeguard future returns.

6. Actions for Investors and Financial Institutions

Investors need urgently to address their exposure to risks from assets in the "old" food and land use economy and learn how to identify the strongest opportunities in the new one. Investors and financial institutions could:

1. **Work with governments** to improve capital markets oversight, adjust financial regulations and introduce natural capital accounting – all actions that will support investment in the new food and land use economy.

2. **Set up a pilot to extend the recommendations from the Task Force on Climate-related Financial Disclosures (TCFD)** to increase corporate and financial reporting of nature, biodiversity, public health and inclusion risks, building on the guidelines of the Task Force on Climate-Related Financial Disclosures (TCFD). A pilot to extend the TCFD approach in this way would explore the full range of risks to the financial sector, including physical risks such as soil degradation and loss of biodiversity, as well as transition risks, including those related to changes in policies and regulation (and the enforcement thereof), changes in supply and demand for certain products and services, technology disruption and risk to reputation. Companies should also accelerate their implementation of the TCFD's recommended approach to reporting climate-related risks and opportunities.

3. **Develop a set of core financing principles**, built on the SDGs and the Paris Agreement, and framed along the lines of the Equator Principles or Principles for Responsible Agriculture Investment, to guide capital allocation into better food and land use systems and withdraw it from high-risk companies. Investors can require the recipients of their finance also to introduce full transparency across value chains and improve reporting on supply chain risks (such as deforestation and other forms of ecosystem conversion, and workers' conditions). In addition, investors can consider gradual divestment from companies that do not over time align with the SDGs, the Paris Agreement and commitments under a future post-2020 framework of the Convention on Biological Diversity.

4. **Develop a roadmap for public and private investors** to drive, over the next five years, between $300 billion and $350 billion a year into asset classes and instruments needed to transform food and land use systems. A new Finance for the Food and Land Use Economy coalition could help coordinate this work, applying the experience and networks of key actors in blended finance, drawing on new instruments and asset classes, and accelerating

development of deal pipelines. Multilateral development banks (MDBs), together with bilateral donors, would set ambitious targets to increase their investments, including the use of first-loss instruments and guarantees, into food and land use systems in developing countries from which much of the demand for new capital emanates.

7. Actions for Civil Society

Civil society can support the transformation agenda by helping to shape government and private sector actions and holding all stakeholders to account.

Of the functions that civil society organisations, including major philanthropic foundations, perform to accelerate this transformation, five stand out:

1. **Shift philanthropic resources towards food and land use systems.** The philanthropic community still directs less than seven percent of its total resources to the environment, and less than one percent to climate challenges, and even less to systemic reform of food and land use systems.[2] A much larger allocation is justified, given the fundamental importance of well-functioning food and land use systems. Philanthropy could have an outsized impact if it significantly increased its funding to food and land use and focused it on the ten critical transitions.

2. **Develop powerful communication campaigns.** The power of civil society organisations to raise awareness of the challenges and opportunities of food and land use systems, and build support for reform, cannot be overstated, particularly if they unite behind shared messages.

3. **Deploy technology tools and ground networks to drive full transparency and accountability** through food and land use systems. This action can shed light on the biophysical and legal state of forests, what damage occurs to them, which companies are responsible, who finances the companies doing the damage, and who finances the companies that own the companies doing the damage. Such insights would provide the evidence to fuel hard-hitting public campaigns against serial offenders.

4. **Support local, national and global social enterprise and impact investment** to speed development of grassroots change movements. These movements would, for example, pursue open source platforms and ensure big data contributes to the public good, promote extension services for smallholders, and help to establish seed enterprises that enable people to eat better while protecting their environment and building inclusive livelihoods.

5. **Drive academic research in under-explored areas.** There is a pressing need to strengthen integrated food economics know-how and modelling capacity. This can be done by developing tools and an international community of practitioners who can combine insights across economics, spatial modelling, climate risk analytics, nutrition, health and political science (around economic transition strategies, for example) in ways that lead to better public and private sector decision-making. The environmental and social impact of healthy diets – beyond diversification to a broader protein base – is an under-researched field that needs more attention.

