BRINGING IT DOWN TO EARTH:

NATURE RISK AND AGRICULTURE

June 2021

Suggested citation:
WWF (2021). Bringing It Down To Earth: Nature Risk and Agriculture.

AUTHORS

Stefano Esposito, Sustainable Finance advisor, WWF-Norway
Alison Midgley, Sustainable Finance specialist, WWF-UK

CONTRIBUTORS

Brent Loken, Global Food Lead Scientist, WWF Global Science
Conor Linstead, Freshwater Specialist, WWF-UK
Helena Wright, Former Vice President, WWF-Singapore
Jan Vandermoesten, Senior Policy Officer, Sustainable Finance, WWF European Policy Office
Joanne Lee, Sustainable Finance Specialist, Finance Practice, WWF International
Martina Fleckenstein, Global Policy Manager Food, WWF International
Natasja Oerlemans, Head of Food & Agriculture, WWF-Netherlands
Paula Peirão, Sustainable Finance Specialist, WWF-Brazil
Raymond Dhirani, Head of Sustainable Finance & Green Economy, WWF-UK
Susanne Schmitt, Nature and Spatial Finance Lead, WWF-UK

EDITING

Barney Jeffries, swim2birds.co.uk

GRAPHIC DESIGN

Lene Jensen, WWF Norway

CONTENT

EXECUTIVE SUMMARY

IMPACTS AND RISKS OF TODAY'S FOOD SYSTEM

Food production and agribusiness is a US$5 trillion industry. Agriculture alone contributes US$2.4 trillion to the global economy, thanks to the work of 1 billion people. Supply chains span the globe, and encompass those involved in the production, processing, distribution, trading, marketing, end-sales and consumption of food. The finance sector is a key stakeholder, providing financial services and financial instruments such as loans and insurance, and investing in a variety of companies throughout the global value chain.

In a little more than 50 years, agriculture has undergone a tremendous transformation. Productivity has boomed, driven by the industrialisation of farming, efficient new technologies and machineries, and a superfluity of agrochemicals and fertilisers, bringing an abundance of affordable foods to many. However, this revolution has come with a colossal price tag. And although many of these costs are hidden by long, opaque supply chains that often span the globe, such impacts are accumulating.

The focus of investors in agriculture is mainly on volume of food produced alone, even to this day. Emphasising productivity over all else has masked inherent inefficiencies that drive a host of social and environmental issues, such as overproduction of resource-intensive meats, rising levels of waste and pollution, obesity and other food-related health problems in our populations etc. Within the next 30 years, we must feed an additional 2 billion people: the current way we produce food is no longer sustainable for our planet and society.

The food sector is increasingly globalised, concentrated, subsidised and industrialised, "locking in" and entrenching conventional practices rather than incentivising alternative approaches. Emerging oligopolies in sectors such as seeds, agrochemicals and fertilisers mean that a handful of players have significant influence on markets and political lobbying power to obstruct reforms. Producers themselves can become dependent on chemical inputs to maintain competitiveness in the short term. As traditional seeds disappear, 60% of all calories consumed are from only three plants – rice, maize and wheat. Large downstream players in agricultural value chains hold power over consumer markets and can set standards for producers that limit their ability to set prices and invest in alternative production practices. As one of the most heavily subsidised sectors in the world, agriculture struggles to be commercially profitable, dependent entirely on indirect and direct financial support for mostly large-scale, industrialised production.

The extractive paradigm of modern agriculture is built on the principle that nature can be artificially and chemically enhanced and replaced *ad infinitum* in order to produce more food on less land. The benefits and services biodiversity offers can be replaced with pesticides, weedkillers and heavy tillage. Traditional and diverse seeds can be replaced by fewer standardised varieties. Soil organic matter and nutrient recycling can be replaced with synthetic fertilisers. This paradigm is translated into a production model that depends on monocultures, low agrobiodiversity, and systematic use of tillage, agrochemicals, fertilisers and antibiotics in intensive factory farming. Agriculture has thus become an activity which extracts resources and slowly erodes the very same natural resource base that it needs to sustain itself.

Agricultural systems are complex and diverse, ranging from small subsistence farms to industrial operations of various sizes and production methods. Small-scale farms constitute about 85% of farms globally and provide 80% of the food in developing countries. However, the extractive paradigm can be recognised in a variety of productive systems, independently of their size. Small-scale farms can be as environmentally damaging (albeit at a smaller scale) and unsustainable as large ones, if land is not managed sustainably. This also means that sustainable practices can be applied to all size and types of farms.

All production systems house a range of externalities – that is, negative impacts on the environment, local communities and public health. And the negative externalities of farming can be as damaging as coal power generation.

Food systems are the major drivers behind the transgression of our planetary boundaries, which define the key physical limits of what our planet can sustainably tolerate. Four of the nine boundaries, namely climate change, biodiversity, land-use change and biochemical flows (nitrogen and phosphorous cycles), have already been crossed, with food systems being a major driver in all four cases, and a significant threat to all the remaining ones. This means that the Earth's system itself is eroding and shifting, rather than absorbing the impacts and regenerating. Loss of nature cannot be reversed without addressing the food sector in earnest.

Food systems are the largest driver of deforestation, water use, biodiversity loss and soil degradation. Agriculture occupies half of our planet's habitable land, with the remainder for forests (37%), shrub and grasslands (11%) and cities and infrastructure (1%). Most agricultural land (82%) is used to produce animal food directly through grazing or indirectly through the cultivation of feeds such as soy, while 10% is used to grow crops for direct human consumption. The sheer scale of land use makes agriculture the largest cause of deforestation and loss of precious habitats such as wetlands. It is also the largest user, and polluter, of fresh water, linked to 92% of the global water footprint. Since 1970, humanity has driven a 68% decline in vertebrate species populations as well as a worrying decline in pollinators. At the heart of this is the current agriculture system.

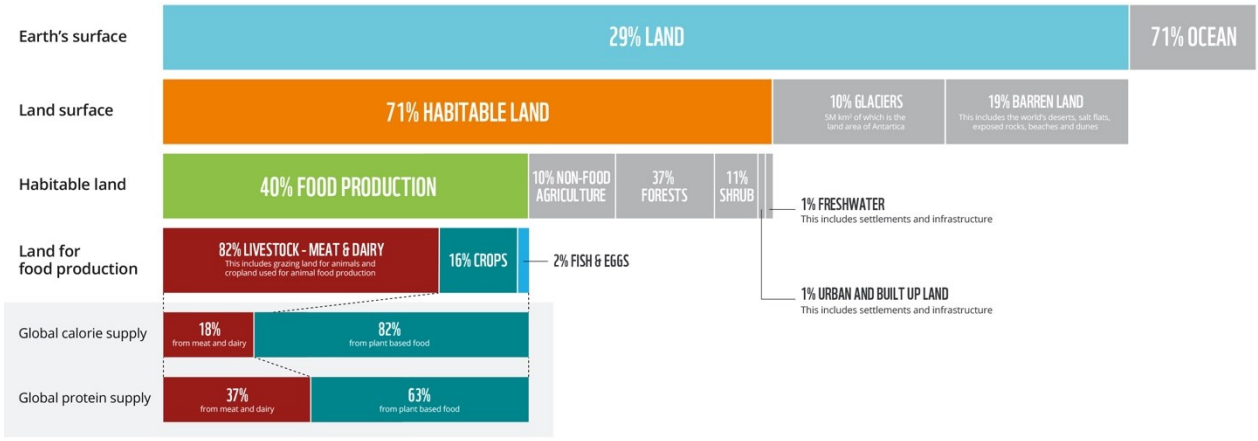


Figure 1: *Total land use taken up by human activities (WWF, 2020)*

Soils are one of the most invisible and forgotten of our natural resources, yet vital to humanity's existence. Soils host at least a quarter of the world's biodiversity and store twice as much carbon as the entire atmosphere. Yet more than half of the land used for agriculture is degraded due to erosion, compaction, chemical pollution and loss of nutrients, and arable land is being lost at 30 to 35 times the historical rate. Degraded soils are less resilient to stress and less productive. The combination of land degradation and climate change is predicted to reduce global crop yields by 10% and up to 50% in some key regions, reducing the amount of productive land per person even as the global population grows. If this is not addressed, agriculture is likely to expand even further into our remaining forests, wetlands and other natural habitats.

Food systems are to nature loss what energy systems are to climate change. As the international community starts to wake up to the risks posed by climate change, early action has been focused on the sector with the highest emissions, the energy sector. Today, as a wave of reports have rung alarm bells on the declining state of nature, a similar focus is needed on the main driver: the food sector. Furthermore, climate change and loss of nature are twin problems that feed each other in a vicious circle: as well as being the biggest contributor to nature loss, food systems are responsible for up to 30% of global greenhouse gas emissions. Nature and climate risks reinforce each other in a way that is not separable – as the climate changes, it drives biodiversity loss, and as biodiversity declines, so do carbon sinks and the environmental resilience needed to resist further impacts of climate change. The two should therefore be addressed together. A focus on the food sector allows financial institutions to connect their ongoing efforts on climate change with nature and biodiversity and become more resilient in the long term.

Nature-related risks are a real and emerging threat. Recent reports on the state of the natural environment present a clear, unified message: loss of nature matters to everyone, including business and finance. Loss of nature is recognised as one of the top five most likely and impactful risks in the coming years, with trillions at risk if ecosystems continue to be damaged by human activities. Central banks and financial supervisors are warning that biodiversity loss is a source of financial risks and threatens the availability of ecosystem services, such as pollination and soil fertility, on which economic activities depend. The food sector, which is so reliant on a healthy and dependable environment, is consistently highlighted as the sector with the largest impacts, dependencies and risks.

Transforming food systems is one of the most effective ways to reduce our impacts on nature and reduce risk. The first step is to understand where risks lie and what changes are needed. For the financial sector, this means that the quest to tackle environmental degradation must focus on understanding and managing the portfolio's impacts and risks related to the food sector. Current risk assessment methodologies fail to capture many of the hidden costs of investments or subsidies in the food systems, leaving the financial sector exposed to the related risks.

Different types of nature-related risks can emerge through businesses' dependencies and impacts on nature. This report provides a framework to understand how these risks can emerge and become financially material, and identifies some major risk categories: physical, regulatory and legal, market and reputational risks can be material to businesses along the whole supply chain, from producers to retailers. Systemic risk arises when tipping points are crossed and the stability of both the food system and society is undermined. Finally, financial risk can arise as a consequence of the other risks.

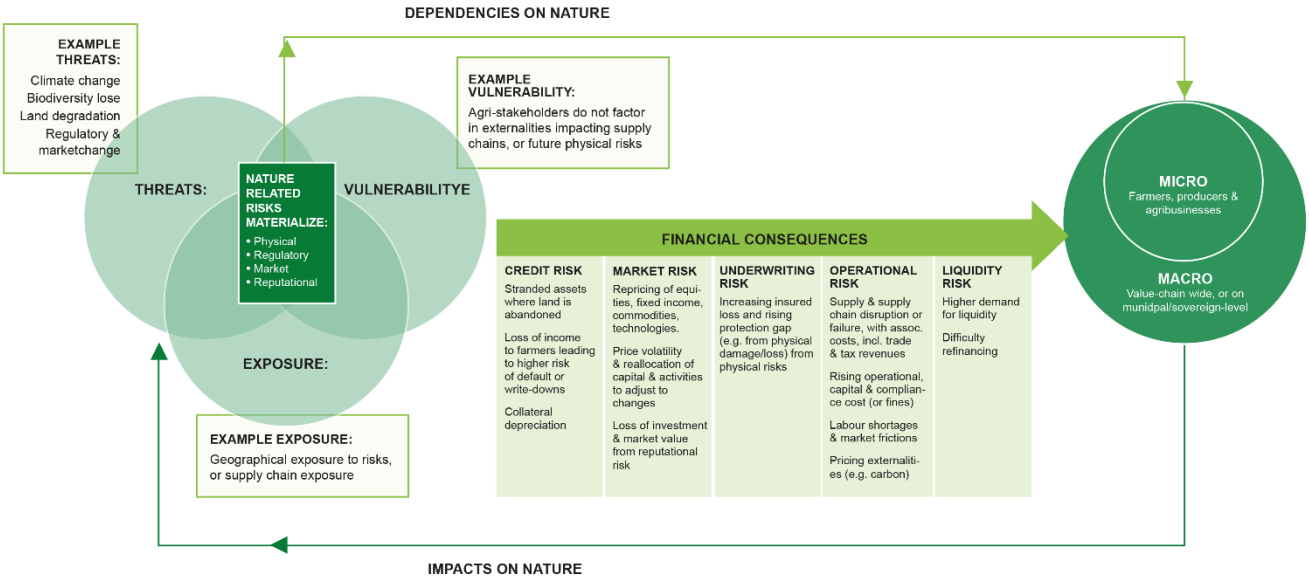


Figure 2: *High level framework illustrating the transfer of nature-related risks to business and the economy. Agribusinesses, and the economy as a whole, both depend and impact on nature. Changes to nature, markets and regulation can pose a threat to exposed and vulnerable agribusiness stakeholders. This gives rise to physical, regulatory, market and reputational risks. Financial consequences arise as an outcome, when stakeholders fail to manage these risks. Impacts on the micro-economy can aggregate across value chains and economy-wide when dependences and impacts become too great (i.e. systemic risk). Adapted from various studies (incl. WWF, 2019; NGFS, 2020).*

Nature-related risks are often interconnected and do not fall into rigid categories. The concrete risks identified specifically for the agricultural sector include physical risks linked to its dependencies and impacts on nature's resources, and may be related to climate change, deforestation, soil loss and degradation, low agrobiodiversity, resistance to agrochemicals and antibiotics, the production and use of synthetic fertilisers and pesticides, freshwater resources and the emergence of zoonotic diseases such as Covid-19. In turn, these can lead to regulatory risks such as stricter limits on use of agrochemicals and subsidy reforms, market risks associated with shifting consumer preferences and reputational risks as the food system comes increasingly under the spotlight. Ultimately, all these risks may become financially material for both companies and financial institutions.

Nature-related risks need to be urgently integrated into business models and the finance sector's strategies. Financial institutions are largely failing to account for nature risks, assuming that only acute and severe environmental disasters are material to portfolios. This perspective needs to be expanded. Although the risks from the food sector are not always visible because many are chronic and indirect, they will only be aggravated if we do not act to shift mainstream practices now. Whereas activities such as mining and oil drilling are visibly extractive, agriculture is less so, because the degradative processes of soil loss, water use, biodiversity loss and pollution are not as obvious as mountaintop removal and strip mining. Yet, especially when practised industrially, agriculture is both extractive and far more extensive than mining, its impacts driven by the sum of many mainstream and legal agricultural practices and bankrolled by our current financial and economic system.

TRANSFORMING FOOD SYSTEMS – A NEED FOR CHANGE, AT SCALE

Transforming food systems will take a seismic shift in the priorities of businesses, policymakers and consumers. However, it is estimated that the societal return on investment in terms of saved costs would be more than 15 times the investment cost, creating benefits for the economy, society and the planet. Contributing to this transformation would help to fight climate change, reverse nature loss, safeguard biodiversity and generate wide-reaching positive health impacts, through nutrition and disease prevention. For the finance sector this is also the leading way to reduce risks and create investment opportunities.

Transforming food systems requires addressing deep-rooted, widespread institutional and market failures and a variety of lock-ins that slow the pace of change. This report identifies solutions that deliver systemic changes in how food systems and agriculture operate and are assessed. It focuses on the preservation of the underlying natural resources to guarantee resilience and longevity of productive systems. For instance, a more sustainable measure of success should consider not only the production output, but also the external inputs required and the negative externalities that a system produces. This should be mainstreamed into financial incentives and in the way that companies are rewarded and evaluated.

The finance sector is affected, directly and indirectly, by the risks and impacts of nature loss. However, traditional financial metrics do not adequately measure or monitor such impacts, and still incentivise short-term profits rather than long-term value. Finance should integrate nature-related considerations into decision-making, beyond carbon and general environmental, social and governance (ESG) issues. It should begin to ensure that mainstream investments have a broader, positive societal and economic perspective, and are aligned with societal and governance goals.

Food systems need to be transformed across three areas: sustainable agricultural practices, plant-based diets and reductions in food waste. These would address the major structural problems of food systems, and also constitute some of the most impactful climate solutions.

1) **Sustainable production: agroecology**


© Shutterstock

'Agroecology' is a set of practices, based on traditional and regenerative approaches, that mimic natural processes and enhance beneficial biological interactions and synergies on the farm. Such practices focus on improving soil heath, boosting fertility and organic content, and increasing biodiversity. Four core principles of agroecology are i) minimising soil disturbance and tillage, ii) maintaining an 'armour' of plant residues and cover crops over the soil rather than leaving it bare, iii) fostering seed and plant diversity on-farm, and iv) ensuring nutrient cycling through waste management and rotation.

These principles contrast with the conventional approach based on heavy tillage, bare soils, monoculture and the systematic use of agrochemicals and fertilisers. Agroecology is widely supported among international and research institutions, as well as progressive business organisations. In an increasing number of cases, economically viable solutions are being developed that also increase

resilience to climate change and other stress factors by improving soil fertility, water retention and biodiversity, while reducing the dependency on external inputs.

2) Planet-based diets

Feeding the world's growing population without further expansion in agricultural area will necessitate a shift in the way we eat. Animal proteins in general, especially when produced using edible crops, have an outsized impact on environmental and human health relative to the nutrients they provide. If the demand for animal products continues to grow, an area the size of Argentina will need to be converted from natural habitats to crops and pastures. A broad consensus supports the need to shift towards plant-based diets to reduce our footprint on nature and unlock a variety of societal and economic benefits. WWF emphasises the importance of eating less, better animal foods from sustainable production systems, based on, for example, a "livestock on leftovers" approach, which limits animal protein consumption to what can be produced by raising animals on available grazing lands, by-products of agricultural crop production and food waste.

3) Reducing food waste

A third of all food produced for human consumption is lost each year, effectively wasting 28% of our agricultural land. If food waste were a country, its greenhouse gas emissions would rank third in the world, behind the US and China. Food waste is a complex issue caused not only by consumer behaviour, but by a combination of systemic challenges. This includes market dynamics that push prices so low that farmers' costs are not covered, investments are limited, and, in many extreme cases, crops are left on the field. Food retailers and companies higher up in the supply chain, and those who providing finance, have a responsibility to secure fair prices so farmers can better manage their waste and lands. Policymakers should ensure that best practice is mainstream practice, and shift to subsidising practices that do not work in direct opposition to environmental subsidies.

All stakeholders have a role to play: farmers, buyers, traders, cooperatives, advisors, researchers, governments, retailers and financial institutions. Collectively, through different channels, they should reduce the burden on farmers to manage the environmental impacts of production on their own farms and at landscape level alone. Currently, the tide of financial incentives is to produce high yields above all else. Incentivising, rather than impeding, the transition to agroecological practices will require strengthening the enabling environment for farmers to transition, and proliferating pilots that demonstrate best agroecological practice and secure markets. Major policy and regulatory changes are needed to reform subsidies, internalise costs and adjust fiscal incentives; research and advisory institutions should correct the current bias towards industrial practices and support increased knowledge on how to improve the efficiency of agroecological approaches. In addition, food retailers should facilitate sustainable dietary trends and make sustainable foods more accessible, while reducing the downward price pressure on farmers.

WWF's recommendations to the finance sector

The financial sector provides a whole suite of products, both directly to farmers and agribusinesses and along the value chain, that promote continuation of "business as usual". WWF has developed a list of five recommendations that can be adapted to different categories of financial institutions, including banks, insurers, asset owners and asset managers. The recommendations include a non-exhaustive list of tools and methodologies that can guide the finance sector in tracking risks, impacts and opportunities - and design a strategy to mitigate risk and enhance value in the food sector. This would enable a shift away from the current system, to one which secures food for a greater population within planetary boundaries.

1: Understand your 'double materiality'- both nature-related risks and impacts

Financing unsustainable agribusiness both impacts on nature and can expose an institution to financial risk. Financial institutions should commit to assessing their impacts on nature from agribusiness investment and lending. They should also encourage agribusiness to be transparent about their sourcing and encourage them to support data capture, to better assess risks. A "Toolbox" approach may be necessary to assess, track and disclose double materiality, as well as understand baselines for impact and risk mitigation. Financial institutions should then track, monitor and disclose through established standards.

2: Capitalise on your opportunities

The financial sector has a key role to play in shifting incentives for better production and consumption. Innovative financial products and 'patient' funding will help mitigate risks and tap into opportunities to strengthen the company's reputation with stakeholders, improve resilience, lower operating costs and make more efficient use of resources. Opportunities also exist in the growing market for carbon storage in soils. Tools such as certification standards and sustainable taxonomies can be used by the finance sector to identify best-in-class operators and opportunities. Investing in nature-positive solutions should be part of an integrated approach that follows the so-called mitigation hierarchy: avoid and reduce damage, restore, and compensate for damage through positive contributions.

3: Design and implement a planet-smart strategy

Financial institutions should design and implement a strong strategy to manages both risks from and impacts on the environment through their investment and lending. A strong strategy can begin with a risk and impact assessment to identify high-risk and high-impact areas of their portfolio, with attention to investments and lending associated with the agribusiness industry. Thereafter, make a strong commitment to manage those risks and impacts, with a target date. Carve it into the organisation's institutional policy, to ensure that actions are more likely to be supported from within the institution. Establish a team that includes voices from critical stakeholders. Set out a risk and impact mitigation plan, and reporting and accountability mechanisms.

4: Engage and educate your stakeholders

Strategies and policies should be anchored within the organisation, providing staff with the necessary knowledge to implement change. Likewise, it is important to continually engage external stakeholders

so that they are aware of the priorities of the organisation. Financial institutions should identify relevant companies for engagement, encouraging them to set sustainable food transition plans with clear targets, manage their impacts and define escalation strategies where engagement efforts do not lead to results.

5: Raise your voice to mobilise a sustainable shift
Progressive financial institutions should ensure that their actions are amplified to achieve a wider impact and strengthen the market for sustainable food systems. Policies should be made public and success and progress should be effectively communicated to companies and service providers. Reporting should include sufficient information about the results of engagement with portfolio companies. Financial institutions should join the public debate, engage policymakers and join relevant investor alliances and other fora to pool efforts and share knowledge and experiences. Communicating successes but also challenges and lessons learned can enable better performance. Incentivising better practice is not only about financing “greener” activities, but also enabling change of business-as-usual practices.

A range of tools is needed to integrate nature risks into the strategies and portfolios of financial sector actors, and there is a growing body of evidence, tools and guidance frameworks to support it. While commercial tools have been developed to account for impact, frameworks for understanding nature-related financial risk is still in its naissance. A major obstacle is the lack of transparency in supply chains, making it challenging to link large, listed food companies or retailers, which are typically part of a financial portfolio, with the broad producer bases constituted by farmers. Decision-grade data is sparse, especially for marine supply chains and at farm-level. Larger corporates remain primary buyers and part of increasingly consolidating supply chains, meaning they are highly influential in setting standards for producers. Currently, accountability to shareholders is still almost solely based on consistent financial returns without consideration of the company’s broader environmental and social impacts, meaning that few assume responsibility for externalities. Because of the variety of production systems and management practices, there is no single method for financial institutions to easily integrate nature risks into their systems, and standardisation of sustainable reporting metrics has not been done to the degree that allows for company comparison. In this regard, traditional ESG metrics are not strong enough. Nevertheless, this should spark incentives to call for standardisation, rather than shrink away from sustainability reporting as a whole.

Loss of nature and biodiversity is happening at such a rate that concrete actions can no longer be postponed, by hiding behind fears of complexity and missing data. With the awareness that no perfect solution exists yet, this report attempts to provide an overview of potential approaches to the problem, providing information for finance providers to agribusinesses and producers to understand risk, impacts and dependencies and ask the relevant information to companies and data providers. The report also provides evidence of the need to transition to sustainable production, and some tools that may be used to demonstrate which farmers are already integrating best practices. The finance sector urgently needs to act to address the risks of today’s industrial food system and realise the opportunities that shifting to a sustainable food system will bring.

PROLOGUE

Food systems are the single largest driver of biodiversity loss worldwide.[1] Complex and diverse, food systems are a driving force behind agricultural expansion, land conversion, exploitation of species, freshwater use and pollution. 'Food systems'[i] refer to all the composite activities and stakeholders that make up food supply and value chains. They include natural and man-made inputs from the production, transport, storage, processing, manufacturing, marketing, retailing and consumption of food. They also include direct and indirect beneficiaries related to food industry. And in the context of this report, includes food system's costs and benefits to the environment, health, society and the economy.

A great variety of food systems exist, at all manner of scales. To different degrees, the entire food supply chain – from production to final consumption and disposal– exerts pressures on the environment. However, the most direct pressures exist at production level. In this report, we provide a bird's-eye view of the cumulative impacts that typify our globalised and increasingly industrialised food systems, focusing on impacts at farm level. Although this report addresses some key elements necessary for a long-term sustainable food system, such as plant-based alternatives to meat and better waste management, the focus is on how and why common agricultural practices need to be shifted to a more sustainable model. We also present evidence of how rising 'nature-related risk'[ii] in this sector is material to farmers, businesses and those who finance them. We present a framework and guidance to those financing and working with the food sector to identify, understand and mitigate these risks. We also outline the transformational changes we need for our food systems to be managed more effectively for people and the planet.

All actors within agricultural value and supply chains can act to shape a more progressive, sustainable food system. While we outline a role for most actors, this paper mainly offers guidance for those who invest in, lend to or own agricultural and production-related assets and want to better understand how to recognise, measure and monitor nature-related risks.

In **Chapter 1** we outline some characteristics of global food systems and home in on certain founding factors, or 'lock-ins', that keep the system inefficient, costly and fundamentally unsustainable. These include excessive subsidisation from government, rising industrialisation without adequate environmental controls and corporate concentration (especially in fertiliser industries, seeds, chemical industries and commodity trading). These factors mask the broader environmental, socio-economic and health implications or 'externalities' we will describe in later chapters.

In **Chapter 2** we describe how food systems, and particularly agricultural production, detrimentally impact on and influence the interconnected issues of land degradation, climate change, biodiversity loss and health. We show how the food system is to biodiversity loss what the energy system is to climate change, and why it is critical for all those investing in and regulating the food industry to address these impacts.

[i] Our definition is based on the paper by UN's scientific group for the Food System Summit, published in 2020: https://www.un.org/sites/un2.un.org/files/food_systems_concept_paper_scientific_group_-_draft_oct_26.pdf

[ii] This report uses the term 'nature risk' or 'nature-related risk' to describe the range of climate and environmental risks that are material to businesses, while 'nature related impacts' is used to describe how business activities degrade nature's natural resilience. Other resources may use the similar term 'environmental' risk, or differentiate between climate risk, water risk or biodiversity risk. However, 'nature-related' or environmental risk is an over-arching category capturing all environmental or climate change-related risks, while biodiversity is a subset of nature-related risks.

In **Chapter 3,** we present a framework for understanding how impacts and dependencies in the food system can lead to a variety of nature-related risks – physical, regulatory, market, reputational, systemic and ultimately financial risks. We identify and present some of the largest risks related to unsustainable farming practices impacting soil and water quality, biodiversity and the climate.