8. Actions for Participants in Multilateral Processes and Multi-Stakeholder Partnerships

The next one to two years – through to September 2021 – provide multiple international opportunities to set ambitious new directions in relation to the climate, nature, land use, the ocean and food security. This will take unprecedented collaboration across forums such as the G7 and G20 meetings, the United Nations (UN) General Assembly Climate Action Summit, the UN conventions on climate change, biodiversity, and combatting desertification, the World Bank and International Monetary Fund Annual Meetings, the Global Nutrition Summit, the UN High Level Meeting on Universal Health Coverage, the World Health Assembly and Sustainable and Intensive Food Systems Summit.

The emphasis on solutions that would deliver on the three focus areas of the environment, health and inclusion should be maintained in all these settings, with the aim of developing a shared agenda to set the world firmly on course to sustainable food and land use systems by 2030. Implementing a global transformation food and land use systems will require strong mechanisms for international collaboration and clear rules at the international level, including strong coordination between the various agencies, conventions and platforms. The mechanisms for action include:

1. **The 15th Conference of the Parties of the Convention on Biological Diversity in Kunming, China, in October 2020.** This conference needs to secure an ambitious agreement – at head of state and head of government level – modelled on the Paris Agreement on climate change. The agreement should include new post-2020 global goals, a mechanism for making and ratcheting up national commitments, and a strong implementation framework to ensure the goals are met. It also presents opportunities to form coalitions of countries, farmers' organisations, businesses, financial institutions, civil society bodies and international bodies that are willing and ambitious enough to establish consensus on the best ways to achieve the practical elements of a sustainable future set out in this report. These include deforestation-free supply chains, action against environmental crime, expansion of regenerative agriculture and sustainable fisheries management, and much larger contributions to conservation finance (including REDD+).

2. **Paris Agreement under the UN Framework Convention on Climate Change.** Countries can integrate ambitious targets and reforms into their Low Emissions Development Strategies and updated NDCs, due in 2020, and strengthen them every five years thereafter. Countries that embrace net zero targets by (or before) 2050, compatible with staying under 1.5 degrees Celsius of global warming, could support scaling of a well-designed international REDD+ market (see Box 26 in Chapter 3), creating a long-term viable basis for payments for ecosystem services.

3. **The UN Secretary-General, leaders of UN agencies, and presidents and shareholders of MDBs** can align their institutions' investment, advisory and normative actions on food and land use systems to support governments' reform agendas. These organisations' governing bodies can provide clear direction across the different entities in the multilateral system to drive complementary actions from all of them on strengthening food, water, climate and biodiversity security.

4. **The International Monetary Fund (IMF)** can include more consideration of climate and food and land use systems risk in its Article IV surveillance activities.[i] More resources may be needed in extended financing facilities to support countries that face balance of payments crises related to the impact of climate change on their food security.

[i] When a country joins the IMF, it agrees to subject its economic and financial policies to the scrutiny of the international community as part of the IMF's Article IV surveillance activities. This regular monitoring is intended to identify weaknesses that are causing or could lead to financial or economic instability.

5. **International cooperation between relevant national actors and international bodies to modify international trade regimes.** Stronger coordination is needed between countries and the international bodies governing trade to ensure trade channels remain open following shortfalls in food production, to limit sudden spikes in food prices. They should consider developing international voluntary standards to promote the SDGs, for example, and agree to integrate the value of environmental externalities of trade in order to internalise them in market prices, potentially via tariffs.

6. **Representatives of governments, business, finance and civil society** can develop and scale pre-competitive coalitions to pursue aspects of the critical transitions that need cross-societal collaboration. The Tropical Forest Alliance – a public-private partnership to promote the implementation of deforestation-free commodity supply chains – provides an excellent example. This report proposes a Global Alliance Against Environmental Crime and Finance for the Food and Land Use Economy. Similar arrangements could be tailored to other critical transitions, including regenerative agriculture, the ocean and inclusive rural development.

7. **Mobilising for sustainable development in Africa.** The total investment required for sub-Saharan Africa's rural infrastructure, agriculture and climate mitigation is small relative to the global economy yet amounts to five percent of the region's gross domestic product (GDP). In addition, the risks are greater than in most other regions. To increase investment, therefore, unprecedented coordination among national governments and the development finance community is needed. For example, payments for ecosystem services schemes that value natural capital can be designed for the region's needs, and multinational businesses can commit to local sourcing and invest in strengthening local supply chains and food markets. To ensure such a mobilisation succeeds, African countries for their part should introduce policies and regulations to enhance stability and facilitate business. Simplified compliance processes, clear and consistently applied enforcement procedures, increased transparency, stronger land tenure regimes and macroeconomic policy that reduces currency volatility would all be crucial to improve the investment environment.