In **Chapter 4**, we present the solutions available to transform food systems across three key levels: agricultural production practices, dietary trends and food waste.

Based on an extensive review of the latest scientific consensus, the proposed solutions are necessary to align food systems with the Earth's planetary boundaries, to allow companies and the financial sector to manage impacts and risks, and to identify opportunities to scale up transformational solutions. For those regulating or investing in production, we outline the key principles of sustainable agriculture. And for those in consumer-facing industries, we outline what a 'planet-based diet' looks like. Finally, we identify five key actions for financial institutions to identify and work with companies exposed to nature-related risks and impacts in the food sector, as well suggestions for tools and approaches that can be used to operationalise this work.

CHAPTER 1

SETTING THE SCENE ON OUR FOOD SYSTEMS

CHAPTER 1: SETTING THE SCENE ON OUR GLOBAL FOOD SYSTEMS

INTRODUCTION

In little more than 50 years since what is known as the Green Revolution, agriculture has undergone a tremendous transformation. The result has been massive yield gains[iii] through increased irrigation and new technologies like scientifically bred seeds, fertilisers, agrochemicals and machinery. This revolution made it possible to grow more food on the same area of land, transforming the trade of international commodities, and making food cheaper and more accessible to many members of the global population. Food production and agribusiness is now a US$5 trillion industry, with agriculture alone generating US$2.4 trillion to the global economy thanks to the work of 1 billion people.[2,3] Supply chains span the globe, and encompass those in production, processing, distribution, marketing and retail as well as everyday consumers.

However, this revolution has come with costs and with consequences that are no longer sustainable for our planet and society. As production has boomed, so have the inputs required to maintain it – fertilisers, agrochemicals, machinery – and this has had disastrous consequences for the environment. Coupled with an increase in demand for animal products and feeds, food systems have become the largest driver of the loss of habitats and biodiversity. Production areas now occupy over half of all our planet's habitable land, expanding at the expense of our forests, wetlands and other natural ecosystems.

"THIS REVOLUTION HAS COME WITH COSTS AND WITH CONSEQUENCES THAT ARE NO LONGER SUSTAINABLE FOR OUR PLANET AND SOCIETY."

The impacts of agriculture on nature are felt both on-farm and in surrounding areas. On-farm, soil is degraded and pollutants damage soils and waters. Declining productivity and soil erosion pushes farming into surrounding habitats, where biodiverse carbon sinks like tropical forests and savannahs are replaced with greenhouse gas-intensive alternatives. Some crops have more impact than others. So-called 'forest-risk' commodities like beef, soy, palm oil, rubber, coffee, timber, and pulp and paper are leading drivers of tropical forest conversion,[4] threatening the stability of regional climates. Similarly, with fish consumption increasing at a rate outpacing population growth, seafood supply chains have become so exploitative that over a third of global fish stocks are now overfished.[5]

Food systems are complex and diverse. Agricultural systems range from small subsistence farms to huge industrial operations, comprising a wide variety of production practices, from monocultures to agroforestry, extensive livestock farming to aquaculture. Differences in irrigation practices, soil management and geographic location all affect the impacts and risks of the system, as do the economic, political and social context.[6]

[iii] From 1967-2007, the production of wheat, rice, maize, soy alone has increased by 116%, 133%, 238% and 634% respectively. Source: Living Planet Report. https://wwf.panda.org/knowledge_hub/all_publications/living_planet_report_2018/

This chapter focuses on the structural characteristics of the globalised industrial food system that emerged following the Green Revolution. We look at the range of mechanisms that shaped this system, such as public subsidies and other supporting policies, as well as the failure to account for negative externalities. We look at the increasingly concentrated market and the tendency for research and development (R&D) to aim for quick-fix solutions, linked to technologies and agrochemicals, rather than improving long-term land management.

"A RANGE OF 'LOCK-INS' REINFORCE AND ENTRENCH FOOD SYSTEMS PRACTICES THAT HAVE NEGATIVE IMPACTS ON NATURE, CLIMATE AND SOCIETY."

A range of 'lock-ins' reinforce and entrench food systems practices that have negative impacts on nature, climate and society, including political and market structures, and a narrow focus on producing cheap food above all else. While such lock-ins can be challenging, they are not insurmountable and many businesses are looking at the added value of more sustainable models.

Many of these characteristics resemble those of the global energy system, which is also characterised by significant and unbalanced subsidies, power concentration, and a primarily extractive paradigm that leads to uncaptured externalities. Both the food and the energy sector are critical to the well-being of people and both are fraught with ecological, social and health-related issues for workers – and both have great potential for reform.

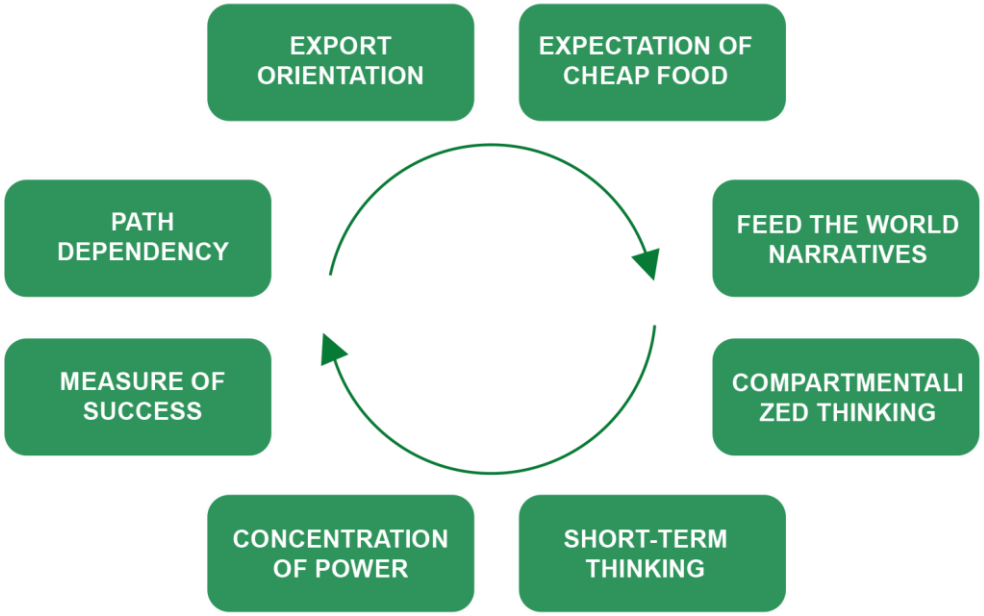


Figure 3: *Institutional, behavioural and technological 'lock-ins' of unsustainable food systems, IPBES-Food (2016)*

In the next section, we will look more closely at these lock-ins entrenched in global food systems, homing in on the current extractive agricultural paradigm, commercial power concentration and subsidies.

GLOBAL FOOD SYSTEMS AT A GLANCE

The extractive paradigm of modern agriculture

Modern agriculture is built on the following principle: that nature's services can be artificially and chemically enhanced and replaced *ad infinitum,* leading to more food on less land. Biodiversity, which provides natural resistance to pests, can be replaced with pesticides, weed killers and heavy tillage. Soil organic matter and nutrient recycling can be replaced with synthetic fertiliser. Genetic diversity can be replaced with genetically modified or artificially bred species. And an additional dose of antibiotics can help win the arms race against pests and diseases.

Conventional thinking holds that to produce more food on less land, agriculture must be intensified.[iv] So far, this has improved the yield outputs of farmland in general, helped by focused R&D that supports this model. An analysis[7] of investments in agricultural R&D in Africa found that most governments and private donors favour research on industrial agriculture instead of regenerative agriculture, with few exceptions. Government subsidies, both private and public R&D and industry knowledge-sharing are still biased towards industrial agriculture. However, as this paper will show, the repercussions of this focus are leading to global-scale issues that cannot be maintained in the long term.[v]

"INDUSTRIALISED PRODUCTION ONLY BECAME ENTRENCHED IN THE SECOND HALF OF THE 20TH CENTURY. AND IT HAS MASKED INHERENT INEFFICIENCIES THAT ALSO MASK A NUMBER OF CHRONIC SOCIAL, ENVIRONMENTAL AND CLIMATE ISSUES."

© Johny Goerend / Unsplash

This extractive paradigm is independent of the size of the producer. Small-scale farms constitute about 85% of farms globally and provide 80% of the food in developing countries. They contribute 30% to

[iv] Intensification inadvertently means more inputs such as fertilisers, pesticides and feedstuffs per hectare of land. For more details on how intensification is measured, refer to chapter 4.

[v] One of the latest reports is from the European Environmental Agency, highlighting that Intensification of the use of inputs has led to impacts on multiple environmental dimensions, such as biodiversity, air quality, climate, soils, water resources and aquatic ecosystems. EEA (2020). Water and agriculture: towards sustainable solutions. EEA Report No 17/2020. https://www.eea.europa.eu/highlights/agricultural-policy-needs-to-secure

global crop supplies and food calories, using 24% of farmland.[8] But they can be as environmentally damaging (albeit at a smaller scale) and unsustainable as large-scale farms if land is not managed well.

Large-scale farms more typically engage in industrialised and homogenous production, which depends heavily on expansive monocultures, industrial-scale feedlots, high chemical inputs, antibiotics to manage high concentrations of animals and heavy tillage. Industrialised production only became entrenched in the second half of the 20th century. And it has masked inherent inefficiencies that also mask a number of chronic social, environmental and climate issues.[9] Both small and large farms need to shift towards better land management practices if we are to remain productive and still mitigate some of the broader impacts of the food system.

Power concentration

The global food business is also shaped by power concentration. Globalisation and price competition have given rise to the emergence of global giants in the seed, agrochemicals, fertiliser, animal genetics, farm machinery, processing and retail business.[vi] Rising mergers and acquisitions in the chemicals and seed industry,[10] for example, have created oligopolies where a handful of players have significant influence over food standards and markets, and significant lobbying power to obstruct political reforms, for example on pesticide restrictions.[11] Much of this has been driven by the removal of trade barriers and corporate deregulation.[12]

It has been clear for some time that dominant agri-food 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 innovation we need." [13,14].

"MODERN AGRICULTURE IS BUILT ON THE FOLLOWING PRINCIPLE: THAT NATURE'S SERVICES CAN BE ARTIFICIALLY AND CHEMICALLY ENHANCED AND REPLACED AD INFINITUM."

Concentration in food systems means that standards and prices are *de facto* set by retailers and traders rather than the farmers themselves, resulting in market prices that squeeze farmers' income and leave many highly leveraged or barely able to cover costs. Such social implications of food systems will be addressed in the next chapter.

Subsidies

Subsidies in the agricultural sector make up the lion's share of farmer incomes. They can come from budgetary disbursements, tax concessions, market price support or tariff barriers to support domestic producers,[vii] as well as bailouts in difficult economic periods. Financial support can also be given for agricultural inputs or credit for irrigation, pesticides, fertilisers, fuel, electricity, seeds, feedstock, machinery, crop insurance and so on.[15] OCED countries still provide the highest subsidisation in the world, although China, India, Indonesia and Turkey are fast catching up.[16]

[vi] For example, some of the biggest mergers and acquisitions to come onto the agribusiness market have occurred since 2015, including the US$130 billion merger between US agro-chemical giants, Dow and DuPont, Bayer's US$66 billion buyout of Monsanto, and ChemChina's acquisition of Syngenta for US$43 billion and its planned merger with Sinochem in 2018. This could leave up to 70% of the agrochemical industry in the hands of only three corporations – Monsanto/Bayer, Dow/Dupont, and Syngenta/ChemChina. The seed industry is also consolidating to near-monopolistic levels, leaving four big companies (Bayer, Corteva, ChemChina, BASF) in control of more than 60% of global proprietary seed sales.
IPES-Food (2017). Too big to feed: Exploring the impacts of mega-mergers, concentration, concentration of power in the agri-food sector. http://www.ipes-food.org/_img/upload/files/Concentration_FullReport.pdf.

[vii] According to the 2019 OECD Agricultural Policy Monitoring and Evaluation report, in the period 2016–18, the 53 countries surveyed provided US$705 billion in support to the agricultural sector. This is likely to continue to increase . Around 75% of this amount was transferred directly to farmers. Source: OECD (2019), Agricultural Policy Monitoring and Evaluation 2019, Paris: OECD Publishing, https://doi.org/10.1787/39bfe6f3-en

Countries promote subsidies for a variety of reasons, and they can be essential. But how they are designed and distributed – and which practices they incentivise – often determines the result. The OECD[17] found that most agricultural policies focus on conventional production- or input-orientated agriculture, which can have environmentally damaging and trade-distorting effects.[18] For example, a number of investigations have revealed that EU subsidy systems can be deliberately abstruse and grossly undermine the EU's environmental and climate goals.[19,20] This includes amendments to the EU's Common Agricultural Policy, which is its largest spending programme.[viii]

In addition, subsidies can favour the few. In the EU about 80% of the direct support to farmers goes to the largest 20% of farms, which are usually the most industrialised. In the US, too, federal subsidies are channelled towards only 10% of farms[21] and support a consolidated group of commodity crop growers.

The subsidisation of agriculture has knock-on effects through the entire supply chain, locking farmers into production that is not profitable without government aid. The resulting price competitiveness means that farmers are subject to demand-side pressures and encouraged to produce more with less. This limits their capacity to invest in natural capital and soil longevity, which they must do at their own cost. Although prices for staple crops are at a historic low, the agrichemicals and the subsidies required to maintain production levels have been steadily rising,[22] meaning that farmers have few choices but to keep depending on state aid. However, this does not need to be the case, and many incentive systems can be adjusted to better manage long-term impacts.

"MOST AGRICULTURAL POLICIES FOCUS ON CONVENTIONAL PRODUCTION- OR INPUT-ORIENTATED AGRICULTURE, WHICH CAN HAVE ENVIRONMENTALLY DAMAGING AND TRADE-DISTORTING EFFECTS."

The systemic externalities of food systems

Fundamentally, the social and environmental costs must be paid by someone. In many cases, this falls on society or those on the sharp end of global supply chains. Food systems work to mask such payments, or 'externalities'. An externality is a positive or negative consequence of an activity that affects someone other than the one responsible for that activity. By definition, an externality is not reflected in the price of the good or service. For this reason, it is common to read externalities as institutional and market failure.

Almost 10 years ago, a breakthrough report[23] showed that most of the world's largest publicly listed companies would not be profitable if they needed to absorb the full cost of their environmental externalities (greenhouse gas emissions, water use, land use, air, land and water pollution). In fact, the total cost of these externalities was estimated to equal about 13% of the world's GDP.[24] In ranking the regional sectors with the most impact on the environment, the food sector was responsible for more than half of the most damaging activities, on a par with the coal industry. It produced a whopping US$856 billion in costs to nature while revenues where many times lower than the externalities. The 10 sectors with the greatest impacts along the supply chain were all in food products and processing. The report concluded that no high-impact regional sectors generated enough profit to cover their environmental costs. From a risk perspective, this exposes the food system, and most of its

[viii] Until the 1980s the cost of the European Union's Common Agricultural Policy (CAP) consumed 66% of the EU budget, which now sits at about 35% of EU public spending. Source: European Union. Financing of the CAP. http://www.europarl.europa.eu/ftu/pdf/en/FTU_3.2.2.pdf

stakeholders, to an array of nature-related risks arising from its own dependence on a healthy environment.[ix,x]

"AN EXTERNALITY IS A POSITIVE OR NEGATIVE CONSEQUENCE OF AN ACTIVITY THAT AFFECTS SOMEONE OTHER THAN THE ONE RESPONSIBLE FOR THAT ACTIVITY."

These studies only estimate the **environmental externalities** of food production. In reality, the food system masks a range of social externalities (see box) that burden the poorest and most vulnerable. A separate study estimated the 'hidden' environmental, health and poverty costs of the food system to total US$12 trillion per year.[xi] These external costs are today not reflected in the price of products. However, many solutions exist both downstream and upstream to transition to better and healthier farm practices and to better manage these social and environmental externalities. We will discuss these further in Chapter 4.

"THE FOOD SYSTEM MASKS A RANGE OF SOCIAL EXTERNALITIES THAT BURDEN THE POOREST AND MOST VULNERABLE."

[ix] In 2019 a report on nature risk showed how biodiversity creates value for the food, forestry, and pharmaceutical sectors. WWF and PWC (2019). Nature is too Big to Fail: https://www.pwc.ch/en/publications/2020/nature-is-too-big-to-fail.pdf

[x] The World Economic Forum estimated that the three largest sectors with high dependency on nature generate close to $8 trillion of gross value added (GVA): construction ($4 trillion); agriculture ($2.5 trillion); and food and beverages ($1.4 trillion). Source: World Economic Forum (WEF), 2020, Global Risks Report, Nature Risk Rising: Why the Crisis Engulfing Nature Matters for Business and the Economy: https://www.weforum.org/reports/the-global-risks-report-2020
WWF and PWC (2019). Nature is too Big to Fail: https://www.pwc.ch/en/publications/2020/nature-is-too-big-to-fail.pdf

[xi] This included costing for obesity, undernutrition, greenhouse gases, natural capital, rural welfare, food loss, waste, fertiliser leakage, pollution, pesticides and anti-microbial resistance. Land Use Coalition (2019). Growing Better: Ten Critical Transitions to Transform Food and Land Use. https://www.foodandlandusecoalition.org/global-report/

THE HUMAN COSTS OF FOOD SYSTEMS

While this report focuses on environmental issues, the socio-economic and health costs of food systems are also severe.

Two-thirds of the 740 million people living in poverty work in agriculture. They are vulnerable to systemic lock-ins that can trap them in debt and leave them dependent on certain suppliers for seeds and agri-inputs. Obscure food supply chains are hotspots for social issues like land grabbing and labour and human rights abuses. Estimates suggest that around 70% of the 250 million working children worldwide are in the agriculture sector.[25] Seafood supply chains have faced allegations of forced labour and slavery for many years.[26]

Companies, financial institutions and other actors increasingly acquire land as a form of investment or as a way to offset emissions through reforestation and other activities. Especially in the global South, where the boundaries between land rights and modern form of property rights can be blurry, this risks of generating land grab for forests and farmlands, with serious consequences for local communities and farmers. This goes along longstanding attempts in several countries to limit the right of farmers to save and exchange seeds, which threatens not only a pillar of traditional farming and local cultural identities, but also the resilience of the entire food system.

Food systems can also hide wider issues associated with the **health and wellbeing** of workers, farmers and consumers. For example, as the availability of inexpensive, calorie-dense foods increases, so does consumption. Although millions of people are still vulnerable to hunger and malnutrition, over 2 billion adults and 41 million children are overweight. This is linked to a rise in non-communicable diseases like diabetes, dementia, inflammatory disease, cardiovascular diseases and some cancers.[27] A calorie-rich diet is not the same as a nutritious diet, and both undernourishment and obesity have been linked to poverty.

Farm work can be dangerous, including accidents linked to machinery, agrochemicals and animal pathogens, amongst others.[28] Around 740 000 cases of unintentional pesticide poisoning of farmers are reported per year, though millions more may be unreported.[29] Chemical inputs bring contaminants in water, soil, air and the food itself.[30]

Food safety issues are widespread, through food-borne illness or diseases associated with agricultural production.[31] Recent decades have seen an increasing emergence of highly contagious diseases, such as Covid-19 and swine flu, linked to the trade of wild and domestic animal species. Coupled with this, widespread use of antibiotics in factory animal farming increases the risk of developing antibiotic-resistant bacteria, which may be harmful to humans. More detail will be provided in the chapters below.

"FOOD SYSTEMS CAN ALSO HIDE WIDER ISSUES ASSOCIATED WITH THE HEALTH AND WELLBEING OF WORKERS, FARMERS AND CONSUMERS."

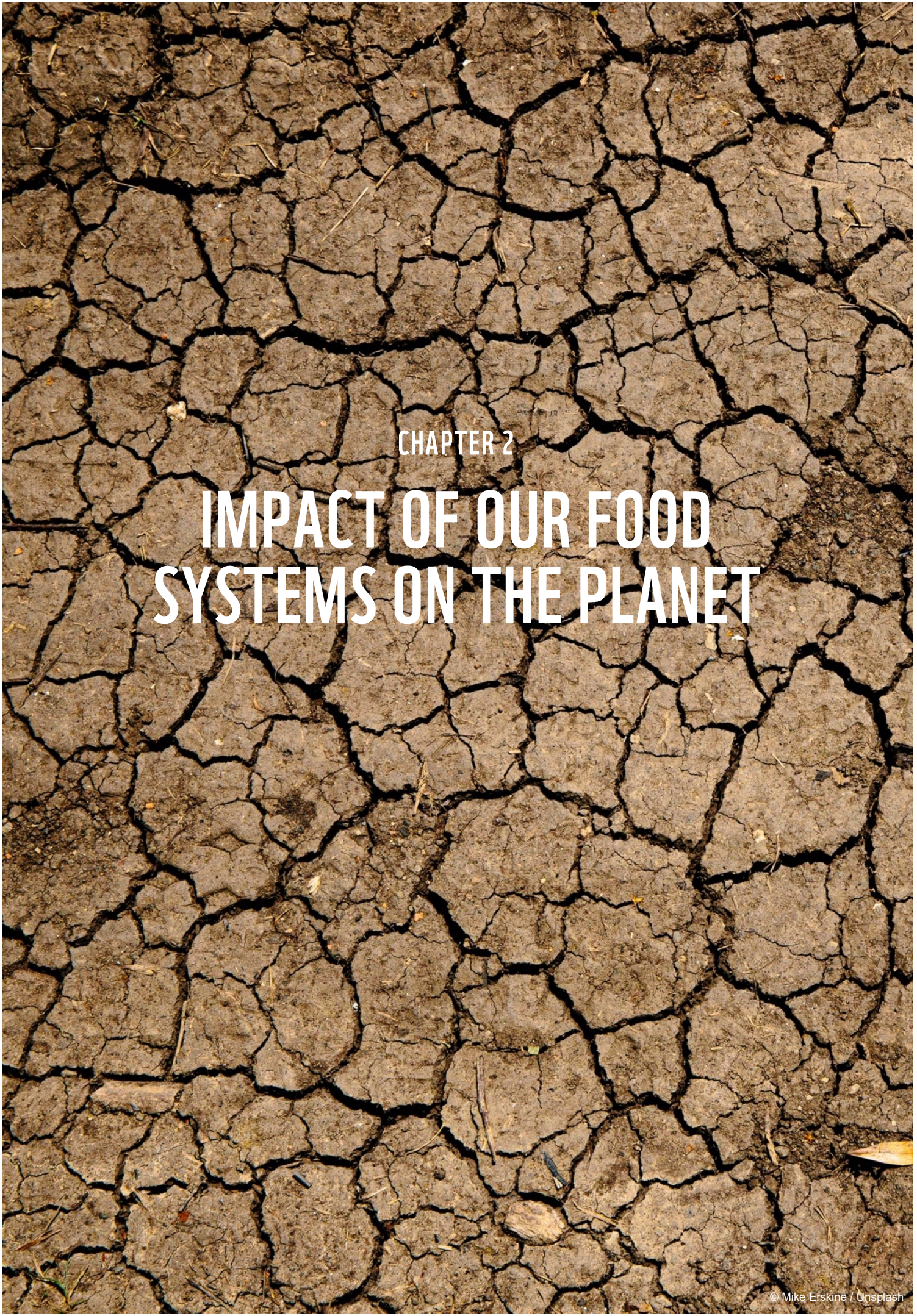
CONCLUSIONS

Despite the environmental, socio-economic and health impacts of current food systems, this is the sector that can arguably achieve the greatest positive impacts through a structural reform. A wide range of innovative technologies and traditional practices exist that can support more sustainable and resilient food systems, with opportunities to improve along the entire supply chain, from farm to fork. In addition to changing the way agriculture operates, which is the focus of this report, solutions can be found in the sale and marketing of the food we eat, the management of waste and plastics, the efficient use of energy in transport and storage, and the management of water use in production and processing.

"DESPITE THE ENVIRONMENTAL, SOCIO-ECONOMIC AND HEALTH IMPACTS OF CURRENT FOOD SYSTEMS, THIS IS THE SECTOR THAT CAN ARGUABLY ACHIEVE THE GREATEST POSITIVE IMPACTS THROUGH A STRUCTURAL REFORM."

However, critical investment barriers hinder the ability of farmers and other stakeholders to better manage natural resources. Without structural reforms, and adequate fiscal and private sector incentives to protect producers and level the playing field for those who prioritise good practice and due diligence, a transition to a better system will not be possible. It is essential to overcome the inertia manifest in public policies, corporate structures, power distribution, education, consumer habits and investment[32] if we are to overcome the lock-ins identified in this chapter.

In the next section, we will examine more closely the environmental externalities of unsustainable production and food supply chains. We will outline how they have contributed to the degradation of nature and the current climate crisis. And we will make the case that financial institutions must assess these issues and the risks they pose in their investment and lending.



CHAPTER 2

IMPACT OF OUR FOOD SYSTEMS ON THE PLANET

CHAPTER 2: IMPACT OF OUR FOOD SYSTEMS ON THE PLANET

INTRODUCTION

Our societal and economic stability – and our very existence – depend on nature's ability to deliver essential resources like food, water and raw materials and a plethora of services from nutrient cycling and soil formation to climate regulation and water purification. Productive food systems are based on millennia of co-evolution between ecosystems and climates, which together provide hospitable conditions – regular rains, temperatures and biodiverse species – for agriculture. Yet the food system is also a key driver of climate change, nature loss and land degradation.

Climate change and loss of nature are interrelated issues that compound each other, and the degradation of natural ecosystems is a fundamental driver of climate change. But while there is now increasing focus on addressing climate change, including from the finance sector, many remain unaware of the risks of nature loss.[33]

This chapter presents the factors at the heart of our food system that drive such issues, and argues that food systems are to nature loss what energy systems are to climate change.

"CLIMATE CHANGE AND LOSS OF NATURE ARE INTERRELATED ISSUES THAT COMPOUND EACH OTHER."

Climate is not the only risk

Financial institutions, central banks, governments and businesses increasingly recognise the risks, both direct and indirect, of climate change. These come from both direct physical impacts, such as more intense floods, fire, droughts and storms, ('physical risks'), and changes in policies, norms and regulations adopted in the fight against climate change ('transition risks').[xii] The insurance industry has documented that since 1980 we have lost at least US$4 trillion and almost a million human lives from the direct physical impacts of climate change,[34] with tropical cyclones alone causing billions in losses.[35] Despite rising awareness, the economy-wide impacts are still likely to be underestimated. Capital continues to be allocated to assets that raise emissions while slowing the transition to a low-carbon economy.

Climate change, however, is only part of the picture. Recent years have seen waves of reports from institutions such as the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES),[36] the Intergovernmental Panel on Climate Change (IPCC),[37] the World Economic Forum (WEF)[38] and WWF's Living Planet Report[39] tracking the state of the natural environment on a global scale. They have one clear and unified message: loss of nature, and the related risks this poses, will have a mounting impact on society, business and finance and must be urgently considered in business models and risk management strategies if we are to avoid global-scale incidents like the current pandemic. The Network for Greening the Financial System (NGFS), a coalition of 87 central banks and supervisory institutions has concluded that loss of nature is already having an impact on financial assets[40].

In 2019, the WEF's Global Risks Report ranked nature loss as one of the top five most likely and impactful risks in the next 10 years.[41] A preliminary and very conservative estimate found that almost US$10 trillion could be lost by 2050 if ecosystem services continue to be damaged by human practices.[42] Likewise, the Dutch Central Bank, among others, has recently warned that "biodiversity loss is a source of financial risks and threatens the availability of ecosystem services, such as wood, animal pollination and soil fertility, on which economic activities depend" and that financial institutions must identify the exposure of their portfolios to biodiversity risks.[43]

"WHEREAS ACTIVITIES SUCH AS MINING AND OIL DRILLING ARE VISIBLY EXTRACTIVE, AGRICULTURE IS LESS SO. YET, ESPECIALLY WHEN PRACTISED INDUSTRIALLY, AGRICULTURE IS BOTH EXTRACTIVE AND FAR MORE EXTENSIVE THAN MINING."

The risks from our food sector are not always visible because many are chronic and indirect. Whereas activities such as mining and oil drilling are visibly extractive, agriculture is less so: degradative processes such as soil erosion, fertility loss, water abstraction, biodiversity loss and water and air pollution are not as obvious as mountaintop removal and strip mining. Yet, especially when practised industrially, agriculture is both extractive and far more extensive than mining. Its impacts are the sum of many mainstream and perfectly legal practices that are incentivised by our current financial and economic system. The following section will look at how food systems transgress our planetary boundaries of climate, biodiversity and land degradation.

[xii] These terms have been used commonly in leading industry papers to separate the impacts of climate change on property and physical assets (physical risk) and on the risks and opportunities posed by the critical economy-wide shift that will need to take place as we shift to a low carbon economy (transition risk).

Transgressing the planetary boundaries of climate, biodiversity and land degradation

The concept of planetary boundaries[44] defines the key physical limits of what our planet can sustainably tolerate in nine major areas. If these boundaries are crossed, the risk of generating large-scale abrupt or irreversible environmental changes escalates.

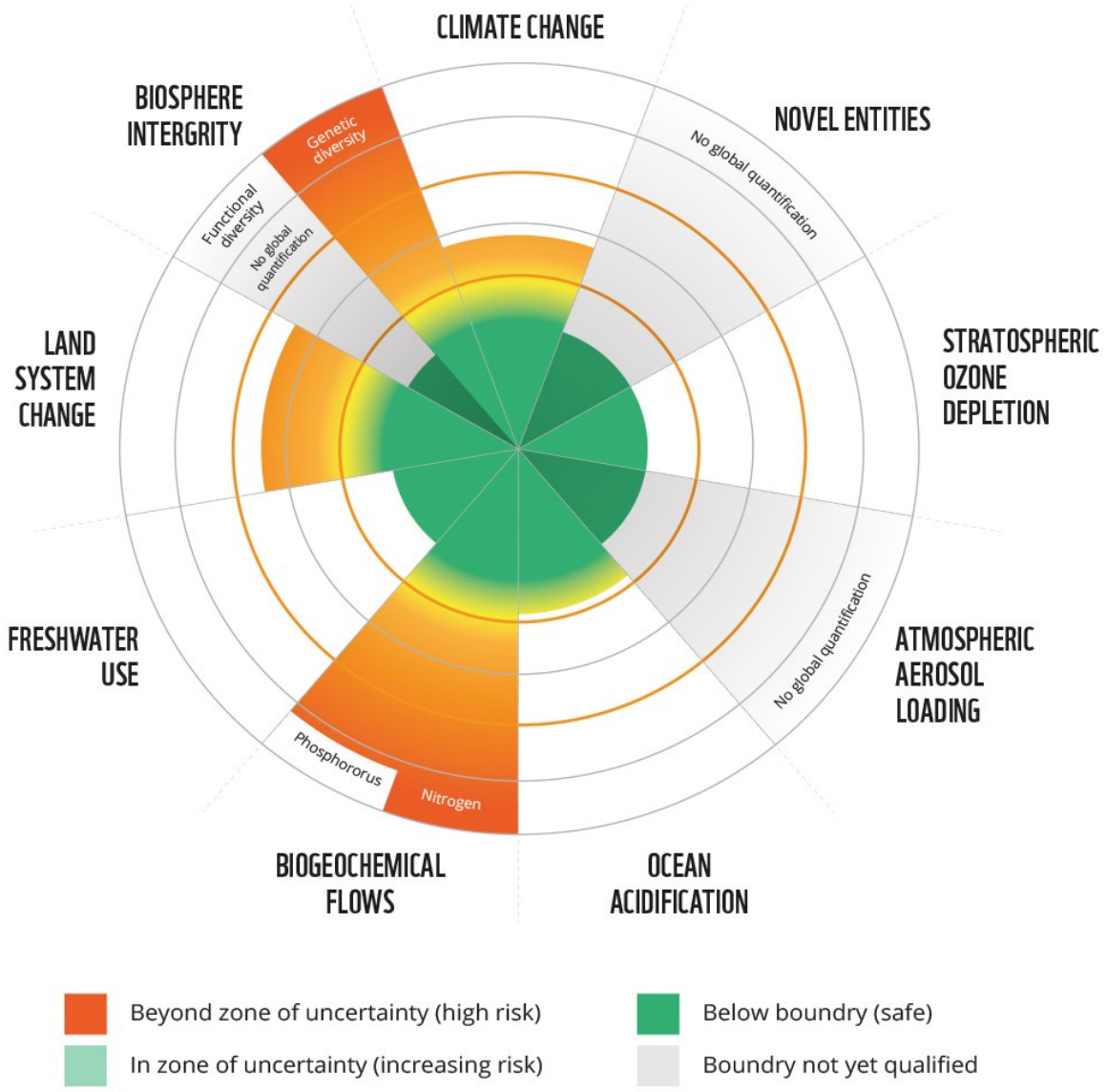


Figure 4: *The nine planetary boundaries (Steffen et al. 2015)*

It is now estimated that four of the nine boundaries have already been crossed,[45] namely:

- Climate change
- Biodiversity and the integrity of living systems (biosphere)
- Land-use change
- Biochemical flows – that is, two fundamental nutrient cycles (nitrogen and phosphorous) disrupted by the use of fertilisers and mismanagement of agricultural waste products.

The “EAT-Lancet Commission on Food, Planet, Health” attempted to redefine what a healthy food system looks like in order to address dietary needs, work within all Planetary Boundaries (Figure below) and limits global warming to 1.5 degrees Celsius[46].

EARTH SYSTEM PROCESS	CONTROL VARIABLE	BOUNDARY (Uncertainty range)
Climate change	GHG emissions	5 Gt CO_2 eq yr^{-1} (4.7 - 5.4 Gt CO_2 -eq yr^{-1})
Land-system change	Cropland use	13 M km^2 (11 - 15 M km^2)
Freshwater use	Water use	2,500 $km^3 yr^{-1}$ (1000 - 4000 $km^3 yr^{-1}$)
Nitrogen re-cycling	N application	90 Tg N yr^{-1} (65 - 90 Tg N yr^{-1})* (90 - 130 Tg N yr^{-1})**
Phospherous re-cycling	P application	8 Tg P yr^{-1} (6 - 12 Tg P yr^{-1})* (8 - 16 Tg P yr^{-1})**
Biodiversity loss	Extinction rates	10 E/MSY (1 - 80 E/MSY)

* Lower boundary range if improved production practices and redistribution are not adopted.
** Upper boundary range if improved production practices and redistribution are adopted and 50% of applied phospherous is recycled.

Figure 5: *Planetary boundaries specific to food production and the upper limits of the environmental impact that food production can have at the global scale (WWF, 2020)*

Agriculture is the major driver behind breaching all four of these planetary boundaries, and has significant impacts on all the remaining ones, in particular freshwater use[47], as can be seen in Figure 3. The following sections will dive into the key impacts that food systems have on the planetary boundaries of land-use change and land degradation, biodiversity loss, and climate change.

"AGRICULTURE IS THE MAJOR DRIVER BEHIND BREACHING ALL FOUR OF THESE PLANETARY BOUNDARIES, AND HAS SIGNIFICANT IMPACTS ON ALL THE REMAINING ONES."

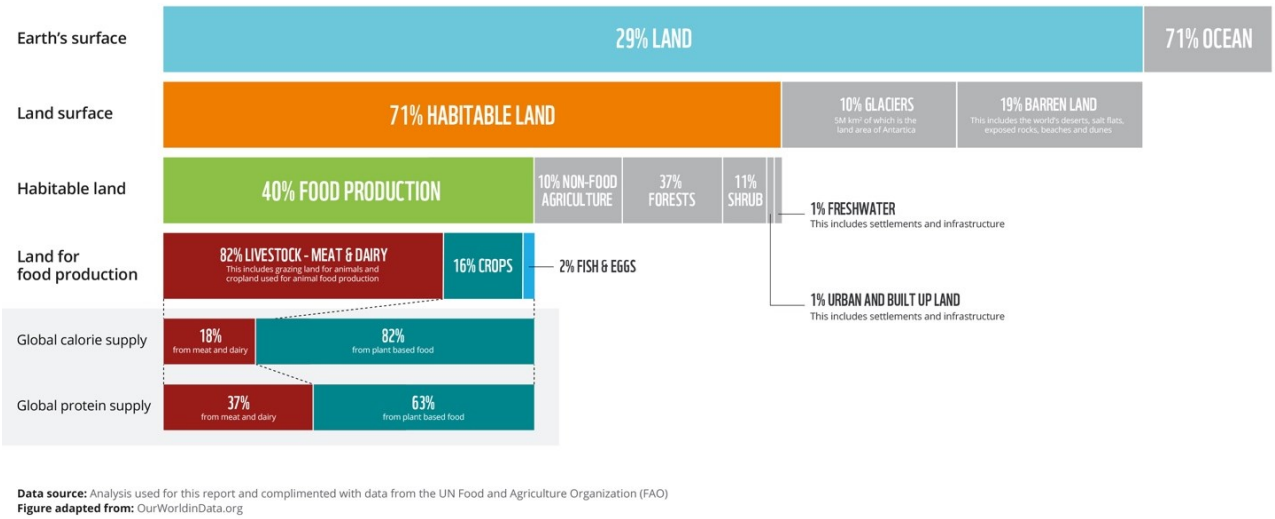
In 2017, WWF set out a proposed set of measurable targets and key performance indicators across food production and consumption to bring impacts within safe boundaries by 2030 and halve the impact of production and consumption on global biodiversity[48].

Land-use change and land degradation

Human actions have significantly altered 75% of all our planet's land, as well as our precious freshwater resources.[49] We tend to associate land alteration with activities such as infrastructure building, urbanisation and extractive industries, while agriculture brings to mind bucolic images of verdant farms. In fact, land-use and degradation driven by agriculture is by far the main factor behind biodiversity loss. It also negatively impacts the well-being of 3.2 billion people and results in a loss of about 10% of annual global GDP through lost ecosystem services.[50]

Of all the land on planet Earth, approximately 71% is defined as 'habitable', with the rest being glaciers and deserts. Half of all this habitable land is devoted to agriculture, with 40% for food production and 10% for other non-food related uses (such as bioenergy). The other half is covered with what remains of the planet's forests (37%), shrublands and grasslands (11%) and all human's cities and infrastructure (1%). Within the food production area, 82% is devoted to producing animal food directly through grazing or indirectly through cropland used to produce feed for livestock; only 16% is used to grow all crops for direct human consumption, such as fruits, vegetables, legumes, nuts and cereals.[xiii,51,52]

"LAND-USE AND DEGRADATION DRIVEN BY AGRICULTURE IS BY FAR THE MAIN FACTOR BEHIND BIODIVERSITY LOSS."



Data source: Analysis used for this report and complimented with data from the UN Food and Agriculture Organization (FAO)
Figure adapted from: OurWorldinData.org

Figure 6: *Total land use taken up by human activities (WWF, 2020)*

[xiii] All figures from WWF (2020). Bending the Curve: The Restorative Power of Planet-Based Diets. Loken, B. et al. WWF, Gland, Switzerland. https://www.worldwildlife.org/press-releases/bending-the-curve-the-restorative-power-of-planet-based-diets

Land degradation has reduced the productivity of 23% of the global land surface, a factor that is directly linked with on-farm biodiversity loss and climate change,[xiv] as we will show below.

Degradation through deforestation

A significant share of land degradation is caused by the conversion of primary forest. Agricultural expansion continues to be by far the biggest driver of deforestation, accounting for more than 70% of tropical deforestation due to large-scale agriculture for cattle grazing, animal feed such as soy, oil palm plantations, timber and pulp, and other commercial commodities, as well as subsistence agriculture.[53] Clearing large areas of tropical forest can disrupt entire regions' hydrological cycle and weather patterns, creating hotter and drier weather and increasing drought.[54] Such a shift in the system would make agricultural production increasingly risky. Areas of highest forest loss are in Africa (where the rate of loss is fast increasing), Southeast Asia and South America, including some of the most biodiverse regions on Earth.[55]

"AGRICULTURAL EXPANSION CONTINUES TO BE BY FAR THE BIGGEST DRIVER OF DEFORESTATION."

The current economic system considers natural forests as non-profitable, or as unproductive spaces competing with commercial exploitation. In reality, forests and trees can support sustainable agriculture by stabilising soils and climate, regulating water flows, and providing shade, shelter, and a habitat for pollinators and the natural predators of agricultural pests. When integrated into agricultural landscapes, forests and trees can increase agricultural productivity.[56]

[xiv] The UN provides a summary report of the 2019 IPBES Report statistics on the state of nature in the following commentary: UN Report: Nature's Dangerous Decline 'Unprecedented'; Species Extinction Rates 'Accelerating' (2019): https://www.un.org/sustainabledevelopment/blog/2019/05/nature-decline-unprecedented-report/

Degradation and erosion of soils

Deforestation is a visible form of land degradation. Less visible, but just as significant, is soil degradation. Often overlooked, soil is vital to humanity's existence, hosting at least a quarter of the world's biodiversity, ranging from earthworms to tiny organisms such as bacteria and fungi. Soil degradation is the consequence of an intensive agricultural model that extracts resources and slowly erodes the very same natural resources base that it needs to sustain itself.[57]

"OFTEN OVERLOOKED, SOIL IS VITAL TO HUMANITY'S EXISTENCE, HOSTING AT LEAST A QUARTER OF THE WORLD'S BIODIVERSITY."

Today, a third of all soils are degraded due to soil erosion, compaction, chemical pollution and loss of nutrients, and some 80% of all farmland has moderate to severe erosion.[58] Soil erosion alone– the permanent loss of topsoil through water, wind or tillage – is happening 100-1,000 times the natural rate.[59] Soil contains about twice as much carbon as the entire atmosphere and, after the ocean, is the largest natural carbon sink, surpassing forests and other vegetation in its capacity to capture carbon dioxide from air.[60] However, over the past two centuries, soil organic carbon has dropped by 8% globally due to land conversion and unsustainable agriculture. With this drop in carbon, our soils are less fertile and productive, retain less water and are more prone to erosion.[61] In addition, the soil that is lost often ends up in aquatic ecosystems, bringing excess nutrients and causing eutrophication.

Degradation of water systems

Land degradation is also about the loss of our most precious resource: fresh water. Agriculture is responsible for up to 92% of the global water footprint (with livestock production accounting for nearly one-third of that), while industrial production and domestic consumption make up 4.4% and 3.6% respectively.[62] In addition to direct water consumption in agriculture, the construction of infrastructure such as dams and barrages to support irrigation affects the continuity and flow of rivers. This has

negative impacts on the functioning of the entire riverine ecosystem as a whole, the provision of water for other downstream communities, and on animal populations such as migratory species.[xv]

Freshwater habitats cover less than 1% of the Earth's surface, yet they host 10% of all known species, including one-third of all vertebrates. And this biodiversity is declining at more than twice the rate of terrestrial or marine populations.[63]

"AGRICULTURE IS RESPONSIBLE FOR UP TO 92% OF THE GLOBAL WATER FOOTPRINT."

Agriculture is one of the leading polluters of rivers, aquifers, lakes and coastal waters due to the intensive use of agrochemicals, runoff of organic matter, drug residues and sediments.[64] Direct application of fertiliser is not the only culprit behind the transgression of this planetary boundary. The 50+ billion animals farmed for food worldwide every year,[65] for the most part in intensive livestock production systems, generate far more excreta than all humans do, constituting the largest source of pollution, eutrophication, and methane and nitrogen emissions.[66] Degradation of water quality directly harms human health[xvi] and has implications for production systems, on land and at sea. For example, many ocean 'dead zones', including the largest one in the Gulf of Mexico, have been linked to runoff from animal farming,[67] harming fisheries and coastal productivity.

In the last 20 years, a new class of water pollutants including antibiotics, vaccines and growth-promoting hormones has moved from farms through water to ecosystems and drinking-water sources.[68] Zoonotic waterborne pathogens are also a rising in number and profile.

[xv] For instance, one-third of all large dams globally are at least in part constructed for irrigation. Lehner, B. et al. (2011). High-resolution mapping of the world's reservoirs and dams for sustainable river-flow management. Frontiers in Ecology and the Environment, 9(9), 494–502. https://doi.org/10.1890/100125

[xvi] "For example, the well-known blue-baby syndrome in which high levels of nitrates in water can cause methaemoglobinemia – a potentially fatal illness – in infants. Pesticide accumulation in water and the food chain, with demonstrated ill effects on humans, led to the widespread banning of certain broad-spectrum and persistent pesticides (such as DDT and many organophosphates), but some such pesticides are still used in poorer countries, causing acute and likely chronic health effects." Source: Food and Agriculture Organization (FAO) of the United Nations Rome; International Water Management Institute (IWMI) on behalf of the Water Land and Ecosystems research program, Colombo, 2017: Water pollution from agriculture: a global review: http://www.fao.org/3/a-i7754e.pdf

Loss of biodiversity and integrity of living systems

In the past few decades, biodiversity has been dropping at a rate never seen in human records, propelling us into the world's sixth mass extinction. Around 1 million species are threatened[xvii]and extinction rates are currently 100 to 1,000 times higher than historical averages.[69] WWF's *Living Planet Report* shows that since 1970 humanity has caused an overall decline of 68% in population sizes of vertebrate species, with freshwater species populations having declined by about 84%.[70] In our seas, fish populations that we rely on for food have fallen by half.[xviii] Despite much talk and many commitments in recent years, these trends are not improving.

Loss of on-farm genetic biodiversity

Agrobiodiversity – the variety of plants and animals used for food production – has sharply declined. Since the 1900s, around 75% of plant genetic diversity has been lost as farmers have abandoned their local varieties in favour of genetically uniform commercial varieties. While more than 6,000 plant species have historically been cultivated for food, today 75% of the world's food is generated from only 12 plants and 5 animal species. Of these, only three plants – rice, maize and wheat – contribute 60% of all calories and proteins consumed from plants.[71] The genetic diversity within livestock species is even narrower.[72]

Diversity is a critical component of plant adaptability and resilience, especially to environmental and climate changes. It provides potential for adaptive breeding so that plant varieties are tolerant to new pests and diseases, insect breeds, extreme heat and cold, and pollution.[73]

"75% OF THE WORLD'S FOOD IS GENERATED FROM ONLY 12 PLANTS AND 5 ANIMAL SPECIES."

[xvii] Out of the 8 million animal and plant species currently known, about 4 million have been studied in sufficient details, and 25% of those, that is 1 million, are considered as threatened with extinction according to the latest IPBES report.

[xviii] Marine vertebrate populations dropped by 49% from 1970 to 2012. Tropical reefs have lost over half their reef-building corals, 20% of global mangrove cover was lost between 1980 and 2005 and 29% of marine fish stocks are being fished at a greater rate than they can naturally regenerate. Living Blue Planet Report, WWF, 2015: https://assets.wwf.org.uk/downloads/living_blue_planet_report_2015.pdf

Loss of on-farm biodiversity: insects and pollinators

Over 40% of insect species, of paramount importance to the overall functioning of ecosystems, are threatened with extinction. Intensive agriculture is the main driver of this decline[74,75] – but also a casualty. Three out of four crops for human use depend on insect pollination for yield and quality. The loss of pollinators puts an estimated 35% of global crop production, representing an annual market value of US$235-$577 billion, at risk.

Loss of wild species

Of all the plant, amphibian, reptile, bird and mammal species that have gone extinct since AD 1500, about 75% have been as a result of overexploitation and agricultural activity.[76] In modern times, around 60% of all terrestrial biodiversity loss has been associated with food production due to deforestation, land degradation and habitat fragmentation; agriculture also drives declines in aquatic biodiversity due to fertilisers and pesticides,[77] water use and wetland conversion.[78] Of all currently threatened land and water species,[79] about 80% and 60% respectively are imperilled by habitat loss driven by agriculture.[80]

"OUR APPETITE FOR MEAT, DAIRY, EGGS AND FARMED FISH IS A PRIMARY DRIVER OF BIODIVERSITY LOSS."

Our appetite for meat, dairy, eggs and farmed fish is a primary driver of biodiversity loss. Humanity is in the process of replacing the wild with the domestic, to the point where today, of all the mammals living on Earth, 60% are livestock, 36% are human and only 4% are wild animals. Farmed poultry makes up 70% of all birds on the planet, with just 30% being wild.[81]

This loss of wild species has implications for our adaptability in the future too. While humans use around 40,000 plants and animals on a daily basis for food, medicine and shelter, millions of plants exist from which medicines and other materials may need to be sourced. About 70% of cancer drugs today are natural in origin, as are 118 of the 150 most prescribed antidepressants, antibiotics and antiplatelets in the US.[82]

Climate change

Climate change needs no introduction. Despite global warming having been known to political and business leaders since at least the 1970s, greenhouse gas (GHG) emissions have continued to rise and global temperature are already 1°C above pre-industrial levels.[83] In 2015, the international community agreed to limit global warming to 1.5°C and in the worst case no more than 2°C. This means that the window to prevent further warming is rapidly closing.

"WHILE EMISSIONS FROM OIL, GAS AND COAL REMAIN THE LARGEST CONTRIBUTOR TO GLOBAL WARMING, THE FOOD SECTOR CONSISTENTLY WINS THE SILVER MEDAL."

While emissions from oil, gas and coal remain the largest contributor to global warming, the food sector consistently wins the silver medal, with estimates linking between 25% (IPBES[84]) and 30% (IPCC[85]) of global GHG emissions to land clearing, crop production, livestock emissions and fertilisation, with animal-based food contributing about 75% of this total.[xix] About two-thirds of all food-related GHG emissions are accounted for in the agriculture, forestry and other land use (AFOLU) sector, while the remaining third comes from processing, transport and packaging.[86]

As explained above, agriculture also degrades essential carbon sinks such as soils (especially peatlands) and forests. However, there are big opportunities to turn its role around: conservation, restoration and improved agricultural practices that increase carbon storage and avoid emissions across forests, wetlands, grasslands and agricultural lands (so-called natural climate solutions) can provide over one-third of the climate mitigation needed to stabilise warming to below 2°C.[87]

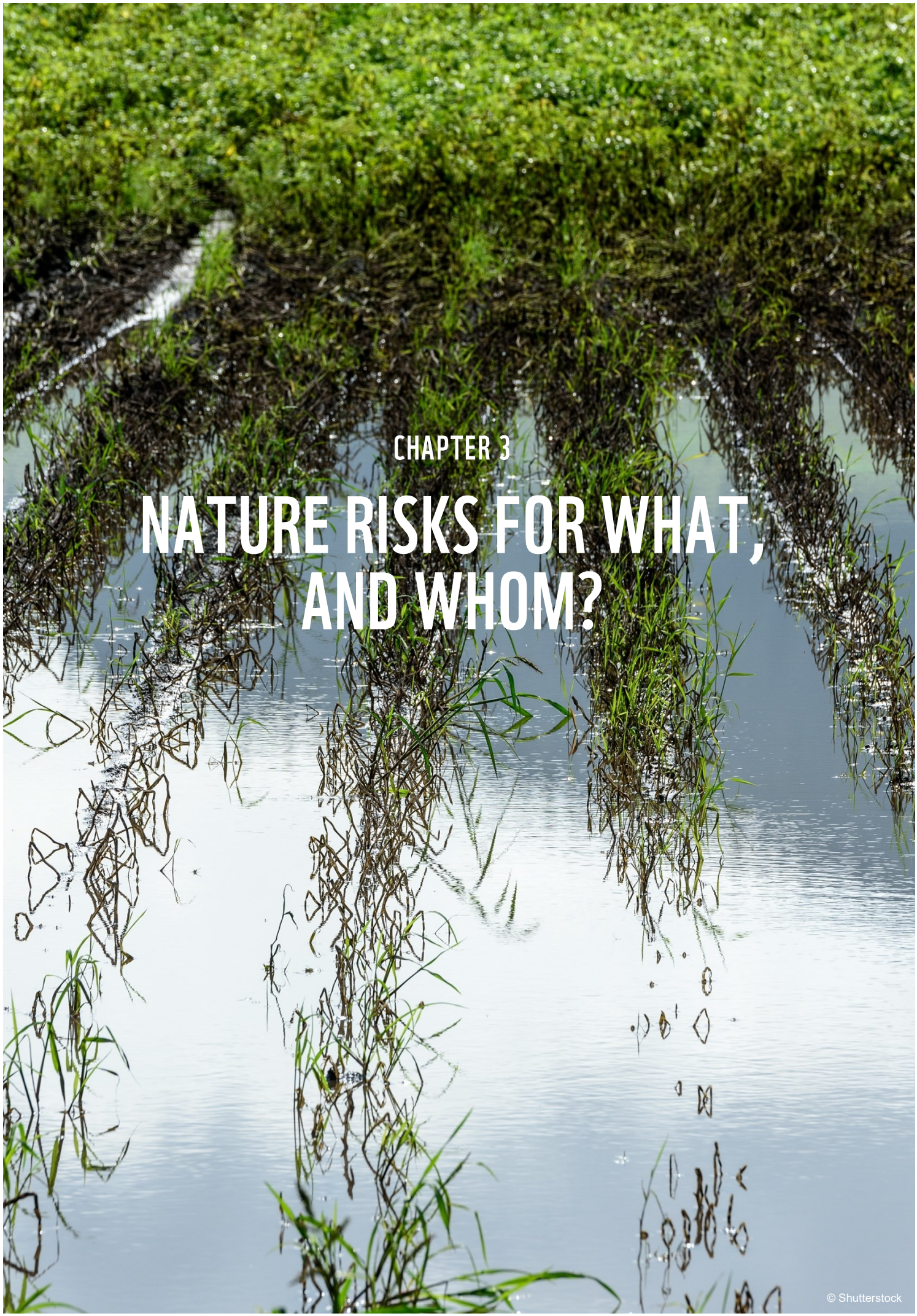
CONCLUSIONS

Successive international reports have voiced concerns that we are reaching planetary tipping points – in other words, a state of change so severe that we are irreversibly pushed into a 'new normal'. This new normal will ripple throughout our globalised system, impacting many of our economies and the ability of people to thrive within them. Food systems constitute the major driver of environmental degradation and biodiversity loss. However, this also means that transforming the way we produce our food offers the greatest opportunities to reverse our negative impacts on the natural world.