BOX 48

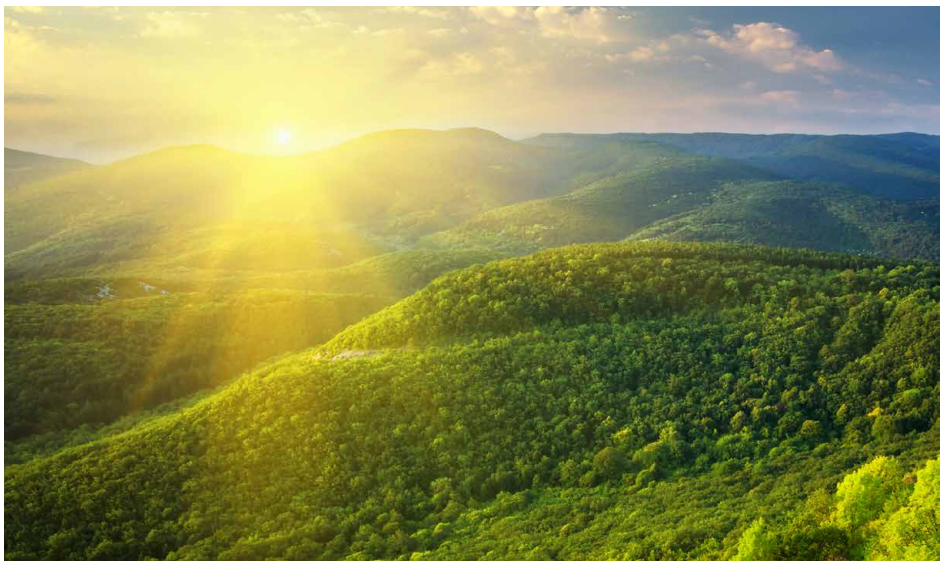
Opportunities and risks in sub-Saharan Africa

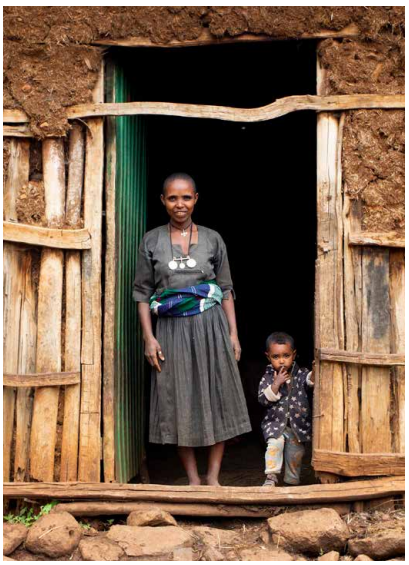
The opportunities and risks linked to food and land use systems in sub-Saharan Africa, and the scale of the investment needed to unlock them, warrants unprecedented international coordination. At $85-100 billion, the estimated annual investment needed to support a sustainable transformation of these systems is five percent of the region's GDP, too large for the region to finance but a small sum relative to the global economy.

The FOLU paper People, Health and Nature: A sub-Saharan African Transformation Agenda outlines four priorities to achieve a sustainable food and land use economy in the region: sustainably increased agricultural yields, stronger domestic markets for nutritious produce, protection and regeneration of natural capital at landscape level, and the attainment of gains from equal rights.[3] The paper also sets out actions that sub-Saharan African governments, businesses, civil society organisations, farmers and investors can prioritise to deliver these transitions – from land tenure reform to creating an enabling business environment and providing training for farmers and entrepreneurs.