"FOR THE FINANCIAL SECTOR, THIS MEANS THAT THE QUEST TO TACKLE ENVIRONMENTAL DEGRADATION MUST NECESSARILY FOCUS ON UNDERSTANDING AND MANAGING IMPACTS AND RISKS RELATED TO FOOD SYSTEMS."

For the financial sector, this means that the quest to tackle environmental degradation must necessarily focus on understanding and managing impacts and risks related to food systems. The following chapter presents a framework to understand nature-related risks to business, and the consequential financial impacts, with a focus on our industrial food production system.

[xix] Specifically: IPBES reported that approximately 25% of GHG emissions come from land clearing, crop production and fertilisation, with animal-based food alone contributing 75% of the total. The IPCC estimated that the food system overall is responsible for about 30% (21%- 37%) of the total net GHG emissions. These include land-use change for crop and feed production, fertiliser, emissions from ruminants, transport and refrigeration.



CHAPTER 3

NATURE RISKS FOR WHAT, AND WHOM?

CHAPTER 3: NATURE RISKS FOR WHAT AND FOR WHOM?

RISING NATURE RISKS – FROM THE IMPROBABLE TO THE QUOTIDIAN

The concept of nature risk (or 'nature-related' risk) today is narrowly defined and often only associated with events such as rampant wildfires and storms, or disasters like the infamous BP oil spill in the Gulf of Mexico or the collapse of Brazil's Brumadinho dam. Th e reality, however, is that nature risks can be as insidious as they can be dramatic. They largely arise from the sum of many perfectly accepted and standard business practices, often incentivised by our financial and economic system.

While the previous chapter presented the risks to nature derived from business practices, this chapter focuses on the other side of the equation: how environmental degradation can in turn impact on a company's business operations and increase its nature-related risks, which can ultimately transfer up to the financial sector.

> "NATURE RISKS CAN BE AS INSIDIOUS AS THEY CAN BE DRAMATIC. THEY LARGELY ARISE FROM THE SUM OF MANY PERFECTLY ACCEPTED AND STANDARD BUSINESS PRACTICES, OFTEN INCENTIVISED BY OUR FINANCIAL AND ECONOMIC SYSTEM."

This risk is very much real, as are the financial consequences. The Network for Greening the Financial System (NGFS) recognises that loss of nature and environmental degradation impacts business on a scale that could "cascade to risks for financial institutions".[88] It has called for thorough assessment of climate and environmental risks to avoid exposure of the financial sector's own balance sheets, which could even impact financial stability.[89] A range of assessments on nature risk have pinpointed the food system as a hotspot for these risks and dependencies.[90, xx, xxi.] In agriculture, nature-related risks are material and can leaded to stranded assets throughout supply chains, putting significant value at risk.[91]

> "LOSS OF NATURE AND ENVIRONMENTAL DEGRADATION IMPACTS BUSINESS ON A SCALE THAT COULD "CASCADE TO RISKS FOR FINANCIAL INSTITUTIONS."

However, an assessment of 75 of the world's largest asset managers holding over US$56 trillion in assets under management[92] shows that not a single institution has developed a comprehensive biodiversity policy. Most financial institutions only include policies addressing a company's risk of

[xx] In 2019 a report on nature risk showed how biodiversity creates value for the food, forestry, and pharmaceutical sectors. WWF, PWC, 2019, Nature is too Big to Fail: https://www.pwc.ch/en/publications/2020/nature-is-too-big-to-fail.pdf

[xxi] The World Economic Forum estimated that the three largest sectors with high dependency on nature generate close to US$8 trillion of gross value added (GVA): construction (US$4 trillion); agriculture (US$2.5 trillion); and food and beverages (US$1.4 trillion). Source: World Economic Forum (WEF), 2020, Global Risks Report, Nature Risk Rising: Why the Crisis Engulfing Nature Matters for Business and the Economy: https://www.weforum.org/reports/the-global-risks-report-2020

causing “severe environmental damage”. WWF-Norway corroborated this finding in a series of in-depth interviews with key financial institutions.[93]

A framework to understand material risks from production

A recent WWF review of over 30 frameworks that help to define nature-related risk,[94] defined the following most commonly used key risk categories:

- **Physical** risk**,** which can be acute or chronic
- **Regulatory and legal** risk
- **Market** risk
- **Reputational** risk
- **Systemic** risk, which arises as macro-risks to the economy or industry as a whole
- **Financial** risk, which arises as a consequence of the previous risks.

“IN AGRICULTURE, NATURE-RELATED RISKS ARE MATERIAL AND CAN LEAD TO STRANDED ASSETS.”

This review provided a synthesis framework to explain how nature-related risk may emerge to become financially material: Businesses connect to nature through both their **dependencies** on nature for their supply chain operations and staff, and through the **impacts** they have on nature’s services and resources. Nature-related risks materialise as a business risk when:

- **A threat arises** through a change in the conditions that might affect a business. Changes can be ‘dependency-related’. They can arise from nature itself, for example through changes to the climate affecting a resource that the business depends upon. It can also arise from changes to policies, consumers or markets that affect a business’s operations, resources, or supply chains. Changes can also be ‘impact-related’ where the actual activities of the company or economy impede their own operations (e.g. through pollution of air or water supplies).
- **The company is both exposed and vulnerable to the threat** when it derives some or all of its revenues or owns assets in the disrupted sector, industry, geography or client base. Vulnerable businesses are often unable to adapt to the threat at hand, because of a variety of factors, such as inadequate liquidity, risk management awareness and mitigation, operational resilience or supply chain diversification. Results include rising costs, curtailed profits or loss of market share. Feedbacks can also aggravate a company’s vulnerability and exposure, like where unsustainable land management practices increase an agribusinesses exposure to a threat.

Figure 5 below shows this process manifest in both the micro-economy (a specific business or area) and the macro-economy, where systemic degradation of nature erodes the functionality of multiple systems. While this perspective is not yet high on the political agenda, the food sector is one area where such **risks** derived from **impacts** and **dependencies** are getting increasing attention.

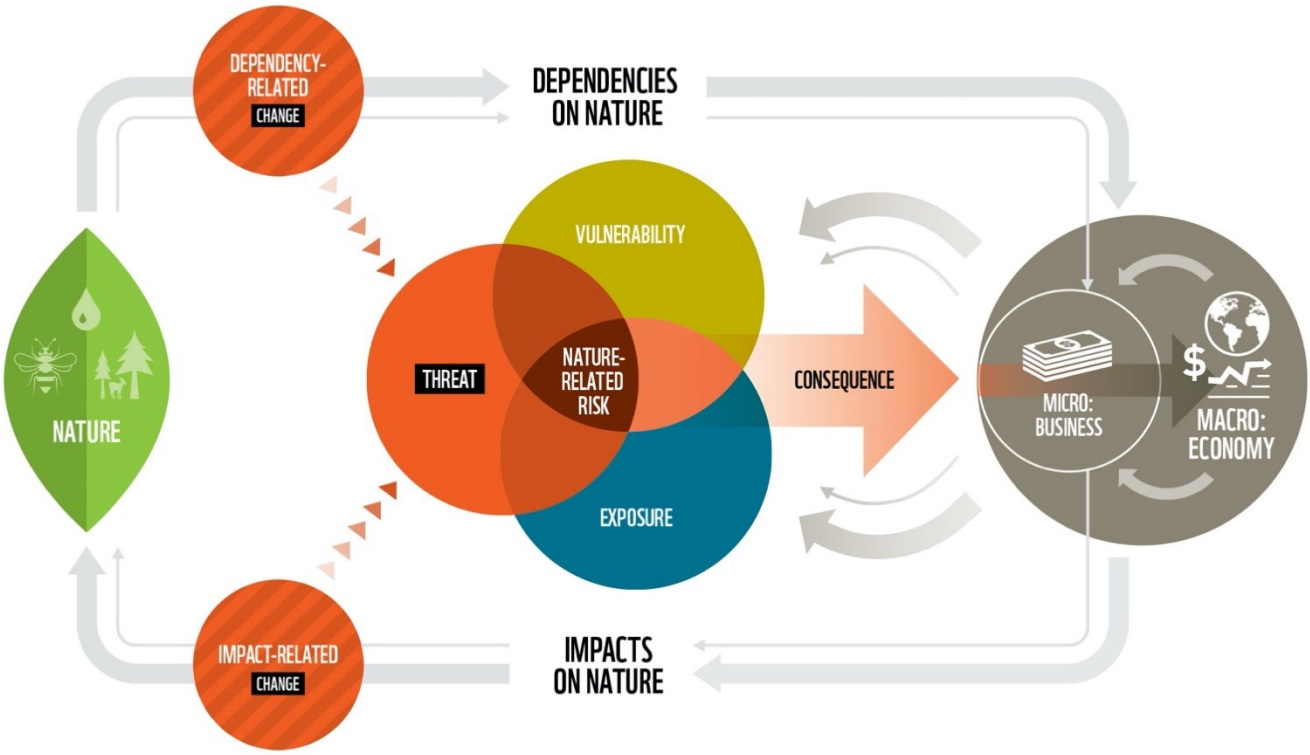


Figure 7: *High level framework illustrating nature-related risk to business, WWF (2019)*

This framework is in line with the increasingly accepted concept of **double materiality**[xxii]**.** A company's impacts and dependencies on nature are equally relevant as they can both lead to the emergence of nature-related risks. For instance, regulatory and legal risks could affect a business through new regulation on the extraction of raw materials (a dependency-related change) or targeting pollution (an impact-related change). Financial institutions should therefore assess both dependencies and impacts of companies in order to identify potential nature risks.

Physical, regulatory and legal, market and reputational risks can be material to businesses along the whole supply chain of the food sector, from producers to retailers. Systemic risk, on the other hand, arises when tipping points are crossed and the stability of both the food system and society is undermined. Financial risk can arise for both businesses and those financing them or be experienced on a national or international level.

The following sections explore the five risk categories of primarily production-level risk in more detail. These categories are not mutually exclusive and must be considered as compounding and interconnected. Physical risks may be precursors of other nature-related risks and may in turn result in financial consequences. For example, the physical risk of soil degradation may lead to new regulations requiring companies to regenerate soil (regulatory risk), an assessment revealing a company's impacts on soils (reputational risk) or emerging financing preferences prioritising sustainable practice (financial risk).

[xxii] Double materiality is a key tenet of the EU regulatory framework, as well as the focus of many international initiatives around nature-related risks, such as the TNFD. In the climate sphere, the focus has often only been put on one-sided materiality, that is, risks to the company.

Physical risks
Nature-related physical risks can arise from material destruction that impedes operations or damages infrastructure, causing economic and financial losses for businesses and financial institutions. They can be acute (event-driven) or chronic (longer-term trends). Acute physical risks are damages from natural or manmade hazards, such as pest outbreaks, biodiversity loss, flooding, drought, and water and soil pollution. Acute events can cause direct damage to farms or disrupt supply chains, and they often get the most attention due to the speed and magnitude at which impacts can be felt.

Chronic risks are cumulative over time, such as overutilisation of water sources leading to scarcity, or progressive soil degradation. Although chronic degradation might be less visible, it acts on a larger scale and can easily deplete the resilience of an entire system and lead to permanent loss of productivity. Some risks that used to be considered acute – such as drought – are now becoming chronic given the frequency with which they occur. Chronic risks can be aggravated by shifting climates or farming practices that degrade soils, pollute fresh water and disrupt biodiversity. This can reduce the resilience of businesses and in some cases even create stranded assets like land abandonment.

TRANSITION RISKS

In the climate debate, 'transition risks'[xxiii] are the risks that arise as the shift towards a low-carbon economy impacts the regulatory landscape, markets, public trends and so on. The same concept can be applied to transition to a sustainable food system, which would manifest through shifts in agricultural policy and legislation, consumer preferences, and a fast-changing landscape of risk and opportunity for agribusiness and finance providers. Transition can be slow or fast. Government action plans may gradually shift subsidy disbursements towards green sectors, or consumer preferences can quickly shift practices and standards. The transition to a low-carbon economy would also have carbon implications for farmers and agribusinesses. Farmers rely on carbon-intensive chemicals, fuels and fertilisers, the cost of which would be altered by a carbon tax or stricter regulation on emissions. Regulatory, legal or market change could manifest as transition risks, including reputational risks, although they can also arise for a variety of other reasons.

Regulatory and legal risks
New and existing laws, regulations and policies are an obvious source of legal and policy risks for actors in the food system. Regulation can impact business operations by limiting access to resources, increasing costs or introducing new standards. Regulatory risks also include the implications of violations of laws, policies, standards and other compliance factors. The food system, with its opaque supply chains that leave ample space for transgression, is already beset with legal and policy risks. As satellite and traceability technologies are enabling better monitoring of these supply chains, and as health and safety regulations tighten in response to risks such as disease transfer, legal and policy risks are likely to heighten. Changes in climate-related policies will also affect regulatory risk for the food sector.

[xxiii] Transition risk was adopted in the climate change discussion and consolidated by the Task Force on Climate-related Financial Disclosures (TCFD), set up by the G20's Financial Stability Board in 2015 with the aim of helping companies and investors understand the risks associated with climate change.

The financial consequences of breaching regulations include:

- Fines or full shutdown of the business for lack of compliance
- Suspension of certification due to violation of standard requirements
- Devalued or even stranded assets due to failure to anticipate stricter environmental regulations
- Increased costs due to additional time needed to adapt the business model to more rigorous laws
- Legal actions or sanctions for failure to address negative environmental or human rights impacts.

Legal risks have historically been associated with companies' impacts on nature, for instance through pollution. In the world's first constitutionally based 'Rights of Nature' lawsuit, a court in Ecuador ruled against the company Los Andes and Palesema Palm Oil[95] in the matter of planting palm oil trees in place of indigenous vegetation. The company was forced to pay restitution to local villages and adopt planting restrictions. Another example is Bunge, one of the largest food companies, which was among five trading houses fined a total US$29 million for purchasing soy grown in conservation areas in Brazil.[96]

"THE FOOD SYSTEM, WITH ITS OPAQUE SUPPLY CHAINS THAT LEAVE AMPLE SPACE FOR TRANSGRESSION, IS ALREADY BESET WITH LEGAL AND POLICY RISKS."

Health-related legal risks also are emerging, such as Bayer-Monsanto paying more than US$10 billion to settle tens of thousands of claims linking the herbicide Roundup to cases of cancer.[97] While in many cases these businesses may recover, the reputational risk arising from such incidents can be significant (see below).

Changes in climate-related policies will also affect regulatory risk for the food sector, as this is increasingly coming under the spotlight due to the huge emission footprint.

Market risks

Market risks are related to factors such as customer preferences, market share or access to new markets, and technology. These risks can lead to financial repercussions such as:

- Higher financing costs, if credit ratings of agricultural suppliers decline with failure to implement risk mitigation processes
- Price increase or volatility of commodities or inputs such as fertilisers, fossil fuels and feed
- Loss of contracts due to environmental or human rights impacts
- Decreased sales due to shifting consumer tastes and sentiments.

Technological changes – such as new protein or feed replacements – can displace and disrupt markets, leading to the emergence of new winners and losers. The timing of technology development and deployment, however, is a key uncertainty in assessing technology risk.

There are many examples of how consumers have changed their behaviour in reaction to news, novel research or food scandals. In addition to event-driven and often temporary changes, it is possible to identify long-term trends, such as consumers shifting toward food that is perceived as low impact, certified by a sustainability standard or that reduce health risks. After 'Horsegate', for example, where unreported horsemeat was found in beef products, over 50% of consumers changed their habits, leading to a decrease in the purchase of processed food and an increase in organic food.[98]

Reputational risks

Reputational risks relate to a company's brand, image, and relationship with customers and other stakeholders. Risks arise when public perception causes loss of confidence in the integrity of the business. It can also arise from changing consumer or political sentiments that lead to a public outcry, or from the discovery of breaches in moral, policy or regulatory norms. Damage to brand equity may lead to consequences including divestment, a loss of customer loyalty and a reduced ability to attract high-end talent.

"UNREGULATED SUPPLY CHAINS CAN BE RIDDLED WITH HIGH-RISK ACTIVITIES, LIKE FOOD FRAUD, HUMAN RIGHTS VIOLATIONS AND ILLEGAL DEFORESTATION."

While a lack of transparency along supply chains can protect upstream actors from issues related to reputational risk, food scandals are increasingly common. Unregulated supply chains can be riddled with high-risk activities, like food fraud, human rights violations and illegal deforestation. However, increasing scrutiny on global supply chains is likely to make it more difficult to disguise exploitative or detrimental activities.[99] Better geospatial technology and data to ensure sustainable, deforestation-free products are becoming more common. The world's largest meat company, JBS SA, for example, had to shelve its IPO on the New York Stock Exchange[100] over concerns that it was purchasing cattle raised on illegally deforested land as well as multiple other scandals.[101] Some leading banks have started using geospatial tools to map client landholdings in native forest and better monitor land-use change.[102]

Systemic risks

The risk categories described so far are usually felt at the scale of a business or its supply chain. But nature-related risks can brew and emerge at a far greater scale, with effects potentially reaching the whole economy or system. The loss of nature can reach tipping points that bring ecosystems, and the human systems that depend on them, to levels of severe instability or even collapse: we refer to these as nature-related systemic risks.

Systemic risk in the food system may be likely to manifest at production level as unsustainable practices cause the degradation of natural resources, undermining the ability to sustain productivity over the long run. Cumulatively, repercussions can be felt across entire portfolios with exposure to the food sector and supply chains, or even to municipal or national debt. Systemic risk can emerge at a company level but, when reaching critical mass, affect entire regions, supply chains and local economies, in turn leading to loss of investment value in a sector or region. For example:

- **At a company and portfolio level:** a farm that undermines soil health will compensate for the loss of fertility by increasing the use of external inputs to sustain production. While this can work for a while, over time it will reach a point where productivity is compromised, and the land may even be abandoned. Those invested in equities or assets that are resource-dependent and vulnerable to these shocks will be affected.
- **At a macro level (at sectorial, municipal or sovereign-level):** soil degradation occurring on multiple farms or many supply chains can ultimately destroy the economy of entire regions and, reinforcing and reinforced by climate change and water scarcity, drive irreversible desertification, eventually leading to the abandonment of land. Indeed, many areas, for example across Mediterranean Europe,[103] have been abandoned, and historical, archaeological and geological records indicate that soil degradation driven by agriculture is a key factor in explaining how the great civilizations of the past have crumbled.[104] This can arise as financial risk where a portfolio is exposed to resource degradation beyond a single company or industry, for example through wider-scale investments in government and municipal bonds in areas that are not prepared to respond to such risks.

Most of the nature-related physical risks in agriculture listed at the end of this chapter can become systemic risks: soil degradation and water scarcity; loss of agrobiodiversity and genetic diversity; loss of biological pest and disease control; and, finally, the emergence of zoonotic diseases linked to food systems.

Systemic risks require increased awareness and efforts to identify, as they may occur beyond traditional financing or business reporting timelines and are therefore not easily recognised. Although measurable, the loss of soil fertility, and its ability to store water, is an invisible issue, as are the risks of zoonotic diseases or antimicrobial resistance.

With many companies barely grasping the risks and impacts of their own operations and largely ignoring those of their supply chains, it is reasonable to say that systemic risk is largely excluded from any business consideration. Financial institutions, given their broad portfolios, have an interest, and a duty, in increasing their ability to identify, understand and contribute to preventing such risks and the serious consequences they can bring to human health, food security and the climate.

There are many indications that systemic risks are emerging. Analysts have warned that, despite its apparent efficiency, "the global food system is losing resilience and is becoming increasingly unstable and susceptible to conditions of crisis"[105]. According to the insurer, Lloyds, "the global food system is under chronic pressure" and "a global production shock …would be expected to generate major economic and political impacts that could affect clients across a very wide spectrum of insurance classes."[106] In 2019, a year before the Covid-19 pandemic, Swiss Re[107] recognised that the severity of food-related incidents has been increasing and that, due to the globalised nature of food supply chains, "local incidents can quickly evolve into international emergencies" such as foodborne diseases that are amplified by globalisation and cause major insured and uninsured losses.

"FINANCIAL INSTITUTIONS HAVE AN INTEREST, AND A DUTY, IN INCREASING THEIR ABILITY TO IDENTIFY, UNDERSTAND AND CONTRIBUTE TO PREVENTING SYSTEMIC RISKS."

Financial risks

Financial risks can be considered an outcome of physical, regulatory, legal, market, reputational and systemic risks, and can impact both businesses and financial institutions. When nature-related risks materialise, revenue streams may dwindle or assets may become redundant, unutilised or non-competitive. This results in financial risks that can arise from various elements of a business or financial portfolio, such as loan defaults, collateral depreciation (credit risk), loss of income that can lead to repricing of equities and fixed income securities (finance market risk), insured losses (underwriting risk), disruptions in supplies, supply chains, facilities or in operations (operational risk) and increased need for liquidity or limited ability to refinance (liquidity risk) (See Figure 6).

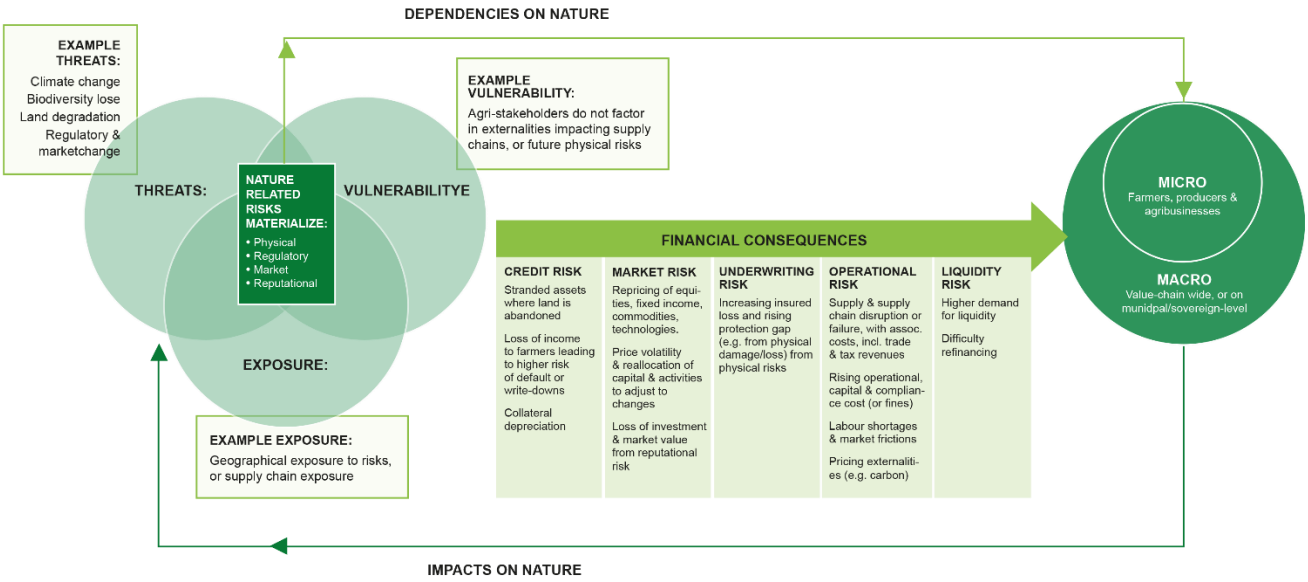


Figure 8: *High level framework illustrating the transfer of nature-related risks to business and the economy. Agribusinesses, and the economy as a whole, both depend and impact on nature. Changes to nature, markets and regulation can pose a threat to exposed and vulnerable agri-stakeholders. This gives rise to physical, regulatory, market and reputational risks. Financial consequences arise as an outcome, when stakeholders fail to manage these risks. Impacts on the micro-economy can aggregate across value chains and economy-wide when dependences and impacts become too great (i.e. systemic risk). Adapted from various studies (incl. WWF, 2019; NGFS, 2020).*

An asset's value may be downgraded or it may become stranded due to lack of ability to compete with the market, well before the actual resource it depends upon becomes depleted completely. Oxford University's Stranded Assets Programme pioneeringly estimated how the decline of natural capital could place the stock of invested capital in agriculture – farmland, infrastructure, and other assets – at risk. It found that the value at risk could reach up to US$11.2 trillion,[108] indicating a significant risk of stranded assets. While financial assets are more liquid and therefore more resilient to these risks, this does not mean that such assets are risk-free, especially in the context of systemic risk to an industry. The study also estimated the environmental and social costs associated with unsustainable practices in the agriculture sector, which were found to be a staggering US$2.4 trillion per year.

In addition, market changes in agribusiness can drive feedback loops that give rise to further environmental damage. For example, lower farm productivity and profitability as environmental externalities materialize could deter future investment, leading to lack of liquidity to invest in competitive resource-efficient technologies, and encouraging further expansion into natural habitats where soils are able to provide short-term productivity. On a micro-level this will affect the business alone. On a macro-level this can lead to systemic risks affecting supply chains, value chains and profitability of an industry in a given region.

Ultimately, the degradation of nature will translate into a material financial risk. The top five risks most likely to materialise identified in the WEF's annual survey in 2019 were all linked to the environment, with loss of biodiversity and ecosystem collapse being among the most prominent.[109] Agriculture and food supply are where the loss of nature and biodiversity become most critical. However, awareness alone is not enough, and to hedge against these risks, businesses must take concrete actions.

Transitioning to a lower carbon economy is likely to entail extensive policy, legal, technological and market changes which could have financial repercussions for businesses. Likewise, the necessary transition to a sustainable food system will require extensive changes which may have financial repercussions.

The financial sector can mitigate some of these risks through strategic planning and risk management, but also through identifying companies and clients that are likely to remain resilient and competitive amidst emerging risks, due to their understanding of their own vulnerabilities and efforts to mitigate them. The financial sector can also improve the incentives for businesses to act with long-term interests in mind, for example with improved credit ratings for investment in restorative activities or through active planning with clients to enable them to transition to a sustainable and resilient production model. Chapter 4 includes concrete recommendations and suggestions for financial institutions.

RISKS TO SOVEREIGNS

Nature-related risks can affect not only companies, but also countries, especially when they emerge as systemic risks that can affect the economy and society as a whole, manifesting through unemployment, civil unrest or food security issues.

Sovereign debt as an asset class is valued at over US$53 trillion globally.[110] Financial institutions are beginning to understand that nature-related risks, left unchecked, can disrupt a country's capacity to raise and repay debt by fundamentally undermining the natural resources upon which it depends. This has already been seen in places such as New South Wales, Australia, where the drop in crop production from drought and fires left institutional investors exposed to Australian national debt issues.

WWF expects to see growing pressure on national governments to take nature-related risks into account. States need to understand, monitor and measure risk and exposure, recognising that failure to mitigate natural capital and climate risks can lead to material economy-wide risks, including shortfalls in budgets, declining tax receipts and asset sales.

WWF and global asset manager Ninety One developed a pilot index, called the Climate and Nature Sovereign Index[111] (CNSI), to assess climate and nature risks in real time alongside other economic and financial factors. The index reflects over 80 indicators across different areas such as natural capital, physical and transition risks, as well as standard economic and financial indicators. A specific set of indicators is related to the agricultural sector, and includes among others nitrogen management, land-use changes, land productivity, and impacts on GDP due to change in pollination and carbon sequestration. WWF is in dialogue with data providers and international organisations to further develop this index and scale up adoption.

How risks materialise in agricultural businesses

In the following section, we discuss how degradation of nature and climate contributes to environmental risk for agribusiness operations and productivity. We limit the scope to risks that are in part controllable by farmers (although many can be incentivised by buyers), and where the lenders and investors in production can best act to enable better practice to reduce those risks. For every risk, we include a short explanation of how they relate to the categories presented above, though it is not always possible to identify a clear-cut categorisation as most risks are cross-cutting.

Climate change

Climate change is a risk which is outside the control of the single farmer. Shifts in growing seasons can have a huge impact on the type of products that can be grown in a specific region, while the severity and frequency of extreme weather events such as droughts, hail or flooding have a direct impact on crops and infrastructure. The effect on the availability of water is one of the main ways in which climate change impacts are going to be felt in agriculture: "*If climate change is the shark, then water is its teeth".*[112]

With some variation across geographies, for each degree of temperature rise, researchers found consistent reductions in yield for the major global staples (maize, soy, rice and wheat), including in the major producer countries (US, China, Brazil and India).[113,114] In 2011, it was reported that the springtime drought may have cost the UK agricultural sector £400 million in lower yields and lost sales.[115]

Climate change can constitute a risk also due to the farmer's dependency on inputs that are linked to emissions, as well as direct emissions due to practices that decrease soil carbon or from livestock. All these impacts can translate into regulatory and other types of risks as the international community seeks to contain global temperature rise to 1.5°C and consumers become more concerned about of their food's climate footprint.

Improving agricultural practices, in particular improving soil health, can reduce farmers' vulnerability to climate change impacts and thus reduce risks. The UN Food and Agriculture Organization (FAO) has pioneered climate-smart agriculture strategies for farmers that can help to guide agricultural systems towards resilience to climate change.[116] At the same time, many of the largest food companies are now diversifying into sustainable foods: Unilever has set a global sales target for meat and dairy alternatives,[117] and even meat producers such as JBS have launched plant-based burger ranges.[118]

Soil loss and degradation

Soil degradation occurs when soils are subject to physical, chemical or biological degradation.[119] This can occur from tillage and heavy machineries that damage soil structure and expose it to erosion, as well as when soils are polluted with agrochemicals and toxic substances, driving up salinity and acidity.

Once these impacts can no longer be compensated, soils lose the ability to produce and land can ultimately be abandoned. Soil degradation is clearly a physical risk but also an example of potential systemic and financial risks for farmers, agribusinesses and financial service providers. It is estimated that an area as large as the entire European Union, about 400 million hectares, has already been abandoned due to degradation.[120]

The reduction in soil organic carbon over the years has real implications for soil fertility, productivity, and resilience to climate change. As mentioned above, a third of the world's topsoil has been eroded, including a large share of farmland. By 2050 the combination of land degradation and climate change is predicted to reduce global crop yields by an average of 10%, and up to 50% in some key regions.[121] The amount of productive land per person will be only one-quarter of the level in 1960, accounting for a growth in population and, critically, consumption rates.[122]

Soil degradation has clear economic costs. However, the estimates vary widely due to the complexity of the phenomenon. Research by the Economics of Land Degradation Initiative in 2015 estimated that soil degradation is costing between US$6.3 and $10.6 trillion per year globally. The NGFS[123] recently highlighted how soil degradation translates into financial risk by lowering agricultural yields, increasing the costs necessary to compensate for the lower profitability (i.e. increasing fertilisation), and finally leading to higher default rates and loss given default (credit risk).

Due to the importance of soils, it can be expected that regulations will be put in place as the problem becomes more visible, and several global or national policy responses have already been initiated.

Conventional wisdom is that farmers and businesses have a direct interest in maintaining the productivity of their soils, but the reality suggests that current economic structures and incentives distort long-term benefits in favour of short-term wins. As mentioned, soil degradation can, until a certain point, be compensated by increasing external inputs such as fertilisers. Moreover, conserving soils does not necessarily lead to short-term yield gains, although conserving soils may lead to cost savings by reducing expensive chemical inputs. Detrimental effects in general tend to become visible only over longer timescales.

"THE FARMERS, FOOD COMPANIES AND THEIR FINANCERS THAT TAKE MEASURES TO IMPROVE SOIL'S ABILITY TO STORE WATER WILL WIN IN A WATER-CONSTRAINED WORLD."

Degraded soils that have lost organic matter and soil structure no longer efficiently absorb, infiltrate and store water. This has evident on-site consequences in terms of less resilience to flooding, and higher dependency on irrigation if available. But it also has wider systemic effects by contributing to modifying the water cycle and even the microclimate of entire regions. The farmers, food companies and their financers that take measures to improve soil's ability to store water will win in a water-constrained world. Just a small 0.4% increase in global soil organic carbon would enhance its capacity to store water by up to 37 billion cubic metres, reducing the need for irrigation and potentially saving costs of US$44 billion per year.[124] Small increases in topsoil organic carbon could also increase drought tolerance of the food production systems operating over 70% of the global harvested area and increase farmers' economic output in drought years by ~16%.[125] Higher soil organic carbon is a win-win in tackling climate and water crises alike.

Agro-biodiversity loss on-farm

Biodiverse ecosystems hold pests and diseases in check by maintaining a dynamic balance between pest species and their beneficial natural predators and competitors such as small animals and insects, fungi and soil microorganisms. Industrial agriculture often follows the opposite principle.[126]

The systematic use of pesticides, fungicides and herbicides harms biodiversity and disrupts populations of beneficial insects, animals, and other microorganisms[127] necessary to hold pests and diseases in check. In a uniform, homogeneous and biodiversity-poor farm, a pest will spread more easily without encountering any obstacle. This is a particular risk in the case of large monocropping systems, where few commercial varieties are farmed, often genetically modified and subject to the same agrochemical treatments. Over the past decades, diversity in farming systems has been greatly reduced and entire landscapes are now characterised by just a few crops. Of the thousands of varieties available, we only grow 170 crops commercially, at scale[128]. This also has broader implications for the genetic diversity of species on-farm.

"DIVERSIFICATION OF AGRICULTURAL CROPS CAN ACHIEVE INCREASED RESILIENCE TO DISEASES AND PESTS, CLIMATE CHANGE AND SOIL DEGRADATION."

This risk is already material to agri-businesses and producers. Between 26 and 40% of the world's potential crop production is lost annually because of weeds, pests and diseases. For crop production, animal pests and pathogens have been estimated to be responsible for around 18% and 15% of crop losses respectively.[129] Invasive pests alone cost the US an estimated US$130 billion in damage and prevention costs each year.[130] Farmers are subjected to loss of production, but also to increased costs for agrochemicals to try to compensate.

Financial professionals are very much aware that diversification in financial activities is a key strategy to manage and reduce the overall risks. It is therefore easy for the financial sector to understand why diversity in agriculture is one of the most important principles of a sustainable food system. Farmers that practise diversification of agricultural crops can achieve increased resilience to diseases and pests, climate change and soil degradation.[131]

CASE STUDY: BIODIVERSITY AND RESILIENCE IN FORESTRY

Forestry, like agriculture, also relies on practices such as monocultures and is therefore exposed to many of the same risks as farmland. For example, the effects of climate change coupled with very homogeneous and artificial landscapes of uninterrupted single-variety spruce forests have facilitated an unprecedented outbreak of bark beetles. This is destroying vast swathes of Europe's spruce forests, with as much as 80% of Czech spruce forests at high risk of dying and more than half the felled timber in Austria damaged.[132] This physical impact immediately translates into financial losses: with forest owners having to cut down affected trees with extra logging and logistical costs, a massive increase in the supply of timber drove prices down and further impacted the financial outlook.

As in farm monocultures, a low diversity of trees offers less natural resistance to the spread of pests and diseases. Not surprisingly, increasing forest diversity is associated with increased biodiversity, better water quality, as well as reduced vulnerability to pest and pathogen damage.[133,134] Heterogeneity can also be increased across landscapes by reintroducing native species to break up large patches of single-variety woodlands.

Antimicrobial and agrochemical resistance

Resistance is a biological phenomenon by which living organisms develop traits that make them resistant to external enemies. On-farm, weeds, pests, fungi and animals such as rodents can develop resistance following the systematic use of pesticides, fungicides and herbicides. Such resistance is particularly likely in monocultures, as well as in herbicide-tolerant genetically modified crops, given the plants' low genetic diversity.

The International Survey of Herbicide Resistant Weeds shows that weeds have evolved resistance to 167 different herbicides, with cases reported in 93 crops in 70 countries.[135] While many resistant weeds can be controlled by using different chemical or non-chemical strategies, weed resistance poses serious challenges and risks, especially for species that have developed resistance to numerous herbicides. The efficacy of chemical pesticides is also at risk of being reduced over time because pests too evolve resistance.[136] This situation has been described as a "biochemical arms race" with new biocides being continually developed as resistance increases; increasing levels of multiple resistance suggest it is a race we are losing.[137]

Resistance develops even in the tiniest organisms. The World Health Organization has declared antimicrobial resistance to be one of the biggest threats to global health, food security and development[138] because a growing number of infections are becoming harder to treat as antibiotics become less effective. Factory farming requires heavy use of antibiotics, predominantly for growth promotion and disease prevention rather than cure, causing concerns for the development of antimicrobial resistant bacteria that are also transferable to people. Examples of bacteria that fit this description and can be transferred through food to people are Salmonella, Campylobacter, and Escherichia coli). This is a cost-saving mechanism for the producers, but it comes with risks and external costs for the society, particularly children, who are most vulnerable to infections and food-borne bacteria. Manure, which are used on soils for crop growing, often contains such antibiotic residues. This impacts on biodiversity where antibiotics accumulate in soils, plants and watercourses. Resistance occurs in soil microbes as well, as they come in contact with animal manure which contains antibiotics and other medicines, leading to concerns that resistant and harmful microbes may spread.[139]

Resistance is a physical risk that can translate into material financial risks for farmers as more or newer, more expensive chemicals are required, or as they resort to heavy tillage to manage weeds, increasing soil erosion and releasing soil carbon. When genetically engineered patented crops are

used, this may create a 'cycle of entrapment'[140] for farmers, as they have no choice but to buy the patented seeds and the pesticides that go along with them. Such lock-ins prevent farmers from breeding their own varieties and preserving traditional seeds and thus erode agrobiodiversity over time.

Fertilisers

Industrial agriculture depends on a systematic use of fertilisers – mainly nitrogen, potassium and phosphorous – to boost yield and to compensate for the progressive degradation of soil fertility. In the period 1961-2014, global fertiliser use increased fivefold.[141]

Agricultural soils need some kind of input to maintain fertility, either through organic or synthetic fertilisers, or through cover crops such as nitrogen-fixing plants. Issues arise, however, when the rate and timing of fertiliser application means that, rather than being taken up by crops, they pollute the atmosphere, soils, ground and surface water, and coastal waters. Furthermore, synthetic fertilisers contain no organic component, which leaves soils vulnerable to erosion and reduces their ability to hold water and nutrients.[142]

The use of fertilisers poses different types of risks. On-farm physical risks are related to the impact on soil biodiversity, as well as on water resources. The use of synthetic fertilisers reduces the effectiveness of the symbiotic relationships between plants and soil microbes.[143] Fertilisers are also a major cause of pollution to freshwater ecosystems and oceans, as rainfall causes them to leach into groundwater or run off into waterways, causing eutrophication. Globally, around 20% of all nitrogen fertilisers applied ends up accumulating in soils and biomass, whereas 35% enters the oceans.[144]. The long-term accumulation of nitrogen in groundwater and soils creates a large pool of potential pollution that means, in some cases, it may take decades for pollution in rivers to return to natural levels.[145,146] As water-related risks increase, poor agricultural practices will increasingly come under scrutiny, raising regulatory and reputational risks.

"STRICTER STANDARDS COULD LIMIT THE USE OF FERTILISERS TO REDUCE THEIR NEGATIVE IMPACTS ON THE SURROUNDING ENVIRONMENTS."

Fertilisers are also susceptible to climate-related transition risks. The production of synthetic fertilisers, in particular nitrogen, is heavily dependent on fossil fuels and generates large quantities of CO_2. Agriculture accounts for 80% of total nitrous oxide (N_2O) emissions, a greenhouse gas 264 times more powerful than CO_2, mainly from the application of both synthetic nitrogen and manure.[147]

While the production of nitrogen is dependent on fossil fuels (in particular natural gas), potassium and phosphorous come from physical mining of potash and phosphate rocks,[148] with all the negative environmental consequences associated with mining and processing. Around 90% of phosphate rock reserves are found in only five countries: Morocco, China, South Africa, Jordan and the US, posing a geopolitical risk. As these are finite resources, uncertainty over supplies could lead to higher costs or even lower yields if inputs become too expensive.[149] Recovery in sewage treatment presents a promising opportunity for closing the loop on phosphorus, although some technical and economic challenges remain.[150,151]

These risks may also translate into regulatory risks, as stricter standards could limit the use of fertilisers to reduce their negative impacts on the surrounding environments. In addition, any changes in the conditions that today guarantee a stable supply of cheap fertilisers could significantly disrupt the industrialised food system. At the same time, farming systems which restore soils and rely less, or not at all, on synthetic fertilisers will have a competitive advantage.

Pesticides

As with fertilisers, industrial agriculture relies on the systematic use of pesticides (as well as herbicides and fungicides) whose use has increased 3.5 times since the mid-1980s.[152] Pesticides, particularly insecticides, have been demonstrated to have a broad range of lethal and sublethal effects on pollinators, and their use has implications for biodiversity as well as land and water pollution.[153] Insecticide application also has impacts on soil biodiversity, including changes in microbial community composition and earthworm reproduction.[154] Other physical impacts of pesticide use have already been highlighted above when discussing resistance.

The use of pesticides also constitutes a reputational risk. Studies highlighting the potential role of these substances in the dramatic declines of bees and other pollinators have spurred a lively public debate and a popular movement calling for the ban of certain pesticides such as the neonicotinoids.

Risks from pesticide uses arise also due to concerns for human health, in particular through chronic exposure and accumulation. Despite being legally authorised, no pesticide has been reliably studied for its real-world impacts on health and the environment, particularly the exposure to a combination of multiple pesticides through food, water, soil and air.[155] Moreover, the legally permitted residues of pesticides in animal feed can be much higher than in crops eaten directly by humans.[156]

Fresh water

The food sector's dependency and impact on fresh water represent a major risk.[xxiv]

The physical risk related to freshwater resources is closely interconnected with other risks discussed above, such as soil degradation and use of fertilisers and agrochemicals. Loss of nutrients and other pollutants from farming to watersheds has a major impact, with an estimated 70-80% of all nitrogen and phosphorous applied as fertilisers in Europe lost in nature before the food reaches consumers. The largest impact and dependency related to fresh water is related to livestock, with animal products representing 53% of all the water consumed to grow food in Europe. Water scarcity, which is often a consequences of excessive water abstraction for crop and livestock production, as well as food and drink processing, is one of the clearest physical risks and its impacts are already felt in many regions of the world, affecting agricultural outputs.

"WATER SCARCITY IS ONE OF THE CLEAREST PHYSICAL RISKS AND ITS IMPACTS ARE ALREADY FELT IN MANY REGIONS OF THE WORLD, AFFECTING AGRICULTURAL OUTPUTS."

Increased scrutiny over the food sector's impact on fresh water and policy action on the horizon also pose clear legal, market and reputational risks to companies and the finance sector.

Zoonotic diseases

Zoonotic diseases are caused by germs that spread from animals to people. Cases such as HIV, Ebola, SARS, MERS and Covid-19 belong to this category. When infectious diseases become pandemics, they constitute a clear example of nature-related systemic risk, affecting society at large, including financial markets.

The scientific evidence indicates that the three biggest factors behind emerging zoonotic diseases are[157]:

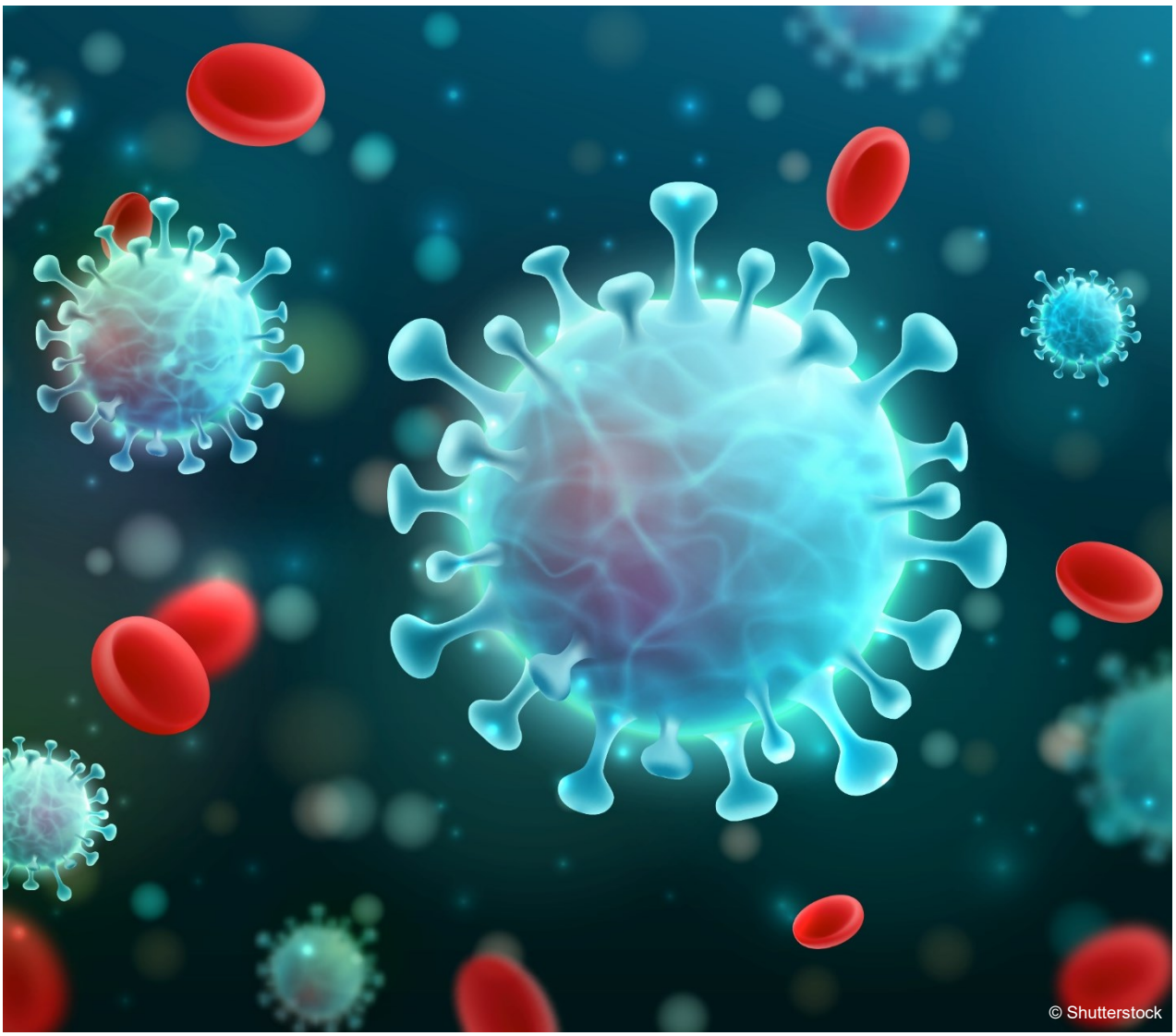
- Land-use change, in particular deforestation, of which conversion for agriculture is the biggest driver
- Exploitation of wildlife through farming, trade and markets for consumption
- Intensification of animal farming, which increases the risk of transmission of pathogens; livestock may become intermediate hosts of pathogens from other species, which are then transmitted to humans.

"FEW CHANGES HAVE BEEN MADE TO ADDRESS THE UNDERLYING DRIVERS OF ZOONOTIC DISEASES."

[xxiv] All quotes and data in this section come from a recent European Environmental Agency report, which provides a good summary of the issue. EEA (2020). Water and agriculture: towards sustainable solutions. EEA Report No 17/2020. https://www.eea.europa.eu/highlights/agricultural-policy-needs-to-secure

The food system, and especially the growing global demand for animal-based foods, is a major driver behind all these.[xxv] Since 1940, agricultural drivers have been associated with over 50% of all zoonotic infectious diseases,[158] and there are countless cases of disease outbreaks in factory farms, leading to containment, shutdown and culling of the infected animals.[xxvi] Many companies in animal agriculture are therefore vulnerable to pandemic risk.[159]

Covid-19 has been dubbed 'the disease of the Anthropocene'.[160] The risk of such a pandemic has been increasing for quite some time, predicted to increase with rising rates of globalisation, urbanisation, deforestation and climate change years to come.[161] Yet few changes have been made to address the underlying drivers of zoonotic diseases. While prevention has its costs in terms of reduced activity in some industries and consequent job losses, these costs are immensely lower than coping with a full-blown pandemic. The UN Environment Programme (UNEP) estimated that zoonotic diseases have already created direct costs of more than US$100 billion in the last two decades, with Covid-19 set to cost at least US$9 trillion.[162]



[xxv] The 7 top drivers of zoonotic diseases are: 1) increasing demand for animal protein; 2) unsustainable agricultural intensification; 3) increased use and exploitation of wildlife; 4) unsustainable utilization of natural resources; 5) increased travel and transportation; 6) changes in food supply; 7) climate change. Source: United Nations Environment Programme and International Livestock Research Institute (2020). Preventing the Next Pandemic: Zoonotic diseases and how to break the chain of transmission. Nairobi, Kenya. https://www.unep.org/resources/report/preventing-future-zoonotic-disease-outbreaks-protecting-environment-animals-and

[xxvi] For example, the recent outbreak of avian flu in European farms: Bird flu continues to spread across Europe. https://poultry.network/4595-bird-flu-continues-to-spread-across-europe/

Moreover, sustainable farming should reduce the conversion of natural ecosystems to farmland, and therefore the risk of pathogens crossing from wild to domestic species.[163]

Policy risks on the horizon

As agriculture comes under increasing scrutiny due to the host of negative impacts, the regulatory and political risks increase. While forceful regulations have often been impeded by the concentration of power in the food sector and the significant lobbying budgets of large agribusiness, regulators are putting increased attention on the importance of guaranteeing the integrity of our natural world. Without attempting to give a full picture, this section presents some examples of relevant initiatives that may increase this type of risk for the food sector and those providing investment, lending and financial services.

As part of the EU Green Deal, the EU Commission launched the Farm to Fork Strategy,[164] a proposal for a legislative framework for sustainable food systems. In particular, the EU outlines:

- A 50% reduction in the use and risk of chemical pesticides and the use of more hazardous pesticides by 2030.
- A reduction of at least 50% in nutrient losses while ensuring that there is no deterioration in soil fertility. This will reduce the use of fertilisers by at least 20% by 2030.
- A 50% reduction in sales of antimicrobials for farmed animals and in aquaculture by 2030.
- 25% of agricultural land under organic farming by 2030.

The EU plan is a clear example of regulatory risks emerging for those companies in the food system, and finance providers, that are not taking sufficient steps to reduce their impacts. These targets and related regulatory and non-regulatory initiatives can directly impact the business models of companies such as pesticide and fertiliser producers, factory farms and non-organic farms. At the same time, progressive companies will be able to reap the benefits of their early transition to more sustainable agricultural practices.

> "FOOD SYSTEMS PRESENT A HOST OF NATURE-RELATED RISKS TO BUSINESSES AND HEALTHY ECOSYSTEMS. MANY SUCH RISKS ARE ALREADY MATERIALISING."

For the financial sector, a broad package of upcoming regulatory measures in the EU Action Plan for sustainable finance are poised to increase their risks related to the food sector. The EU Taxonomy, coupled with upcoming regulations forcing companies to disclose their alignment by the end of 2021, is poised to create strong incentives to shift investments towards more sustainable agricultural practices. In the UK, the Green Finance Strategy[165] is aiming at ensuring that all listed companies and large asset owners, including pensions, make disclosures using the Task Force for Climate Related Financial Disclosures (TCFD)[166] guidelines by 2022. This could expose deficiencies in the effort of companies to manage climate and environmental risk, particularly those related to GHG emissions, water and energy use. Supplementary guidance is provided for all sectors, including financial sector actors,[167] with supporting guidance documents for agribusiness companies by activity, sector, industry or product.[xxvii]

Policies to curb emissions will also impact the food sector, given the growing momentum to apply carbon taxes to farm and animal emissions. New Zealand has announced its intention to begin taxing emissions at the farm level[168] (although this excludes methane, which accounts for one-third of the country's total emissions linked to animal farming), while the EU is reportedly considering a tax on meat to compensate for the industry's impacts.[169]

[xxvii] Including Carbon Disclosure Project, GHG Protocol, Global Reporting Initiative, Sustainability Accounting Standards Board (SASB).

A host of international initiatives have also pushed for action on issues such as soil degradation. The authoritative European Academies' Science Advisory Council (EASAC), formed by all national science academies of the EU, has increased pressure for policy reforms that place soils at the centre,[170] and provided an overview of all high-level initiatives promoting new legislation for the protection of soils at global and national level.

CONCLUSIONS

Food systems present a host of nature-related risks to businesses and healthy ecosystems. Many such risks are already materialising at production level, with knock-on effects that can disrupt supply chains, or emerge as systemic risks.

Businesses and financiers need to consider the risks that emerge from both their dependence on nature, and the impacts they have upon it – their 'double materiality'.[171] This is particularly true for actors incentivising or financing agribusiness and farmers, and can press for better risk identification and management.

It is imperative that the financial sector starts to identify such materiality in its investments. Businesses and financial institutions need to start accounting for dependencies and impacts on nature and to measure and disclose nature-related risks alongside climate-related risks, as recommended by the Dasgupta Review. Central banks and financial regulators should also assess the systemic extent of nature-related financial risks, which has so far gone unmonitored by them.[172]

At the same time, it is important that the financial sector supports government initiatives to scale up more progressive agricultural practices and level the playing field for those producers who are already initiating sustainable reforms, such as restoring their soils and sequestering carbon, rather than relying on cheap chemical and carbon-intensive inputs. Delaying support to these producers further increases the risk that we will cross planetary boundaries and reach tipping points that compromise our productive systems.

The next chapter presents solutions that are in line with the international consensus around sustainable agricultural practices and the changes necessary to transform food systems. It also presents a range of tools and frameworks that financial institutions can use to begin to identify and evaluate their impacts and dependencies along agricultural supply chains and disclose them publicly. Such solutions can address most of the risks highlighted in this chapter and support a coherent transition to a sustainable food system.

"BUSINESSES AND FINANCIAL INSTITUTIONS NEED TO START ACCOUNTING FOR DEPENDENCIES AND IMPACTS ON NATURE AND TO MEASURE AND DISCLOSE NATURE-RELATED RISKS ALONGSIDE CLIMATE-RELATED RISKS."