While these interventions must be led by and build on the experience of Africans themselves, there are opportunities for complementary action by the international community. One is action to improve regional infrastructure and institutions so they support more dynamic, connected and transparent food and land use systems. Another is working together to address inequalities in value chains and trade agreements so that countries in sub-Saharan Africa can benefit fully from engaging in the global food and land use economy. Priority actions include:

- The development finance community and national governments partnering to increase investment in rural infrastructure
- Multinational businesses committing to local sourcing and investment in agricultural value chains to increase demand for domestic produce and boost investment opportunities
- Development finance institutions increasing the proportion of climate mitigation and adaptation finance that flows to sub-Saharan Africa, recognising its importance to global mitigation efforts and the potential impact of greater climate resilience on its stability and prosperity
- National governments worldwide strengthening regulatory and governance capacity to ensure that investments and trade agreements deliver fair outcomes for sub-Saharan African countries and consumers





Right: Mekle Wunete, with her son Adisu. They are beneficiaries of The Debre Yacob Watershed Learning Restoration Project in Bahir Dar, Ethiopia. Wunete says, "I have just bought 24 chickens. Before they started the project 8 years ago there was nothing growing here. Since they supported the community, I can now grow vegetables, fruits and raise chickens."

There are no easy single solutions and there is no universal blueprint for transforming food and land use systems that is right for every country. Rather, change will look different from one country to the next and from one system to the next. But the complexity of the task is a strength. It provides scope for building winning political coalitions behind broad transformation agendas. And it means the process will be distributed, making it more open and accessible and, hence likely to engage millions of citizens and entrepreneurs.

In any process of change, the first steps are the hardest. The Food and Land Use Coalition calls on leaders in government, business, finance, multilateral organisations and civil society to take those first steps and set about designing food and land use systems that protect the environment, improve human health, increase social justice and strengthen food security. As farmers, communities, small and medium-sized businesses and civil society organisations explore the opportunities, this movement will take on a dynamic of its own and steer the world towards a productive, healthy, sustainable and fair future. The opportunities are inspiring. The solutions are known. The resources are there.

Humanity has one to two years – until September 2021 – in which to turn food and land use systems in the right direction, and a decade thereafter to transform them. There are already many courageous people working to this end, often at significant professional and sometimes personal risk. This consultation report is fundamentally for them: to support their efforts, to accelerate the process of creative discovery, debate and learning, and to help us all redirect our ways of using land and producing food on to pathways that will meet the SDGs and Paris Agreement targets on climate change. There is no time to lose.

"Do. Or do not. There is no try."

Yoda

Annex A:

FOLU partners, supporters and Ambassadors

FOLU partners:

African Green Revolution Alliance (AGRA): Growing Africa's Agriculture
EAT
Global Alliance for Improved Nutrition (GAIN)
International institute for Applied Systems Analysis (IIASA)[i]
Sustainable Development Solutions Network (SDSN): A Global Initiative for the United Nations
SYSTEMIQ
World Business Council for Sustainable Development (WBCSD)
World Resources Institute (WRI), including the New Climate Economy: Global Commission on the Economy and Climate

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[i] Note that SDSN and IIASA convene the FABLE Consortium (Food, Agriculture, Biodiversity, Land Use and Energy)

FOLU Ambassadors:

Sri Adiningsih, Chairperson, Indonesian Presidential Advisory Council; Professor of Economics, University of Gadjah Mada
Assefa Admassie, Director, Ethiopian Economic Policy Research Institute; Professor of Economics, Addis Ababa University
Rina Agustina, Chair, Human Nutrition Research Center of the Indonesian Medical Education and Research Institute; University of Indonesia
Bethlehem Tilahun Alemu, Founder and Executive Director, Sole Rebels, Republic of Leather, Garden of Coffee
Sharan Burrow, General Secretary of the International Trade Union Confederation
Helen Clark, Former Prime Minister of New Zealand; Former Administrator, United Nations Development Programme
Nicolás Cock, Co-founder, EcoFlora and President Bio-protection Global
Sebsebe Demissew, Executive Director, Gullele Botanic Garden; Professor of Plant Systematics and Biodiversity, Addis Ababa University
Wiebe Draijer, Chairman of the Board, Rabobank
Shenggen Fan, Director General, International Food Policy Research Institute
Jessica Fanzo, Professor of Food Policy & Ethics, Johns Hopkins University; Co-chair, Global Nutrition Report
Meaza Biru Gebrewold, Founder, General Manager, Producer & Owner of Sheger 102.1 FM, Ethiopia
Rosario Córdoba Garcés, President, Private Council for Competitiveness, Colombia
Alejandro Gaviria, President, Universidad de Los Andes, Colombia
Marion Guillou, President of the Board of Directors, Agreenium
Lawrence Haddad, Executive Director, Global Alliance for Improved Nutrition
Kurniatun Hairiah, Professor, University of Brawijaya, Indonesia; Partner, World Agroforestry Centre
André Hoffmann, Board Director, MAVA Foundation
Naoko Ishii, Chief Executive Officer and Chairperson, Global Environment Facility
Ajay Vir Jakhar, Chairman, Bharat Krishak Samaj
Agnes Kalibata, President, Alliance for a Green Revolution in Africa
Sam Kass, Founding Partner, Trove Worldwide
Segenet Kelemu, Director General and Chief Executive Officer, International Centre of Insect Physiology and Ecology

Marco Lambertini, Director General, WWF International
David W. MacLennan, Chairman and CEO, Cargill Limited
Strive Masiyiwa, Board Chair, Alliance for a Green Revolution in Africa; Panel Member, Africa Progress Panel
Sara Menker, Founder and Chief Executive Officer, Gro Intelligence
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Ndidi Nwuneli, Founder and Director, Leadership Effectiveness, Accountability and Professionalism (LEAP) Africa
José Antonio Ocampo, Co-Director, Bank of the Republic of Colombia
Ngozi Okonjo-Iweala, Former Minister of Finance, Nigeria
Cristiana Paşca Palmer, Executive Secretary, Secretariat of the Convention on Biological Diversity
Ángela Penagos, Director, Rimisp Colombia
Paul Polman, Co-founder & Chair, IMAGINE; Chair of the International Chamber of Commerce (ICC)
Vineet Rai, Chief Executive Officer & Managing Director, Aavishkaar; Co-founder & Chairman, Intellecap Group
Juan Lucas Restrepo, Director General of Bioversity International; Co-Director, Bank of the Republic of Colombia
Felia Salim, Vice Chief Executive Officer, PT Bank Negara Indonesia
Cristián Samper, President, the Wildlife Conservation Society
Jaidev Shroff, Global Chief Executive Officer, UPL
Feike Sijbesma, Chief Executive Officer, Royal DSM
Erik Solheim, Ex-Minister of Development and Environment, Government of Norway
Budiman Sudjatmiko, Coordinator of Advisory Board, PAPDESI (Perkumpulan Aparatur Pemerintah Desa Seluruh Indonesia/Association of the Village Governments in Indonesia)
Ishmael Sunga, Executive Director, Southern African Confederation of Agricultural Unions
Getachew Gebru Tegegn, President, Ethiopian Society of Animal Production; Deputy Director, MARIL Ethiopia
Izabella Teixeira, Co-chair, International Resource Panel
Svein Tore Holsether, President and Chief Executive Officer, Yara International
Laura Tuck, Vice President for Sustainable Development, World Bank
Ann Tutwiler, Senior Fellow, Meridian Institute; Senior Advisor, SYSTEMIQ
Gerda Verburg, Coordinator, Scaling Up Nutrition Movement
Sunny Verghese, Co-Founder and Group Chief Executive Officer, Olam International
Dominic Waughray, Managing Director, Head of the Centre for Global Public Goods, World Economic Forum
Kathy Willis, Professor of Biodiversity, Oxford University

The FOLU Ambassadors network is co-chaired by Shenggen Fan, Agnes Kalibata and Paul Polman.

FOLU Global Report Reference Committee:

Per Pharo, Co-Chair of FOLU Global Report Reference Committee & Lead Author
Lawrence Haddad, Co-Chair of FOLU Global Report Reference Committee & Executive Director, Global Alliance for Improved Nutrition
Mari Elka Pangestu, Professor of Economics, University of Indonesia
Johan Rockström, Director, Potsdam Institute for Climate Impact (PIK)
Bernice Lee, Research Director for Global Economy & Finance and Executive Director of the Hoffmann Centre for Sustainable Resource Economy at Chatham House
Jianguo "Jack" Liu, Rachel Carson Chair in Sustainability, University Distinguished Professor at MSU and Director of the Centre for Systems Integration and Sustainability
Ruth Oniang'o, Editor and founder of the African Journal of Food, Agriculture, Nutrition and Development (AJFAND), Professor of Food Science and Nutrition
Louise O. Fresco, President of Wageningen University & Research
Juliano Assunção, Associate Professor in the Department of Economics at the Pontifícia Universidade Católica do Rio de Janeiro (PUC-Rio) and Executive Director at the Climate Policy Initiative Brazil
Frances Seymour, World Resources Institute Distinguished Senior Fellow
Zhang Linxiu, UN Environment's International Ecosystem Management Partnership (UNEP-IEMP)
Charles Godfray, Hope Professor of Zoology at Jesus College, Oxford, and Director of the Oxford Martin Programme on the Future of Food