CHAPTER 4

A LAND OF SOLUTIONS

CHAPTER 4: A LAND OF SOLUTIONS

INTRODUCTION

Transforming food systems will take a seismic shift in the short-term priorities of business, policymakers, and consumers. Should we succeed, however, the benefits will be enjoyed by the economy, society, and the planet. In addition to helping fight climate change, reverse nature loss, safeguard biodiversity and improve health, nutrition and disease prevention, the transformation can also reduce financial risk, create investment opportunities, and save on public spending.

Decarbonisation of our global economy by 2050 is a critical global priority, and producers and agribusinesses have a key role to play. Researchers at Project Drawdown[173] ranked the most impactful climate solutions based on their potential emissions reduction and found that the top five with the most potential positive impact were in the food sector, including reducing food waste, switching to plant-based diets, and managing the restoration of tropical forests.[xxviii] Improving land carbon sinks that are vulnerable to agricultural expansion, and adopting sustainable agricultural practices (including silvo-pasture, peatland and forest protection and restoration, agroforestry and agroecology) were also ranked highly.

> "TRANSFORMING THE FOOD AND LAND-USE SYSTEMS WOULD LEAD TO A GIGANTIC US$5.7 TRILLION IN ECONOMIC SAVINGS BY 2030. SOCIETAL RETURN WOULD BE MORE THAN 15 TIMES THE INVESTMENT COST."

The Food and Land Use Coalition has estimated that transforming the food and land-use systems by 2030 would require about US$300-$350 billion (less than 0.5% of global GDP) each year. Yet this would lead to a gigantic US$5.7 trillion in economic savings by 2030 based on avoided hidden costs (externalities). In other words, societal return would be more than 15 times the investment cost, and this would create US$4.5 trillion in annual opportunity for businesses.[174] The Global Commission on the Economy and Climate supports this economic case, showing that developing sustainable food and land-use business models could be worth up to US$2.3 trillion and provide over 70 million jobs by 2030. And at the same time, missing this opportunity to transition *"entails risks and costs that no responsible leader should accept".*[175]

Food systems need to be transformed along three major dimensions:

1. **At the producer level, by adopting sustainable, agroecological practices.** Changes in the way farmers operate will lead to much of the positive direct impacts linked to transforming food systems. Agriculture needs to be reorientated towards sustainable practices that work in synergy with nature and reduce the trade-offs between loss of nature and productivity. Securing a long-term sustainable food supply requires moving away from conventional models relying on uniformity and a systematic use of external inputs, while managing emissions and ensuring that soils are improved and there is no agricultural expansion into new territory.

[xxviii] Other factors include improving health access and education, particularly for women, especially from disadvantaged backgrounds; energy-related actions including increasing wind and solar power; and managing refrigerant emissions.

2. **At the consumer level, by rebalancing diets towards more plant-based alternatives.** Consensus is emerging around the need to move to healthier[xxix] and plant-based diets, based on higher consumption of vegetables, legumes, fruits, and nuts, as a critical step for both the climate and biodiversity. A host of studies have modelled how changes in dietary patterns would impact planetary and human health, and the results are striking. If consumption of animal foods were reduced, replacing most meat and dairy with plant-based alternatives, current global food production would be sufficient to provide enough food for 9.7 billion people in 2050, leading researchers to conclude that "*industrialised meat and dairy production is highly inefficient and is incompatible with a sustainable global food system.*"[176]
3. **Throughout the supply chain, by reducing food loss and waste**. The UN Sustainable Development Goal 12 set a target of halving global food loss and waste, which is the most visible inefficiency of our current food system.

These three areas of reform are broadly agreed upon by a range of leading global publications[xxx] from international agencies such as the UN, civil society organisations and research institutions, including the EAT-Lancet Commission on Food, Planet, Health, which provided the first scientific targets for a healthy diet and sustainable food production within planetary boundaries while avoiding global warming beyond 1.5°C.[177]

While new technologies can contribute to the transformation needed across all three dimensions, we cannot rely on technology alone, which is why the focus of this chapter is on systemic solutions. This is in line with, among others the Dasgupta Review, which underlines that we need to fundamentally change consumption and production patterns; the way we think, act and measure success; and our institutions and systems, in particular our finance systems, to enable these changes and sustain them for future generations.[178] Das Gupta also highlights the role of the global financial system in supporting this transformation and helping us manage and mitigate the risks and uncertainty that result from our unsustainable engagement with nature.

The following sections will equip stakeholders with a working understanding of the concrete changes needed across the three dimensions, and the general principles of agroecology, sustainable diets and waste management. It will also show how financial institutions can reduce the impact of their own portfolios and the corresponding risks arising from unsustainable activities by supporting and incentivising better production practices for agribusinesses.

[xxix] The understanding of a 'healthy' diet is highly divergent between cultures, countries, age groups and individuals. However, scientific consensus tends to converge around some main characteristics of healthy diets; that is, an emphasis on the consumption of plant-based foods (wholegrains, fruits, vegetables, nuts and legumes) and a reduction in animal-based and processed foods. For more information, refer to e.g. the EAT-Lancet report https://eatforum.org/eat-lancet-commission and WWF's Planet-Based diets: https://planetbaseddiets.panda.org/methodology/#dietary-shifts

[xxx] Many of the references used thorough this report refer to the need to transform food systems across these three dimensions, highlighting the importance of tackling them in tandem in order to bring food systems within planetary boundaries. Publications vary greatly, ranging from UN-led agencies such as FAO, IPBES, IPCC, research teams in leading universities, institutions such as the European Environmental Agency, and many more.

1. SUSTAINABLE PRODUCTION AND THE PRINCIPLES OF AGROECOLOGY

Agroecology is a well-recognised solution to many of the on-farm risks and impacts identified in previous chapters. Although 'sustainable agriculture' has many different definitions,[xxxi] in this report we refer to 'agroecology' as a set of practices that mimic natural processes and enhance beneficial biological interactions and synergies in the farm environment. Such practices focus on improving soil heath, boosting fertility and organic content, and increasing biodiversity, including pollinators.[179] While agroecology is not synonym for organic farming, it greatly reduces (although does not necessarily eliminate) the need for synthetic pesticides and fertilisers. An important take-away for the financial sector is that these practices are universal and can be promoted and applied across geographies, types and sizes of farms.

Why is agroecology important?

Agroecology seeks to transform food and agricultural systems by addressing the root cause of issues in production, while increasing climate resilience.[180] Conclusive evidence of the damage of conventional farming and benefits of adopting agroecological principles was demonstrated over a decade ago through the International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD), a massive multi-year review involving hundreds of experts, 110 countries, UN agencies and the World Bank.[181] Agroecological practices were found to decrease soil erosion and pollution runoff. They were also found to reduce fuel consumption, emissions and the risk from flooding and other extreme weather events, all the while increasing carbon sequestration and water retention and recharging underground aquifers.

[xxxi] There is no univocal definition of sustainable agriculture, and several terms are often used interchangeably: agroecology, regenerative agriculture, conservation agriculture, organic farming, climate-smart agriculture, sustainable intensification, mixed farming, agroforestry. The IUCN (2020), has recently tried to identify features and commonalities across these definitions.

Agroecology is also part of the climate solution. More than 10% of countries' nationally determined contributions (NDCs) to the Paris Agreement explicitly mention agroecology, while the FAO has concluded that it is an effective climate adaptation strategy.[182]

While yields of conventional farming are, overall, higher than those that use smaller amounts of external inputs in the form of fertilisers and agrochemicals, this does not necessarily mean that agroecology compromises global food security. Access to nutritious food is a complex issue that is not necessarily linked to the volume of food produced, but more often linked to poverty, food distribution and market dynamics. EU modelling[183] has shown that it is possible to transition the entire farming sector to agroecological practices by 2050, while still producing enough food and maintaining export capacity. This scenario would have beneficial health and environmental implications and reduce agricultural emissions by 40%. The IUCN[184] too has concluded that agroecological systems can provide a viable alternative to traditional farming in both developed and emerging economies, as well as job opportunities due its knowledge-intensive nature.

"REGENERATIVE MODELS OFTEN OUTPERFORMED THE CONVENTIONAL MODEL IN ECONOMIC, ECOLOGICAL AND FOOD PRODUCTION TERMS."

Research pilots on farms in Europe show that implementing regenerative agricultural principles can improve yield stability and resilience while reducing emissions.[185] In these studies, regenerative models often outperformed the conventional model in economic, ecological and food production terms, including during a transition period where farmers are starting to integrate new agroecological principles into their practices. In most cases, the financial benefits arose from cost savings from lower inputs and were frequently the final determinant of farmers' decisions to shift approach, although soil degradation concerns were also a factor.[186] FAO-Biovision noted that smaller scale agroecological farms exhibit higher yields and income than non-agroecological large-scale farms, with polycultures showing higher productivity per unit area compared to monocultures, due to reduced losses by weeds, insects and diseases.

A growing body of research is corroborating these findings, showing that agroecology can be as productive as other models of production.[187] The EEA notes that the yield gap still observed for some crops decreases as soil fertility improves, and that farmers are compensated by lower input costs (e.g. fuel, nutrients, pesticides, irrigation) and more stable yields.[188] Research and development have historically favoured conventional farming, and a shift in the focus of R&D will be essential.

The principles of sustainable agriculture

The core principles of agroecology contrast directly against conventional approaches to agriculture, which are characterised by heavy tillage and soil disturbance, leaving soils bare during certain seasons or between crops, monocultures and the systematic overuse or mistiming inputs of chemicals and synthetic fertilisers. It is possible to highlight a set of common practices for sustainable agriculture, below. [xxxii]


© Shutterstock

[xxxii] The benefits of the principles outlined are highlighted in a vast array of reports, including from UN-FAO and other specialised agencies. For a concise summary, we recommend EEA (2019). Climate change adaptation in the agriculture sector in Europe. EEA Report No 4/2019. https://climate-adapt.eea.europa.eu/metadata/adaptation-options/conservation-agriculture

Principle 1: Minimise soil disturbance

Soil plays an integral role in delivering many of the SDGs[189] and provides vital ecosystem services such as carbon sequestration, biodiversity conservation, water retention, food supply and nutrient cycling.[190]

Soil disturbance, through heavy and sustained tillage, has an array of negative impacts on soil quality, structure and its ability to absorb water and to resist erosion. In minimum or no-tillage systems, only the narrow row where the seeds are planted is tilled and the remaining ground surface is left intact. When this approach is combined with the other principles, it reduces the need for agrochemicals and other external inputs, including energy consumption by machineries. It enhances soil properties, protects it from erosion, increases soil carbon stocks and water retention, and improves the overall resilience to climate change.

Principle 2: Permanent living armour

The soil needs to be covered at all time with crop residues and by growing cover crops (e.g. legumes or other crops planted between the main crops). This 'armour' prevents soil erosion by wind and water and improves soil fertility and quality by preventing runoff. It can also suppress weed growth, provide a habitat for biodiversity, and improve pest and disease containment. It helps to manage soil moisture and temperatures, again improving the overall resilience to climate change. Cover crops are one of the best demonstrated practices to increase carbon in the soil, while nitrogen-fixing cover crops naturally improve the fertility of the soil, reducing the need for added fertilisers.

Principle 3: Fostering plant and species diversity at all levels

Increasing agrobiodiversity is a key principle of sustainable agriculture. Through strategies such as crop rotation, polyculture or associated plant species, cover cropping, intercropping and agroforestry, farmers can enhance biodiversity and encourage natural enemies of pests to protect crops[191] and the soil from various pathogens. At the same time, managed on-farm biodiversity can suppress weeds and increase organic content. Diversified cropping systems are more stable and resilient than monoculture systems, while crop rotations and multi-cropping has been shown to substantially reduce the yield gap which, for some crops, exists between organic and conventional agriculture.[192]

Principle 4: Nutrient cycling and circularity
Agriculture needs to transition from a linear extractive system towards a circular one, where nutrient cycles are closed as much as possible and natural resources are used as efficiently as possible. Circularity can be enhanced by using farm animals for what they are good at, namely converting by-products from the food system and grass resources into food and manure, thus recycling biomass and nutrients that would otherwise be lost.[193] Controlled grazing can also improve soil fertility, control weeds, provide animal power when mechanisation is not possible and constitute an important income stream for farmers. For this to be sustainable, livestock should be fed on products that cannot be eaten by humans directly – rather than, for example, soy-based feeds sourced from tropical forest frontiers. Similarly, grazing should occur on areas which are already in use and not fit for the cultivation of crops for human consumption.

Keystone principle: a holistic approach to managing on-farm impact
Agroecology is a holistic approach which considers both ecological and social concepts and principles to optimise the interaction between plants, animals, humans and the environment. Agroecological practices are most effective when applied in an integrated way. For instance, no-tillage alone is not always found to benefit soil organic carbon, and farmers often end up relying on herbicides for weed control. The principles set out above are needed to build the sustainable agricultural system the world needs. Farmers and producers that adopt these practices have a higher likelihood of reducing their nature-related risks while contributing to maintaining ecosystem services and productive systems in the long run.

Holistic approaches to agroecology also include social considerations of sustainable livelihoods, fair working conditions on the farm, and resilience of rural communities. Agroecological approaches also reduce exposure of workers and surrounding systems to fertilisers, pesticides and, in some cases, antibiotics.

SUSTAINABLE AGRICULTURE AND FRESH WATER

Adopting the principles of sustainable agriculture reduces pressure on freshwater resources and improves the resilience of businesses facing an increasing risk of water stress and pollution.

The Water Risk Filter[194], a tool developed by WWF, is used by financial institutions to manage the risks and impacts of water stress to their projects and assets. It is a practical, free online tool that helps companies and investors explore, assess, respond to and value water-related risks facing their operations and investments across the globe. It includes tailored water risk assessments for the agriculture sector, and assessments of additional future risks likely under a range of climate scenarios.

Adopting sustainable farming practices that reduce the need for nutrients and pesticides as well as preventing soil erosion is a key strategy to maintain water resources and freshwater ecosystems.[195] Policy and legislation also need to be in place to ensure that the environmental needs of rivers are considered when allocating water resources to agriculture and other uses. Sound and holistic management of water resources at landscape level would also increase the resilience of the agricultural sector and therefore reduce the risks related to water stress.

2. PLANET-BASED DIETS

By 2050, it is estimated that 2 billion more people will be on the planet. This will necessitate a shift both in the way we farm and produce food, as explained above, but also in what we eat. Virtually every prominent publication agrees that reducing over-consumption of animal foods and shifting to plant-based diets is a necessary transformation. It can reverse the loss of our natural world, combat climate change, improve human health and food security, reduce biodiversity loss, save lives, decrease the risks of future pandemics, and unlock economic benefits.[196, xxxiii]

"STUDIES CONSISTENTLY FIND THAT THE MORE THE DIET MOVES AWAY FROM ANIMAL FOODS, THE MORE THE FOOTPRINT IS REDUCED."

In 2018, the UN FAO director general suggested that governments target the demand side of the food system with policies that reduce meat and dairy consumption.[197] To do this, the global imperative must be translated into national and sub-national contexts. A sustainable diet is highly dependent on geography and the consumer, and should reflect the diversity of preferences, resource needs and culinary traditions around the world. Current dietary patterns show strong unbalances and different responsibilities across countries. Globally, around 2 billion people are obese or overweight, while 700 million people are undernourished.[198] The average global consumption of fruits and vegetables is 38% below the healthy minimum level, while the average meat and dairy consumption – mainly in high-income countries – exceeds healthy levels by 20%.[199] Following the industrialisation of food production, diets around the world became more similar and based on fewer food types.[200] This could have a wide range of implications for human health and the environment.

WWF's recent report *Bending the Curve: The Restorative Power of Planet-Based Diets* analysed the dietary patterns of 147 countries. Based on the global carbon budget for food, it underlines how some countries may need to increase consumption of certain foods, including dairy, fish, fruits and

[xxxiii] Most of the sources (UN, IPBES, IPCC, EAT-Lancet Commission, Food and Land Use Coalition, New Climate Economy Commission, Dasgupta Review, European Environmental Agency) are referenced several times thorough our report. The World Business Council for Sustainable Development also has a strategy to increase adoption of plant-based foods in line with the EAT-Lancet Commission: https://www.wbcsd.org/Programs/Food-and-Nature/Food-Land-Use/FReSH/Plant-forward-Foods

vegetables, to fight undernutrition, while rich countries need to decrease meat and dairy consumption. The EAT-Lancet report[201] outlines what a healthy and sustainable diet within planetary boundaries looks like, again underlying the need for a significant reduction in animal foods. Companies can act to facilitate the shift: for example, the WWF Future 50 Foods initiative, in partnership with Knorr,[202] was developed to inspire greater variety in the foods we eat – encouraging diversity for our diets and in the products that are grown.

ALIGNING TO ONE PLANET: LESS MEAT, BETTER MEAT

WWF emphasises the importance of eating less but better meat from sustainable production systems, and reducing reliance on wild meat where this is a factor in biodiversity loss.[203] Livestock can be part of sustainable systems, helping to eliminate farm waste and improve nutrient cycling. But such a system looks vastly different to today's industrial farming. Currently, meat, dairy and eggs provide an estimated 18% of calories and 37% of protein consumed globally, but use 83% of all agricultural land and account for 60% of agriculture's GHG emissions.[204] An estimated 33-39% of all edible crops are used to raise livestock in intensive factory farming rather than for direct human consumption, which means that, 24% of calories and other nutrients produced globally are lost in the process.[xxxiv] Producing animal foods is therefore inherently inefficient, and increasing animal production at scale is unsustainable.[205]

Studies consistently find that the more the diet moves away from animal foods, the more the footprint is reduced in terms of land use (-76%), food-related emissions (-49%), eutrophication (-50%), water use (-19%). Shifting the trajectory of global diets towards plant-based alternatives is likely to secure land, food supplies, and could lead to healthcare-related savings and avoided climate damages of US$1.5 trillion by 2050.[206,207] One study estimated that, in the US alone, such a shift would add enough food for an extra 350 million people.[208] A 40% reduction in animal-protein consumption among the world's wealthier populations could free up twice the land size of India, potentially enabling the world to feed 10 billion people by 2050 without further expansion into forests and other natural ecosystems[209].

One way for consumption of animal foods to remain within planetary boundaries[210] is to adopt a "livestock on leftovers" approach. This would limit the availability of animal protein globally only to what can be produced by raising animals on available grazing lands, by-products of agricultural crop production and food waste. In practice, this would rule out most of the animal food produced today in industrial farming and naturally rebalance prices, consumption and production to more sustainable levels.

However, if the demand for animal products[xxxv] continues to follow current trends of growth, global agricultural land may need to expand by about 5% by 2030, an area the size of Argentina, which will likely mean expansion into our remaining forests, wetlands and natural ecosystems. This would spell disaster for a world that needs to stabilise warming to well below 2°C.[211]

[xxxiv] Of all the calories produced by the world's crops, only 55% are eaten directly by people, 9% are used for biofuels and other industrial uses, and 36% are being used for animal feed. Of those feed calories, only 12% are ultimately eaten by humans as meat and other animal food.

Cassidy, E. S., West, P. C., Gerber, J. S., & Foley, J. A. (2013). Redefining agricultural yields: From tonnes to people nourished per hectare. Environmental Research Letters, 8(3), 034015. https://doi.org/10.1088/1748-9326/8/3/034015

[xxxv] Soy and maize are expected to be responsible for the majority of this expansion, stimulated largely by increasing demand for poultry and pig meat in developing countries. Source: WWF UK (2017). Appetite for destruction. https://www.wwf.org.uk/updates/appetitefordestruction

3. REDUCING FOOD WASTE

Food waste is one of the most visible inefficiencies of the food system, and an intolerable drain on our precious natural resources. A third of all food produced for human consumption, produced on 28% of our agricultural land, is lost each year. [xxxvi] Saving just one-quarter of the food currently lost would be equivalent to the amount of food needed to feed 870 million people annually.[212]

If food waste was a country, its GHG emissions would rank third behind the US and China; reducing food waste globally has the potential to be the third most impactful climate solution.[213] And it would lead to substantial economic benefits too: for every dollar invested, businesses would gain 14 dollars in returns.[214] A study by WWF[215] shows that waste lost only at farm-stage is estimated to amount to 1.2 billion tonnes per year, which is akin to 15% of global production and enough to feed the world's undernourished four times over. The cost of this is equivalent to US$370 billion. Farm-stage food loss accounts for 4% of our total GHG emissions (2.2 $GtCO_2$), 0.4 billion hectares of land (larger than India) as well as vast amounts of water.

Food waste is caused by a combination of systemic challenges all along the value chain, from farming practices to consumer behaviour. The current centralised system, with few large traders and buyers, is likely not as efficient as believed in preventing food waste, as the power of those higher up in the value chain exerts a downward pressure on price. This often results in prices so low that farmers' costs are not covered, hindering their ability to invest in necessary equipment to reduce food waste; in extreme cases, crops are left to rot in the field because harvesting costs are not covered by sales revenues.

[xxxvi] Figures and sources from World Economic Forum (2015). Which countries waste the most food? https://www.weforum.org/agenda/2015/08/which-countries-waste-the-most-food

Companies higher up in the supply chain therefore have a responsibility to secure fair prices for farmers as a key tool to reduce food waste at farm level. On a system level, more decentralised local markets with a shorter connection between farmers and consumers could contribute to securing farmers' incomes and reducing food waste.

Agroecological farming operations often support other enterprises that seek to 'close the loop', transforming what was previously considered to be waste or pollutants into a resource or added-value product. Managing food waste through circular approaches can have a significant impact on reducing GHG emissions and ocean pollution.

INCENTIVISING THE TRANSITION TO SUSTAINABLE FOOD SYSTEMS: THE ROLE OF OTHER STAKEHOLDERS

The environmental case for adopting agroecological principles is clear. However, the economic case is only more recently being made. To date, the application of regenerative or agroecological practices has been limited by a number of factors, including farmers' concerns over increased costs, the risk of lower yields (especially in the initial years) and the need for training. Cultural factors too play a role, as many farmers may be more comfortable with established, 'in-family' practices that have been used for generations.[216] Demand-side barriers exist, as high-value crops are produced at scale as monocultures for the export markets, rather than for the purpose of food security and supporting nutrition. Surveys of farmers across Europe have shown that the transition to agroecology may also be slowed by declining farm profitability and high levels of farmer debt, meaning that farmers have little financial leverage to consider and test alternatives.[217]

> "STAKEHOLDERS CAN ACT TO REDUCE THE BURDEN ON PRODUCERS AND INCENTIVISE, RATHER THAN IMPEDE, THE USE OF AGROECOLOGICAL PRACTICES."

To overcome these barriers, support, commitment and incentivisation is needed from those along the entire value chain: from food buyers (or 'offtakers'), advisers, cooperatives, farming associations, corporate actors, governments, and finance. Stakeholders can act to reduce the burden on producers and incentivise, rather than impede, the use of agroecological practices in the following ways:

Research institutions, NGOs, philanthropists and public/private funds can play a critical role in strengthening farmer buy-in by supporting positive agroecological pilots and research, *showcasing* the positive business case to farmers. Focusing on practices that lead to equal or greater yield, or that reduce input costs to remain competitive, will strengthen farmers' incentive to invest time and research into this. This can also help to overcome cultural barriers if done alongside cooperative farmer groups.

Farmer cooperatives, **food buyers and farming associations** can help to manage the barriers of additional upfront capital costs, provide technical support, and share knowledge.

The transition to agroecology requires high levels of knowledge sharing and farmer capacity building. This sophisticated level of knowledge transfer may require a progressive change of practice over multiple years.
In a study piloted in Europe by SystemIQ, the success of farmers who attempted to transition to agroecological practices was far higher if they were given agronomic support, for example in the form of independent agroeconomic advice, group support to share costs and access to multi-year offtake agreements.[xxxvii] Independent agroeconomic advice from trusted consultants helped to unlock cost

[xxxvii] An offtake agreement is an arrangement between a producer and a buyer to purchase or sell portions of the producer's upcoming goods. Purchase agreements guaranteeing offtake beyond a one-year time horizon can help to stabilise costs, and allow both the grower and buyer to plan further ahead. Multi-year offtake agreements provide assurance for major investments in capital, allowing a farmer the security to change practices and invest in new technology.

savings; in Belgium, using such advisors was linked to a 30% reduction in input costs for farmers, more than covering the advisory costs.[218]
In addition, famers who undertook the transition in an organised group or hub experienced better or faster returns on investments through sharing costs of equipment and machinery. Usually, farmers carry the risk and costs of changing their well-established practices. Given that many farmers are highly leveraged, this presents a significant risk. Financial support is therefore necessary but can come in the form of leasing equipment at cost, or pre-financing a portion of multi-year offtake agreements. In fact, the SystemIQ study showed success in changing practice was highest where buyers provided multi-year commitments to underwrite costs associated with the change in practice.[219]

Retailers and consumer-facing buyers can be levers for change in a number of ways. Retailers often set product standards, reflecting consumer demands. This increasingly includes the expectation that food is traceable and sourced without harm to the environment, or those in the supply chain. Retailers can also make it easier for consumers to make the right choices, through helpful nudges, new product lines and innovative signposting. In collaboration with other actors, like policymakers, retailers can support a better balance of prices in favour of more sustainable foods (see below).

Consumers also have a critical role to play in influencing the adoption of sustainable practices. Frequently, consumers' only means of differentiating between products are prices and labelling/certification. Certifications have their own cost and limitations in terms of scalability, especially given the low margins of those in the food sector. Because the externalities of food production are not included in prices, environmentally damaging products are often much cheaper than more sustainable alternatives. Balancing externalities through price adjustment (see: Box) is a way to address this.

BALANCING EXTERNALITIES THROUGH PRICE ADJUSTMENT

Integrating the externalities of food into prices is a sensitive subject. Researchers in Germany[220] estimated that, if externalities of GHG emissions alone were integrated into product prices, conventional and organic animal-based products would cost 146% and 71% more respectively. Conventional dairy products would cost an additional 91%. But organic plant-based products would only have 6% surcharge, confirming the higher 'carbon burden' of animal products compared to plant-based products.[221] In another study looking at wider environmental and social externalities, processed red meats were shown to carry the most significant environmental and health burdens together[222].

Balancing and redistributing these costs will be vital to address a major market unbalance and to incentivise both farmers and consumers to shift production and consumption practices. Governments, buyers and retailers should consider alternative pricing and incentivisation in targeted groups, such processed foods and animal proteins. Price compensation for healthier, plant-based products and higher costs for those products with the highest externalities could contribute to rebalancing diets in a more planet-friendly direction, while guaranteeing easier access to healthy food for low-income households.

Governments have a key role to play in levelling the playing field and smoothing the transition towards a sustainable food system. Where markets fail to price externalities, policymakers have a variety of tools at their disposal to address this, including redirecting subsidies to regenerative practices and rewarding those that protect biodiversity; managing incentives that e.g. promote excessive use of chemical inputs; establishing standards and technologies to measure the environmental health of farms (or carbon content); and improving the enabling environment and supporting technical assistance and capacity building.