FOLU country platforms:

FOLU has country platforms in seven countries, as well as a regional platform in the five Nordic countries. The country platforms are co-chaired by Claudia Martinez and Nirarta Samadhi. The following paragraphs provide an overview of the Coalition's work in each place.

Annette Rypalski, Biodiversity director at Odonata in Mount Rothwell research and conservation centre in Victoria, Australia.

Liu Guiyan, from Heilongjiang province, China, left her hometown to work on a farm in Beijing in 2014. Last year she joined Shared Harvest, an organic farm promoting the Community Shared Agriculture model.

FOLU Australia

ClimateWorks Australia, CSIRO and Deakin University are participating in FOLU through the Land Use Futures project, which resources and convenes a highly participatory, evidence-based process centred on developing integrated land use pathways and action roadmaps for sectors, including national, state and local government. In early 2019, ClimateWorks hosted a Natural Capital Summit, hosting 150 leaders from diverse sectors. The Summit identified key areas for action including fit-for-purpose systems for measuring and valuing natural assets, mainstreaming innovative sustainable land management practices, accelerated demonstration of blended finance and investment models, and introduction of government incentives and support.

FOLU China

In China, FOLU has established a national FOLU platform to support domestic and international approaches that strengthen ecological protection, alongside improved health and rural prosperity outcomes. The national platform seeks to strengthen the evidence base for action, and to support efforts in China to ensure responsible commodity sourcing. It also provides a bridge to the larger FOLU network, enabling China to share its rich development and environmental experience with other countries. Core partners in the platform include WRI China, China Agricultural University and Tsinghua University. A crucial component of the FOLU work in China is to support the development of the data and modelling infrastructure needed to produce long-term pathways towards sustainable food and land use systems, led by the FABLE Consortium.

Antigegn Wunetu (pictured here) and his wife Mekle farm on a watershed restoration and homestead development project in Bahir Dar, the Amhara Region of Ethiopia. They have just bought 24 chickens.

FOLU Colombia

FOLU in Colombia is a vibrant national platform, comprising over 100 actors from national and local government, the private sector and civil society. FOLU Colombia has initiated a number of action coalitions, including on the sustainable use of pesticides and fertilisers, the promotion of jurisdictional approaches to better food and land use in two regions (Quindío and Urabá), the measurement of food loss and waste, supporting healthy school diets and action on the ocean. The Coalition is also working with partners to pursue behavioural change and more effective communications, as well as in a series of value chains – including milk, meat and a cocoa and forest initiative – to bring about more sustainable outcomes. Across these areas, FOLU brokers strategic alliances between universities, governments, civil society organisations and the private sector. Colombian research institutions also participate in the work of the FABLE Consortium, where they advance analytical and modelling capacities to assess long-term sustainable development pathways in land use.

FOLU Ethiopia

FOLU in Ethiopia comprises a vibrant network of partners and experts working together to provide support to policymakers and other influential stakeholders at the national and local level. These include the Agricultural Transformation Agency, the Ministry of Agriculture, the Environment, Forest and Climate Change Commission, and the National Planning and Development Commission. The Coalition is also supported by a diverse and proactive group of "Goodwill Ambassadors" – prominent figures who advance and champion the vision and objectives of the Coalition. To catalyse action, the Coalition partners have prepared an Action Agenda with broad stakeholder engagement including diverse development actors, government, private sector, and experts. The Action Agenda outlines a vision and proposes innovative actions on food and land use for incorporation into the country's forthcoming five- and ten-year plans. FOLU Ethiopia partners are also working with the FABLE Consortium to develop long-term science-based targets and pathways that set out what sustainable food and land use systems could look like in Ethiopia.

Workers in the R&D fileds of the Jain Irrigation in the Jalgoan facility in Jalgoan, India.

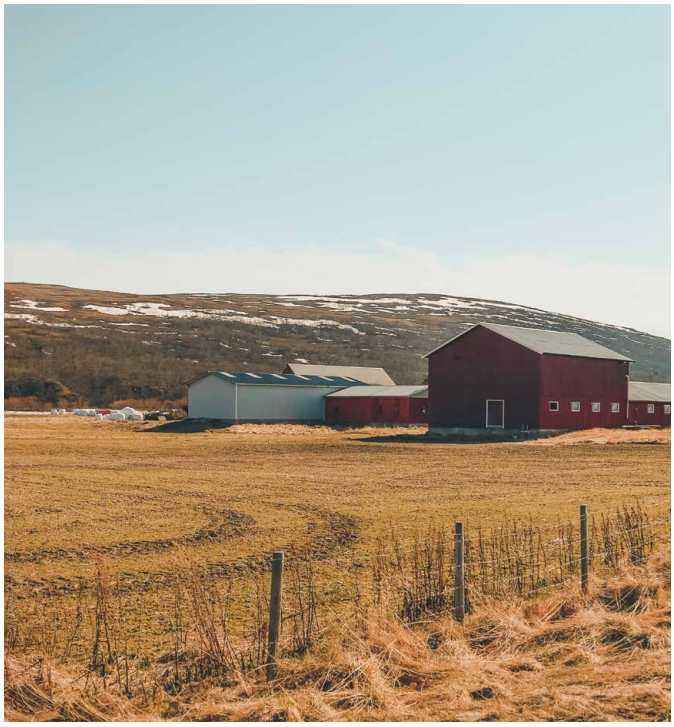
Portait of an ilipe nut farmer at the forest in Sintang regency, West Kalimantan, Indonesia.

FOLU India

In India, the work of FOLU is being spearheaded by a core group of four organisations: Council on Energy, Environment and Water (CEEW), the Indian Institute of Management, Ahmedabad (IIMA), The Energy and Resources Institute (TERI), and WRI India. A key component of the FOLU work is the development of decision-support tools by the FABLE Consortium, led by IIMA, which can inform policy decisions in rigorous ways, beginning with a test case on the impacts of biofuels on India's food and land use systems.

FOLU Indonesia

FOLU in Indonesia is housed in the National Planning Ministry BAPPENAS' signature Low Carbon Development Initiative, where it contributes to the formulation of Indonesia's next mid-term national development plan (the RPJMN for 2020-2024). FOLU Indonesia's Action Agenda, Ambassadors, partners, studies, research and convening have played a critical role in support of the LCDI as well as other relevant national policy (e.g. EAT's work on sustainable and healthy diets with the Ministry of Health). Indonesian research institutions are involved in the FABLE Consortium's scenario and development pathway planning exercises. FOLU has also worked at the regional level, including in the provinces of East Kalimantan and Papua and West Papua, in areas including food security, sustainable aquaculture, eco-tourism and mobilising finance for forest protection and restoration.



FOLU in the Nordics

FOLU has an active and growing network across the region with a strong set of civil society organisations and innovative private sector players, led by the Stockholm Resilience Centre of Stockholm University and the EAT Foundation. The role of the Coalition includes coordinating the Nordic Modeling Network (a group of over 15 modelers representing Sweden, Finland, Norway and Denmark, engaged in the FABLE Consortium) and progressing stakeholder dialogues with critical actors across the food system.

FOLU UK

FOLU has entered into a partnership with The Royal Society of Arts' "Food, Farming and Countryside Commission". The Commission is an independent inquiry, chaired by Sir Ian Cheshire, involving 15 Commissioners from farming and food businesses, public health and citizens' groups, think tanks and universities, all committed to tackling the challenges faced by the sector. The Commission recently published flagship reports, "Our Future in the Land" and "Field Guide for the Future" which draw on their national consultations.

FOLU is also contributing to the National Food Strategy, led by Leon restaurant founder Henry Dimbleby, and is involved in the FABLE Consortium through research organisations in the UK.

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