"BALANCING AND REDISTRIBUTING EXTERNALITIES COSTS WILL BE VITAL TO ADDRESS A MAJOR MARKET UNBALANCE AND TO INCENTIVISE BOTH FARMERS AND CONSUMERS TO SHIFT PRODUCTION AND CONSUMPTION PRACTICES."

Viewing degraded land as a national resource, rather than a private sector issue, can unlock support for farmers to manage restoration. In some cases, a price premium for restoration of carbon or ecosystem services may support the transition. *Landscape management approaches* (see: Box) can be extremely effective in managing long-term impacts of agriculture at scale.

A LANDSCAPE APPROACH

All stakeholders and actors operating in a landscape, including policymakers, farmers, buyers and financial institutions investing in businesses or conservation activities, should be aware of the importance of cooperating and adopting a landscape approach. Thinking at a landscape level can help to address both dependencies and impacts.

Any landscape is likely to have a mosaic of land uses, ranging from relatively undisturbed native habitat to industrial agricultural production systems. For these landscapes to be sustainable, it is necessary not only to focus on improving the single farm's impacts and practices, but to adopt a holistic landscape approach (or integrated landscape management) that aims at achieving synergies between production and conservation. This can increase resilience and sustain biodiversity and ecosystem services, while also benefiting productive activities such as farming.

For instance, reducing pesticide use at the farm level may be inadequate to ensure that pollution in local watercourses remains within safe thresholds. Addressing the cumulative impacts from a landscape perspective can improve water quality for all farmers as well as for people and nature.

WHAT THE FINANCIAL SECTOR CAN DO

The financial sector provides a whole suite of products, both directly to farmers and agribusinesses and along the value chain. Finance is a key sector that can help identify risks and impacts by fully integrating nature-related considerations into decision-making, and channel investments towards economic activities that enhance our ecosystems and encourage sustainable consumption and production.[223]

There is growing interest in financial mechanisms for agricultural systems that regenerate soils, restore ecosystems services and support rural communities and their value chains. For instance, a study mapped 127 US-focused investment funds, with assets worth US$321 billion, that explicitly integrate sustainable food and agriculture, with 70 of these specifically including criteria on regenerative agriculture.[224]

However, the finance sector is still largely failing to identify and manage the risks related to loss of nature and unsustainable land-use practices. In an assessment of 37 listed equity funds in the food and agriculture sector, Planet Tracker[225] found that asset managers largely fail to measure, manage and report the natural capital risks for their investments, and that they should align with sustainable food and agriculture systems to improve investment performance.

The following section presents a list of recommendations which can be adapted to all major financial institutions, including banks, insurance companies, asset owners and asset managers, and a non-exhaustive list of tools that can guide investors in managing nature-related risks in the food sector.

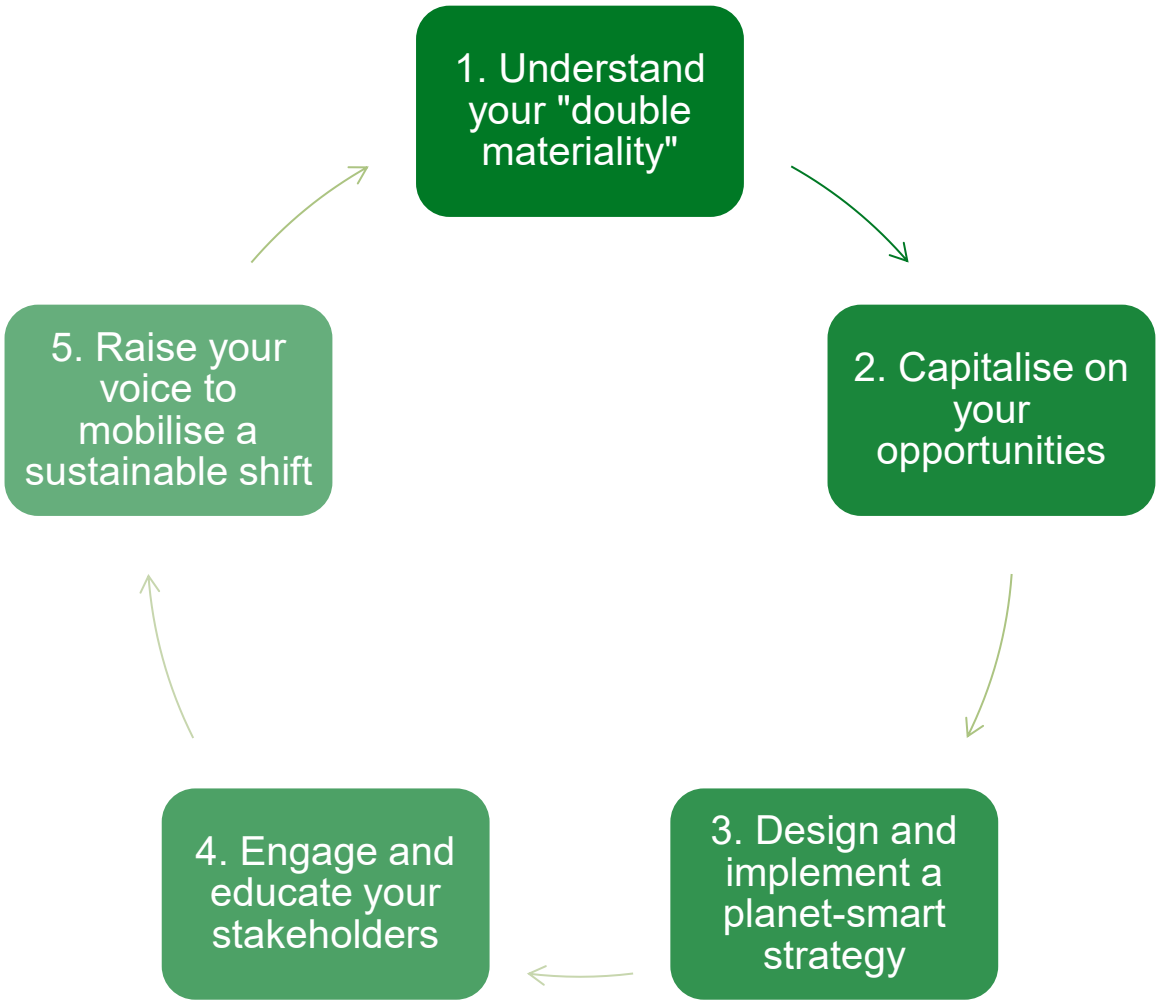


Figure 9: *The virtuous cycle that begins at home, but helps to shift the system towards more sustainable practice*

1: UNDERSTAND YOUR 'DOUBLE MATERIALITY' - BOTH NATURE-RELATED RISKS AND IMPACTS

In a nutshell: Financing unsustainable agribusiness both impacts on nature and can expose an institution to financial risk. Financial institutions should commit to assessing their impacts on nature from agribusiness investment and lending. They should also encourage agribusiness to be transparent about their sourcing and encourage them to support data capture, to better assess risks. A "Toolbox" approach may be necessary to assess, track and disclose double materiality, as well as understand baselines for impact and risk mitigation. Financial institutions should then track, monitor and disclose through established standards.

Assess, monitor, and disclose nature-related risks and impacts

Although investing in activities and practices that have positive impacts on nature are critical, the most important first step is to reduce the damage in the first place by recognising the practices driving us to planetary tipping points,[226] and how they might be related to a financial portfolio. Financial institutions should assess, monitor, and disclose their findings and progress in line with existing sustainable reporting standards. Through reporting, an organisation can build knowledge, identify priority risks, seize new opportunities and increase accountability. Public reporting also enables knowledge to be shared, best practices to be standardised, and regulators, researchers, and civil society to monitor and identify potential systemic risks.

We will outline some standards and tools to assess, monitor and disclose impacts and risks. However, we encourage the use of standards that go beyond carbon emissions reporting. In addition, we recognise the complexity of adequately assessing risks down supply chains and where land is not directly or completely owned. We therefore suggest a complementary analysis that tracks areas of greatest risk in a portfolio, for example financing to agribusiness, and reviews the materiality linked to asset-level data.

One of the most well-established reporting frameworks for risk assessment is the **Task Force for Climate Related Financial Disclosures (TCFD).**[227] The TCFD Guidance is closely aligned to other established sustainability reporting frameworks, like CDP, Climate Disclosure Standards Board (CDSB), and the Sustainability Accounting Standards Board (SASB). It supports companies to account for their carbon emissions, for the most part enabling financial sector actors to understand climate-related material risks that could affect portfolio companies. Reporting on climate risk is due to become mandatory in the UK and the same is being proposed elsewhere. However, the TCFD relies on company reporting, much of which gives only a fraction of the impacts and risks. The latest status report on the TCFD indicated that only 166 agriculture, food and forest products companies were reporting in 2018.[228] In addition, many agribusiness clients do not collect or report data on their impacts. It is therefore important to begin engagement to encourage adequate knowledge and information-sharing.

As we have shown in this report, viewing sustainability from the lens of carbon only provides part of the picture. In response, an informal working group comprised of 74 financial institutions, regulators and corporates stakeholders was launched to develop the **Task Force for Nature Related Financial Disclosures (TNFD).**[229] The TNFD, which is due to publish its recommendations in 2022, follows the reporting framework of the TCFD but will extend to both *nature-related risks and impacts*- so-called "double materiality". The TNFD will also be reviewing all relevant tools and datasets in this area, including food and land use, with a view to supporting standardisation of reporting.

A variety of other leading organisations are looking beyond carbon to understand impact and risk related to biodiversity loss, and to support progressive financial institutions to measure and manage their impacts. For example, the **One Planet Network's Sustainable Food Systems Programme** has published technical guidance on methodologies and tools for biodiversity metrics, with a specific focus on agricultural and fishery, food and beverage sectors.[230] In 2021, WWF will publish a thorough review of the best currently available tools and methodologies that aim to measure, analyse and report environmental impacts (including to nature and biodiversity) of financial portfolios. This review will explore emerging impact measuring and footprint tools that are taking a different approach from the more prevalent ESG ratings or climate risk assessment tools.

Biodiversity "footprinting" methodologies for the finance industry are increasingly being improved, focussing on quantifying the *impact* of a portfolio on nature. The **Business @ Biodiversity Platform**[231] created a summary report[232] on major biodiversity assessment approaches for businesses and financial institutions to understand impact, including a review of data costs and accessibility.[233] Many of these tools explicitly include land-use change and agribusiness impacts. In 2020, the **Finance for Biodiversity pledge**[234] was launched by a group of 26 financial institutions who formed part of the European Commission's EU Finance and Biodiversity Community (F@B) under the EU Business @ Biodiversity Platform. The **Finance for Biodiversity pledge** aims to reverse nature loss by 2030 by managing impacts of their investment and lending. They committed to knowledge sharing, engagement of client companies, assessing their impact on biodiversity, setting targets to mitigate impact, and reporting their progress publicly by 2024. Annex I provides more detail on existing methodologies that can be used by financial institutions.

At present, the **ENCORE**[235] **tool (Exploring Natural Capital Opportunities, Risks and Exposure**) is one of the few investor-ready tools available to track both impacts and risks related to agribusiness investment and lending. The tool can be used to understand and identify specific sectors' dependencies and impacts on ecosystem services and nature, at portfolio level. ENCORE was used by the Dutch Central Bank in its assessment of portfolio risk from dependencies on nature, which showed that 36% of Dutch financial institution portfolios are highly dependent on at least one ecosystem service, with fisheries, food and forestry being frontrunners.[236] Developed by the Natural Capital Finance Alliance (Global Canopy and UNEP FI) and UNEP-WCMC, the tool was released with a guide to banks[237] on how to conduct a natural capital risk assessment, from identification to assessment, management, monitoring and communication using the tool. In 2021, ENCORE will also release a biodiversity module that will enable biodiversity target setting, helping financial institutions understand how their agricultural and mining portfolios are aligned to global biodiversity goals, and the potential future risks and opportunities. The tool covers a wide range of ecosystem services, natural capital assets, impact drivers and production processes and 11 Global Industry Classification (GICs) sectors. It can be used for initial screenings, and the ENCORE Map page[238] can identify location-related relationships if asset locations are known. However, users should follow with spatially explicit and company-specific assessments and investigation into risks along the full value chain.

Understand the data gaps and collect primary data

Better production practices can reduce damage on-farm and to surrounding habitats from pollution and conversion of natural ecosystems. As we argue in this paper, agroecological principles are the primary way to mitigate broader risks and identify opportunities. But many of the tools and approaches available to monitor "double-materiality" at portfolio level have a barrier in common: standardised, decision-quality asset and supply chain data that can link a production facility to a geolocation. No global farm database exists, and data on production locations and practices in marine environments is particularly sparse. This makes it difficult to determine which risk mitigation strategies to put in place or understand how risk and impact could be transferred across value chains.

However, the depth and granularity of geospatial information that can support financial decision making (so-called “spatial finance”) is changing fast, spurred on by growing demand for more transparent supply chains and tools to collect complex data. The **Impact Observatory**[239] integrates artificial intelligence and consolidates sustainability data, providing tools for governments, NGOs and those seeking ESG solutions to monitor the health and impact of farming, settlements and resource extraction across an entire country or regional watershed.

For adequate, granular assessments, companies should be encouraged to establish monitoring systems that collect data at farm level and reward better performing individuals. Local-level indicators are undoubtedly the best for on-site biodiversity assessments. Agribusinesses and farmers can be encouraged to use tools such as the **Cool Farm Tool**[240] and metrics such as those in the box: '***Metrics for farmers to measure on-farm impact***'. These tools measure of how aligned producers are with agroecological practices and monitor progress on issues such as GHG emissions, biodiversity or water along their supply chain. Financial institutions can also refer to these to set baselines for improvement.

There is a rapidly growing body of specialised tools and initiatives being developed to encourage the collection of asset level data, to improve supply chain traceability and identify and risk to financing trade of high-risk commodities (see: Annex I). Existing data gaps should therefore not prevent financial institutions from starting to use some of the available tools to screen for risks and impacts in their portfolios or requesting that their business clients use them.

WHY CHANGE THE WAY WE MEASURE SUCCESS IN PRODUCTION SYSTEMS?

The IPBES global assessment[241] and Dasgupta Review[242] both highlight the need to radically change the way we measure success and move away from a focus on short-term output in a system based on unlimited linear growth crossing planetary boundaries. A proper measure of success in agriculture must take into account not only the raw production output (yield per hectare), but also the amount of external inputs required, the production of multiple resources on the same land, and the negative externalities that a system produces. It should look at quality as well as quantity; for instance, many touted high-yielding crops contain lower concentrations of micronutrients and secondary metabolites.[243]

Metrics for farmers to measure on-farm impact
Climate impacts and risks are primarily assessed by looking at a single indicator: GHG emissions. There is no equivalent single indicator for sustainable land management, although some proxies exist. Based on the work of among others the World Resource Institute,[244] we have identified some candidates that can work as proxy indicators of sustainable farming:

- Soil organic matter (carbon) content (tonnes of carbon per hectare)[xxxviii]
- Fertiliser and pesticide used per unit agricultural land (e.g. kilograms of nitrogen and phosphorous per hectare; tonnes of active chemical ingredient applied per hectare)
- Withdrawal of freshwater sources (chemical inputs and pollutants can also be measured)
- Indicators of agrobiodiversity (variety of crops per area, etc.) and biodiversity (e.g. mean species abundance). This measurement may need to be adjusted to reflect rotational land use by crop and on-farm versus off-farm biodiversity.

[xxxviii] In a landmark pilot study of the costs and benefits of transitioning to agroecological principles in the EU, soil health metrics were compared, with a final recommendation to look at the ratio of soil organic carbon to clay. Different soil types can support different levels of carbon content, but if the ratio of carbon to clay drops below 10% (or equivalently the clay:carbon ratio rises above 10), the soil’s structure becomes less able to retain water or nutrients to the same extent. This leads it to be more vulnerable to erosion. Source: SystemIQ, 20 Regenerating Europe’s soils: Making the economics work: https://www.systemiq.earth/wp-content/uploads/2020/01/RegeneratingEuropessoilsFINAL.pdf

The degree of intensification of a farm can also be a good proxy for environmental pressure. It can be measured e.g. following the approach used in the EU,[245] based on:

- Expenditure on inputs such as fertilisers, pesticides and feedstuffs per hectare of land
- Livestock density (number of animals per hectare).

Based on these indicators, the European Environmental Agency estimated that 61% of the total agricultural area in the EU is managed by farms of high to medium intensity, and 39% by low-input farming systems.

Changing the way that we measure success in agriculture should be an absolute priority. Using the wrong indicators affects the quality of research and knowledge, how subsidies and investment are distributed, and how companies are rewarded and evaluated. It is therefore important that financial institutions engaging with the sector are aware of these aspects.

2: CAPITALISE ON YOUR OPPORTUNITIES

In a nutshell: The financial sector has a key role to play in shifting incentives for better production and consumption. Innovative financial products and 'patient' funding will help mitigate risks and tap into opportunities to strengthen the company's reputation with stakeholders, improve resilience, lower operating costs and make more efficient use of resources. Opportunities also exist in the growing market for carbon storage in soils. Tools such as certification standards and sustainable taxonomies can be used by the finance sector to identify best-in-class operators and opportunities. Investing in nature-positive solutions should be part of an integrated approach that follows the so-called mitigation hierarchy: avoid and reduce damage, restore, and compensate for damage through positive contributions.

With more than 2 billion hectares of previously productive land now degraded,[246] a huge opportunity exists to restore land and turn it into production again. Globally this could lead to US$84 billion of economic benefit and generate both income and capital gains for investors.[247]

However, investing in nature-positive solutions and supporting green mechanisms should be part of an integrated approach which prioritises other actions first, following the so-called mitigation hierarchy:

- **Avoid** damage
- **Reduce** damage
- **Restore** nature
- **Compensate** through positive contribution.[248]

Such a strategy is necessary to reverse the loss of nature, as a focus on positive contributions alone will not be enough to compensate for the damage done in the first place.

To **avoid and reduce damage** to nature from financial products, a financier needs to identify which assets have the largest impacts and risks, and which companies and public institutions are more vulnerable – i.e. less able or willing to adapt, and the tools in the annex may provide a reference point. Likewise, it is important to explore opportunities to **restore nature** and **compensate** for nature loss, by improving the ability of clients or investees to adapt and improve resource efficiency, both internally and within the supply chain.

The financial sector has a key role to play in incentivising transformation to sustainable farming practices. Businesses adopting sustainable practices not only reduce risk but can reap benefits in the form of raised reputation among consumers and employees, and improved resilience and yields. Sustainable businesses often benefit from lower operating costs due to more efficient use of resources and reduced need for external inputs. They may also avoid higher operational costs and long-term risks and impacts by using resources sustainably (e.g. water and soil). Good management of soil and water resources also reduces climate-related risks, which will have increasing benefits as the global lens turns towards managing the climate crisis.

One way to identify better producers is to look for those with **sustainability standards**, such as **Regenerative Organic Certified (ROC**) – the world's first certification scheme that attempts to integrate the complete spectrum of agroecological practices. It requires that farmers build soil organic matter; practise conservation tillage, cover crops and crop rotations; do not use GMOs or gene editing, soilless systems, or synthetic inputs; and promote biodiversity and rotational grazing. Financiers can use this to identify which clients may be eligible for support or green financial solutions. Some of the first companies that are incorporating ROC into their supply chains are Patagonia Provisions, Nature's Path and Lotus Foods.

"THE FINANCIAL SECTOR HAS A KEY ROLE TO PLAY IN INCENTIVISING TRANSFORMATION TO SUSTAINABLE FARMING PRACTICES. BUSINESSES ADOPTING SUSTAINABLE PRACTICES NOT ONLY REDUCE RISK BUT CAN REAP BENEFITS."

Similarly, the **EU 'Green' Taxonomy** is being developed and will in the future likely also legally categorise sustainable agricultural activities. This can support investors in a transition to a low-carbon, resilient economy (see: Box). Complementary 'blue' taxonomies are also being developed for investors who want to support sustainable oceans and freshwater systems. Standards that more broadly support better 'green' investment practices include the **Green and Sustainable Bonds Standards**, which certify low-carbon activities[xxxix] and can apply to sustainable diets, waste management and agricultural activities.

One of the many positive side-effects of adopting agroecological practices is **carbon sequestration,** which will become more relevant as **global carbon markets grow**. The ability of soils to capture significant amounts of our carbon emissions is one of the most impactful nature-based climate solutions. The '4 per 1000' initiative[249] – launched at COP21 by France – aims at increasing soil carbon stocks at a rate of at least 0.4% per year. This could offset a significant share of humanity's annual emissions, while improving soil fertility and agricultural production. However, some caution around transforming carbon sequestration into a marketable activity is needed, as estimates of the potential for soil carbon sequestration are uncertain[xl] and the real impact can be limited by, among other things, failing to account for carbon moved from one place to another through material cycles (e.g. waste).

[xxxix] For example, the EU has published a Green Bond Standard to prevent greenwashing: https://ec.europa.eu/info/business-economy-euro/banking-and-finance/sustainable-finance/eu-green-bond-standard_en. The Climate Bonds Standard and Certification Scheme has also published sector-specific eligibility criteria for assets and projects that can be used for climate bonds and green bonds: https://www.climatebonds.net/standard

[xl] For an in-depth discussion of these challenges, we refer to WRI (2020). Further Explanation on the Potential Contribution of Soil Carbon Sequestration on Working Agricultural Lands to Climate Change Mitigation. https://www.wri.org/blog/2020/08/insider-further-explanation-potential-contribution-soil-carbon-sequestration-working

THE EU TAXONOMY FOR SUSTAINABLE ACTIVITIES

The EU Taxonomy Regulation introduces a classification system to define which economic activities can be considered as environmentally sustainable, setting a common language for financial institutions, companies and policymakers and introducing new reporting requirements. The Taxonomy will also likely be used to build environmental tax incentives, secure green public procurement and ensure the sustainability-proofing of public investments.[250] Financial institutions will be required to track and report on the proportion of their portfolios that is aligned with the EU Taxonomy.

To be defined as sustainable, an activity must:

- **Contribute to at least one of six environmental objectives**: (1) climate change mitigation; (2) climate change adaptation; (3) sustainable protection of water and marine resources; (4) transition to a circular economy; (5) pollution prevention and control; and (6) protection and restoration of biodiversity and ecosystems. Compliance is defined through adherence to performance thresholds (referred to as 'technical screening criteria') that are set for every economic activity.
- **'Do no significant harm'** to the other five objectives.
- Comply with **minimum social safeguards** and the **technical screening criteria**.

For the food sector and agriculture, criteria are still under discussion. The first draft proposal included a set of requirements in line with the agroecological principles outlined in this report. The EU Taxonomy's Expert Group explicitly supported the principles of agroecology, noting that these are 'no-regret' measures that have benefits for many aspects of the environment.

3: DESIGN AND IMPLEMENT A PLANET-SMART STRATEGY

In a nutshell: Financial institutions should design and implement a strong strategy to manages both risks from and impacts on the environment through their investment and lending. A strong strategy can begin with a risk and impact assessment to identify high-risk and high-impact areas of their portfolio, with attention to investments and lending associated with the agribusiness industry. Thereafter, make a strong commitment to manage those risks and impacts, with a target date. Carve commitments and company principles into the organisation's policy, to ensure that actions are more likely to be supported from within the institution. Establish a team that includes voices from critical stakeholders. Set out a risk and impact mitigation plan, and reporting and accountability mechanisms.

A strong, planet-smart strategy and implementation plan is necessary to manage risks and impacts across a financial portfolio. Financial institutions can use the tools above to do an initial risk and impact assessment, drawing on external expertise where needed. Thereafter, the following steps can help financial institutions and the companies they finance to take effective action to mitigate the identified risks and impacts:

1. **Set bold, time-bound commitment** to manage impacts and risks in priority areas, such as agribusiness. A time-bound commitment identifies a broader goal rather than a key performance indicator, such as “share of producers adopting sustainable agroecological practices”.

The lack of a ‘Paris Agreement for nature’ is often cited as an obstacle, yet there are internationally agreed frameworks that can be used to set targets. In 2010, the **UN Convention on Biological Diversity (CBD)**[251] identified a set of 20 targets (the Aichi Biodiversity Targets) to be met by 2020; these have unfortunately been largely ignored, and few were met. A robust and ambitious post-2020 global biodiversity framework is expected to be agreed at the next CBD COP later this year. The **UN Sustainable Development Goals**[252] include a number of food sector-relevant targets on soil degradation, genetic agrobiodiversity, fresh water and food waste.

2. **Carve commitments and principles into institutional policies:** the company should set out its position and objectives in relation to nature-related risks and impacts and why sustainable food systems are a focus area. Set out the principles of sustainable food systems and priority areas across portfolios, whether on the production side (agriculture), demand side (dietary trends), food waste or all of these.

3. **Establish a team:** a strong implementation plan needs a strong team, one that can help navigate the internal and external landscape of stakeholder. Ensure that key voices from stakeholder groups are represented, if not in the Managing Team, through other engagement opportunities at semi-regular intervals. Ensure adequate representation of decision-makers and establish responsibilities, reporting mechanisms and accountability mechanisms.

4. **Establish a mitigation plan:** A plan to execute the strategy should set a realistic scope, analyse resource, capacity and information gaps and assess timescales to achieve commitments. Key performance indicators (KPIs) for target-areas can be helpful in assessing the current baseline and managing progress. Define the range of tools that will be used to induce companies to meet the expectations described in the policy, e.g. active ownership, ratings, divestment, positive investing, etc. Financiers should also ensure that processes are in place to implement and monitor compliance with policies throughout the life of the relationship, including implementing due diligence processes, safeguards and action plans. Establishing protocols and successive actions expected in the case of non-compliance with company policy is also necessary, including escalation protocols. In reality, this may take several years and require additional external support from experts, advisors and knowledge-sharing industry platforms.

PRINCIPLES AND PLATFORMS THAT SET THE BAR ON SUSTAINABLE PRACTICE

Some high-level international frameworks specific for food and agriculture are available to financial institutions and businesses to help support their understanding of how to manage risk and impact:

- The FAO's Committee on World Food Security set out the **Principles for Responsible Investment in Agriculture and Food Systems,**[253] a set of 10 principles that apply to all types and sizes of agricultural investment including fisheries, forests and livestock. They address the core elements of what makes investment in agriculture and food systems responsible, including contributing to food security and nutrition and preventing negative environmental impacts.
- **The United Nation's Principles of Responsible Investment in Farmland**[254] provide a set of guidelines within the broader Principles for Responsible Investment (PRI) framework that are tailored to farmland investment. They promote environmental sustainability, labour and human rights and uphold business standards.
- **The OECD-FAO Guidelines for Responsible Agricultural Supply Chains**[255] provides an industry-orientated general framework to help companies across the entire agricultural supply chain, as well as financial institutions, to identify, assess and mitigate potential negative impacts associated with their business.
- **The Global Reporting Initiative (GRI)**[256] provides a common set of global best practices for public reporting on the *impacts* of company activities on issues like climate change, human rights and corruption. The GRI has developed a sector standard for agriculture and fishing[257] to identify the most significant impacts, which should be released by the end of 2021.

4: ENGAGE AND EDUCATE YOUR STAKEHOLDERS

In a nutshell: Strategies and policies should be anchored within the organisation, providing staff with the necessary knowledge to implement change. Likewise, it is important to continually engage external stakeholders so that they are aware of the priorities of the organisation. Financial institutions should identify relevant companies for engagement, encouraging them to set sustainable food transition plans with clear targets, manage their impacts and define escalation strategies where engagement efforts do not lead to results.

In general, management of nature risks should be anchored in the organisation at the level of the board, trustees and executives. Often, this means an internal engagement plan is needed to educate and inform internal employees, senior colleagues, management committees and key stakeholders in other legs of the business.

Building internal relationships and securing agreement from senior management is an essential, although time-consuming, process. Some key elements to consider include empowering teams to understand nature-related risks through appropriate training and establishing partnerships with experts to gain a deeper understanding of the field. It is also essential to ensure that staff are well resourced, and that there is a clear identification of roles and responsibilities for implementation.

At the same time, it is important to continually engage external stakeholders, so that they are aware of the priorities of the organisation as early as possible. Engagement with individual farmers as clients may be possible if there is direct lending to production facilities. Understanding the challenges of the farmer in identifying and managing environmental risk is a key starting point.

However, in practice, relationships with agribusiness may be primarily through retailers, key traders and buyers, seed producers, and agrochemical companies that are consolidated and more likely to be publicly listed and have a global presence. An institutional investor is more likely to have more influence through these channels, unless they engage directly with governments after purchasing government bonds. As with the global energy industry, a few key actors tend to be centre points for most of the broader impact, through their supply chains.

Encourage companies to set sustainable food transition plans with clear targets, join industry platforms and put in place performance metrics. Speak to them about managing business impacts, but also putting in place strategies for supply chain impacts.

Companies should have a phased but timebound approach to develop their own strategies and implement mitigation measures on their nature risks. Investors can also prompt companies to set these **time-bound quantitative targets**, for example, to reduce food waste and outline a plan for implementation and reporting/monitoring along the way.[xli]

"COMPANIES SHOULD HAVE A PHASED BUT TIMEBOUND APPROACH TO DEVELOP THEIR OWN STRATEGIES AND IMPLEMENT MITIGATION MEASURES ON THEIR NATURE RISKS."

In order to accelerate the transition to Paris alignment, the **Science-Based Targets initiative**[258] was launched with partners such as CDP, UN Global Compact, World Resources Initiative and WWF. The targets currently enable corporates to identify how much and how fast they should reduce their GHG emissions to be in line with the ambitions of the Paris Agreement. The framework is being further developed to align with planetary boundaries beyond climate, which include food-relevant areas such as land-use, biodiversity, freshwater and oceans. The initial guidance on **Science-Based Targets for Nature**[259] allows companies to start the process of target settings today, although the final methods will be ready by 2022. Forest, land and agriculture targets are currently being scoped to develop GHG emissions targets by the end of 2021.

This is where requests for disclosures and reporting that can provide benchmarking against other companies can be helpful, both for financial sector actors to understand portfolio constituents and for food companies to understand where they can improve. Benchmarking can also prove useful. The **World Benchmark Alliance's Food and Agriculture Benchmark**[260] evaluates the commitments of the world's 350 most influential food and agriculture companies across three key topics underpinning the food systems transformation agenda: environment, nutrition and social inclusion. It has now extended the assessment to the most influential financial sector companies.

[xli] In setting targets, ensure that ambition is adequate. For example, for targets on food waste, they should at least be on the same level of ambition as the SDG target of halving per capita food waste at retail and consumer levels. The EU Commission has recently announced that it will propose, by 2023, legally binding targets to reduce food waste across the EU.

5: RAISE YOUR VOICE TO MOBILISE A SUSTAINABLE SHIFT

In a nutshell: Progressive financial institutions should ensure that their actions are amplified to achieve a wider impact and strengthen the market for sustainable food systems. Policies should be made public and success and progress should be effectively communicated to companies and service providers. Reporting should include sufficient information about the results of engagement with portfolio companies. Financial institutions should join the public debate, engage policymakers and join relevant investor alliances and other fora to pool efforts and share knowledge and experiences. Communicating successes but also challenges and lessons learned can enable better performance. Incentivising better practice is not only about financing "greener" activities, but also enabling change of business-as-usual practices.

Progressive financial institutions should ensure that their actions have a signalling effect to amplify efforts, achieve broader impact and strengthen the market for sustainable food systems. Given the urgent threats that loss of nature poses, this signalling effect is critical to raise awareness among all relevant stakeholders.

Engaging in the public space allows for lessons to be learned and shared, and new ambitions to be set once the original ones are achieved. This can enable a snowball effect where engaged companies become leaders beyond their peers and effectively raise the bar on industry standards of practice.

Financial institutions should also provide information about their engagement activities with portfolio companies/customers, directly or through investment managers (e.g. names of portfolio companies engaged with or divested, questions asked, type of engagement, filing of shareholder resolutions and voting at AGMs), as well as monitor the KPIs towards the outcomes set in the policy.

Financial institutions can also engage more widely with policymakers and regulators, for example by sending inputs to open consultations on new legislation. Policymakers can act to support incentives for both companies and the financial sector, and to create an enabling environment that can manage risks associated with new ventures.

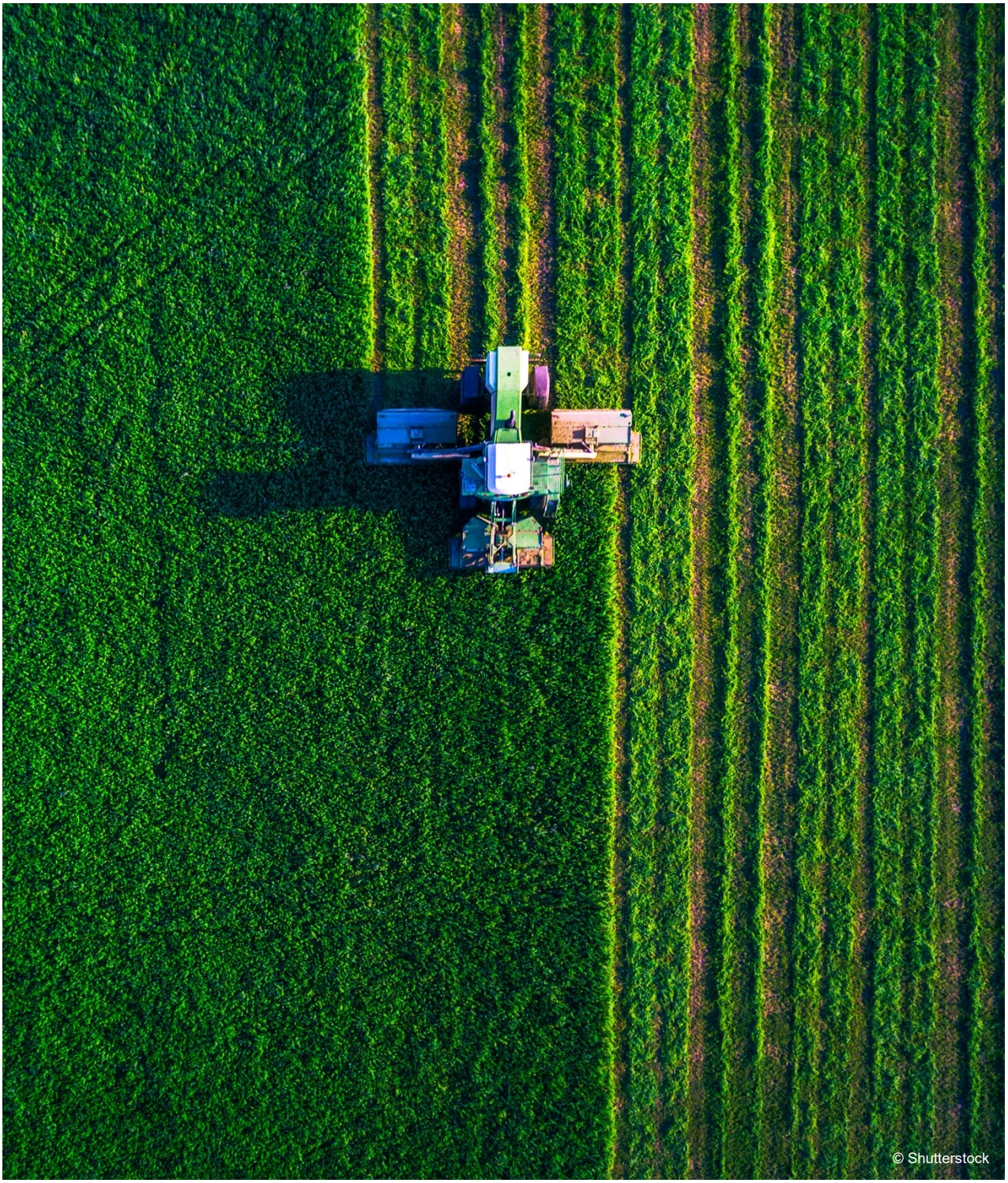
Engaging with large agribusiness conglomerates can also be done via investor alliances that pool power and allow financial institutions to keep pace with industry leaders.

Examples of investor-led initiatives and knowledge-sharing forums include:[xlii]

- **United Nations Principles of Responsible Investment (UN PRI)[261]** is an investor initiative to help members understand the investment implications of ESG factors, and hosts working groups related to food and agriculture.[262]
- **Coller FAIRR Investor Initiative[263]** works with its industry members to demonstrate ESG issues related to unsustainable industrial farming.
- **Business for Nature coalition** was created by the World Business Council for Sustainable Development, the World Economic Forum, the International Chamber of Commerce, We Mean Business and others.
- **EU Business @ Biodiversity Platform,[264]** set up by the European Commission, provides a forum for dialogue and policy interface to discuss the links between business and biodiversity and help businesses integrate natural capital and biodiversity considerations into business practices.

[xlii] The list is meant as an initial guide to the landscape. It is non-exhaustive and WWF has not assessed all initiatives in terms of the quality of their work and the resources they provide.

- **One Planet Business for Biodiversity** (OP2B)[265] is a business-led coalition aimed at contributing to the agenda and pillars of the CBD and transforming existing food and agricultural models to achieve positive impact on human and planetary health.
- The **Consumer Goods Forum**[266] is an industry platform that provides support to members to meet targets for improved value chains, including on ESG criteria. It comprises eight coalitions geared at improving data, health, food waste, plastic, forests, human and labour rights, sustainable supply chains and global food safety, as well as 30+ regional and global working groups. Financial sector actors and companies can join as members.



CONCLUSION

The complex supply chains and conventional, damaging practices of global food systems house an array of environmental, social and health issues that are aggravated by short-termism and lack of transparency. These materialise as a range of risks at business level and in the form of systemic risk. Mitigating these risks and transforming food systems will require a broad range of efforts across the spectrums of sustainable diets, managing food waste and sustainable production practices.

Supporting producers to adopt agroecological approaches is a key strategy to mitigate much of the damage outlined in previous chapters. Agroecological practices take a landscape perspective on land management to foster synergies between agriculture and biodiversity. They actively conserve, use, improve and sustain biodiversity at different scales, from genetic diversity to ecosystem diversity.

While unsustainable activities in agriculture constitute a material risk for businesses and their financiers, we also need to acknowledge that today's market largely fails to capture and internalise such risks. Most current market incentives, including the pressure of shareholders, make it still profitable for companies to continue with an extractive paradigm in agriculture, thinking short term while ignoring sustainability. The financial sector largely supports this paradigm due to how portfolios are built, performance is rewarded and risk is measured. This is possible because the negative consequences and the costs associated with them are externalised to society as a whole, meaning that no-one assumes the responsibility of management – until such a time as a cure is needed. By then, the time for preventative measures will be well over.

"WHILE UNSUSTAINABLE ACTIVITIES IN AGRICULTURE CONSTITUTE A MATERIAL RISK FOR BUSINESSES AND THEIR FINANCIERS, WE ALSO NEED TO ACKNOWLEDGE THAT TODAY'S MARKET LARGELY FAILS TO CAPTURE AND INTERNALISE SUCH RISKS."

Changing this dynamic is not easy. Short-term gains in production are represented by well-defined, organised interests, while the services that ecosystems provide, like healthy soils and fresh water, are not represented by a defined category of interest but benefit society as a whole. So far there is little evidence that businesses are willing to lobby for changes that would increase their costs, reduce their profits or put limits on their extraction of natural resources and thus their ability to grow.

While short-termism remains a key barrier to sustainability, the loss of nature is becoming so visible and dramatic that we see both a moral and economic argument for reversing the trends, especially for financial institutions with a longer-term horizon and with a serious commitment to sustainability.

Interestingly, several institutions are making a strong business case for investing in agroecological practices and consider soil health the most important of the economic fundamentals. The World Business Council for Sustainable Development[267] makes a compelling case for investing in soil health, building on case studies to show how gains can derive from maintaining or increasing revenues, reducing or avoiding costs, enhancing reputation or opening up finance opportunities.

The Boston Consulting Group[268] also makes a clear business case for sustainable agriculture, highlighting the risks for businesses in the food sector not taking biodiversity and nature into account, mentioning positive examples such as Unilever, which has announced a new regenerative agriculture code for all its suppliers. The outdoor clothing company Patagonia helped establish Regenerative Organic Certification and is piloting its uptake on over 550 cotton farmers. The One Planet Business for Biodiversity (OP2B) initiative, launched at the United Nations General Assembly in 2019 and counting

21 corporate members, promotes actions around three pillars, one of which is the scaling up of regenerative agricultural practices.

This is not only about large food companies. Sustainable agriculture is found to be generally more economic for small-scale farmers as well because the input costs (fertiliser, irrigation, etc.) are significantly smaller. This improves their food security as it makes it easier to buy needed supplies.

It is key that financial sector players understand their role in enabling a shift to sustainable practices. Since a transition from one model to another requires time and can lead to a temporary reduction in production during the first period, it is necessary to provide 'patient funding' for the transition.

"THE FINANCE SECTOR URGENTLY NEEDS TO ACT TO ADDRESS THE RISKS OF TODAY'S INDUSTRIAL FOOD SYSTEM, AND REALISE THE OPPORTUNITIES THAT SHIFTING TO A SUSTAINABLE FOOD SYSTEM WILL BRING."

Finance actors can define policies that outline best practices and expectations for companies in the food sector, with a focus on concrete practices to be applied on-farm. Banks can require that clients comply with a set of sustainability criteria in order to access financing, or design loans linked to transition plans towards sustainable agricultural practices. Investors will typically have less hands-on actions, and more of a wider portfolio approach. In this case, strong policies outlining expectations and requirements to companies can be an important tool. Investors can also contribute to developing tools that allow them to screen portfolio companies based on their agricultural practices and results.

Climate change and nature loss are tightly interwound, and both will define how our economic systems and our societies shift over the next decades. Our food system is the key driver of nature loss as well as a major contributor to climate change, with costs to the global economy running into trillions of dollars. Yet it also holds the greatest potential to halt and reverse the loss of nature to replenish the vital services that ecosystems provide, as well as huge opportunities to reduce GHG emissions and sequester carbon through nature-based climate solutions – all of which will bring significant environmental, social and economic benefits. The finance sector urgently needs to act to address the risks of today's industrial food system, and realise the opportunities that shifting to a sustainable food system will bring.


ANNEX I:
METRICS AND TOOLS FOR MANAGING PORTFOLIO-LEVEL BIODIVERSITY RISK
© Unsplash

ANNEX I: METRICS AND TOOLS FOR MANAGING PORTFOLIO-LEVEL BIODIVERSITY RISK

At company and portfolio level, a variety of online tools and databases exist to provide information on investment-level risk and impact. While many broad, generalist databases have their limitations, they can provide an indication of risk hotspots. Tools are emerging to assess and score the impacts of financial portfolios, as well as companies or projects, on biodiversity. Though not limited to the agriculture sector, most of these tools measure portfolio impacts on species and biodiversity and specifically land use change, which is where much of the impacts are measured. Broadly, most of these tools focus on impact rather than risk, and many do not drill down to asset-level impacts and risk. Information that includes marine production is also quite sparsely covered. More information is covered in the EU **Business @ Biodiversity Platform** summary guidelines.[269]

Biodiversity "footprinting" tools and data for financial institutions

Corporate Biodiversity Footprint (CBF) expanded for Financial Institutions[270] is a methodology currently under development by Iceberg Data Lab and I Care & Consult for a consortium of actors including Axa, BNP Paribas, Sycomore Asset Management and Mirova. The tool is based on the Corporate Biodiversity Footprint, a metric quantifying the impact on biodiversity of corporations across their activities, although risk metrics may be added in 2021, as will monetization options. It is being expanded to allow investors to quantify the biodiversity impact of constituents of financial portfolios and subsequently enable financial institutions to integrate that impact into their investment strategies. Food is identified as a key sector with a focus on land use.

Biodiversity Footprint for Financial Institutions (BFFI)[271] is a methodology used by the Dutch ASN Bank and developed by PRé Consultants and CREM.[272] It is used to calculate the biodiversity impact (although risk metrics are due in 2021), in terms of an the Potentially Disappeared Fraction (PDF) of species over space and time across all sectors and countries, for the businesses the bank invests in, including the value chains – and across a wide range of financial asset categories. The result measures impact on biodiversity in PDF/ha/year, which can be translated per Euro invested. The footprint result shows how the biodiversity impact hotspots relate to the different investments of the bank across the portfolio and where in the value chains linked to these investments the impact is highest and why. The BFFI integrates relevant production-level data in the input-output database Exiobase, to assess what land use, water use, and emissions are linked to business activities, and include Life Cycle Analysis databases like the World Food Database and Agrifootprint database.

Global Biodiversity Score for Financial Institutions (GBSFI)[273] is a commercial tool used by financial institutions to measure the footprint of their portfolios on biodiversity, over space and time, across all countries and sectors, with risk metrics to be added in 2021. Created by CDC Biodiversité's B4B+ Club and the University of Cambridge's Institute for Sustainability Leadership, it demonstrates the biodiversity footprint in mean species abundance per square kilometre, ranking a portfolio's economic activities by pressure on biodiversity (land use, fragmentation of natural ecosystems, human encroachment, infrastructure, atmospheric nitrogen deposition, climate change), and creating a measure of the 'footprint' of a portfolio. As it is a spatially-explicit, tailored-approach, a minimum level of data must be provided by the financial institution.

Biodiversity Impact Assessment (BIA)[274] is a commercial tool developed by Carbon 4 Finance and CDC Biodiversité focussing on impact and building from the GBSFI methodology. To be launched in Q2 of 2021, the BIA will be suitable for calculating the footprint of listed equities and/or corporate and sovereign bonds. It will be spatially explicit, incorporate a link between pressures, drivers and impacts and cover both terrestrial and aquatic biodiversity.

Species Threat Abatement and Restoration (STAR)[275] is a biodiversity metric tool used by financial institutions to assess the impact of their assets on biodiversity. Based on the IUCN Red List of Threatened Species, it is used to measure the existing or past impacts of investments on important species at site, land management unit, province or country level. STAR can provide a way to avoid conservation impacts before investment activities commence. Its strength is that it can be used to achieve on-site conservation outcomes, including restoration, in the form of a global heat map at 5x5km resolution. Star will soon be incorporated into ENCORE. STAR data layers will also become accessible via a free early-access programme through the **Integrated Biodiversity Assessment Tool (IBAT)** in 2021**.**

The Integrated Biodiversity Assessment Tool (IBAT)[276] is a platform that offers access to the key global nature/biodiversity related datasets of the World Data Base of Protected Areas (WDPA), Key Biodiversity Areas (KBAs) and the IUCN Redlist, as well as a variety of resources. It is most useful for biodiversity risk screening for project finance. Users can import their own asset locations and screen for biodiversity risks. To date it has been used primarily by financial institutions that have asset level data.

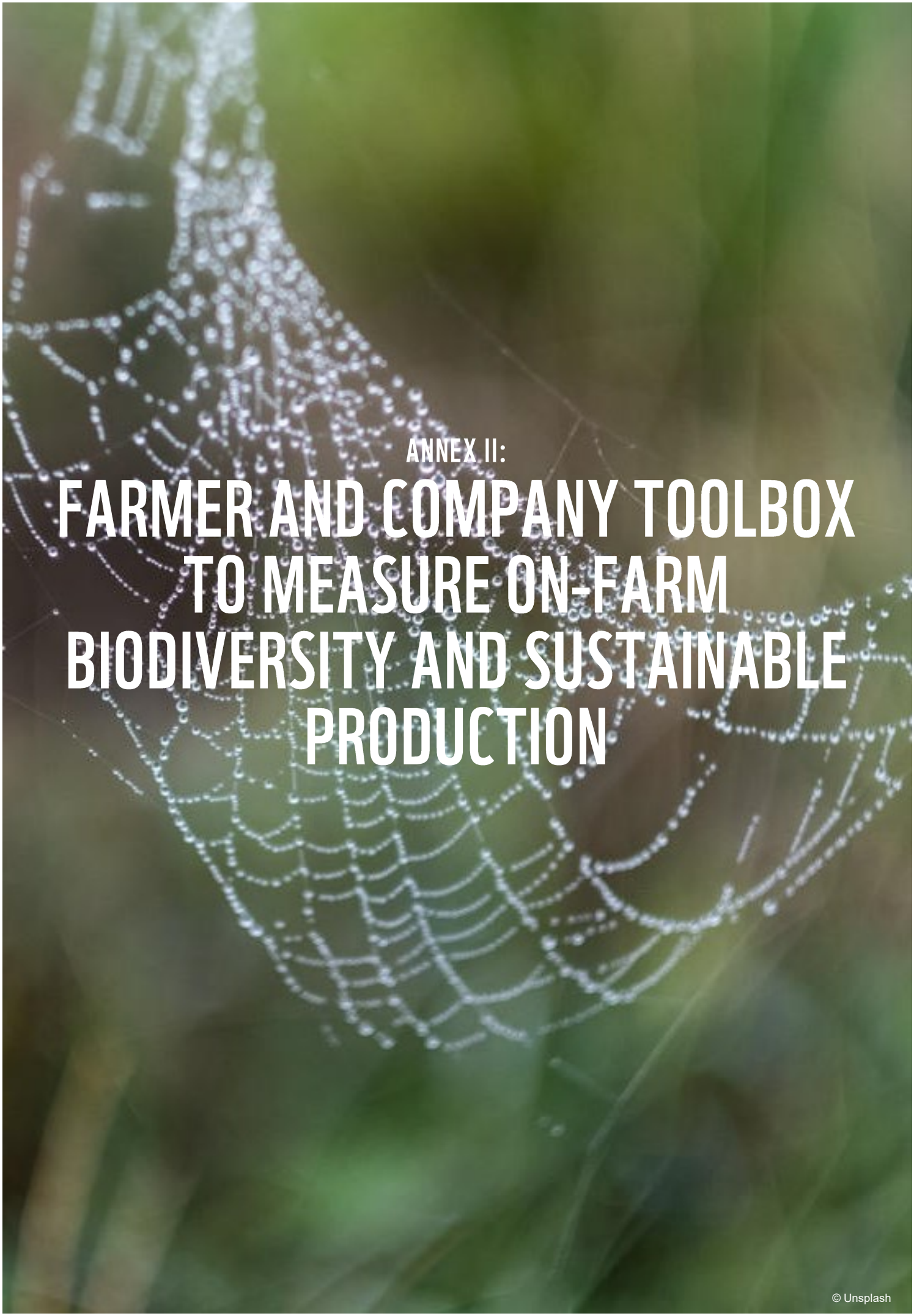
Accounting for off-site impacts and reducing deforestation

Sustainable agricultural practices are key to shifting to a sustainable food system. Much of the restorative aspects of sustainable agroecology mean that expanding into forests and using excessive chemical inputs that damage soils and waters is not necessary. Many commodities that are usually farmed as expansive monocultures, are often at the frontiers of conversion of biodiverse ecosystems like wetlands, savannahs and forests and can be associated with higher incidence of social and human rights issues.

Producing such commodities can be a reputational risk, and a variety of certification exist to show that they are sustainably produced. The **Global Map of Environmental and Social Risks in Agro-Commodity Production (GMAP)**[277] was developed to understand the environmental and supply chain risks of financing the trade of certain agricultural commodities. Developed by WWF and the IFC, GMAP is an established tool that maps risk across 250 country-commodity combinations. It enables risk assessment for trade financiers, provides sourcing information, and lists certifications available for each country-commodity in line with the IFC Performance Standards on Environmental and Social Sustainability.

For investors and lenders who want to screen their portfolios for particular companies that are linked to high-risk commodity trade, the **Trase.Earth tool**[278] has been developed by Global Canopy to provide advanced transparency into sensitive global supply chains. Trase is a free tool that can be used to estimate company and country contributions to deforestation. It can be used to identify high-risk players and expose potential company-level reputational risks. It's counterpart, **trase.finance**[279] provide intelligence to link companies and financiers to heightened deforestation and conversion risks.

A rising number of initiatives have been launched to help companies and financiers understand what constitutes habitat conversion and share knowledge on best practice. The **Accountability Framework initiative**[280] provides a common framework to align understanding and targets related to deforestation and ecosystem conversion. Businesses that **align with the Accountability Framework** have established monitoring and verification frameworks for deforestation, and policies and accountability mechanisms that demonstrate they are adhering to best practice.



ANNEX II:

FARMER AND COMPANY TOOLBOX TO MEASURE ON-FARM BIODIVERSITY AND SUSTAINABLE PRODUCTION

ANNEX II: FARMER AND COMPANY TOOLBOX TO MEASURE ON-FARM BIODIVERSITY AND SUSTAINABLE PRODUCTION

Tool name	Description	Audience	Applications
Tool for Agroecology Performance Evaluation (TAPE), *full monitoring and reporting framework for sustainable production*	Developed by FAO and other partners, a comprehensive tool that aims to measure baselines, set targets and report on progress, measuring the multi-dimensional performance of agroecological systems across the different dimensions of sustainability.	Governments, policymakers and public actors monitoring and setting targets for food companies and producers, enabling financiers and policymakers to monitor progress.	The tool can be used to establish a baseline of agricultural sustainability for project design, monitoring and evaluation, and to diagnose and compare the performance of different agricultural systems over time. It can help the adaptation and re-design of research and development programmes, rural advisory services and extension programmes to properly address sustainable agriculture in the context of the SDGs, including SDG 2.4.1 (sustainable agriculture), SDG 1.4.2 (land rights) and SDG 8.6.1 (biodiversity).
EU's FaST[xliii] *digital service for monitoring and regulating farms*	An EU-supported digital service platform where capabilities for agriculture, environment and administrative simplification are made available to stakeholders, informed by satellite data and imagery.	Farmers, member states, researchers, private actors, advisors and farm association, for national and regional CAP agencies, policymakers and government agencies.	Farmers can access reliable data to monitor environmental targets, and as the indications provided by FaST are in line with EU regulation, government and advisory agencies/associations can monitor farmer compliance, fast-track farmer access to finance and implement landscape approaches.
Agrobiodiversity Index[xliv]	The index aims at detecting agrobiodiversity-related risks and opportunities by measuring biodiversity across three domains: nutrition, agriculture and genetic resources. It is an action-oriented tool that identifies policy and business levers, good practices and areas for improvements, risks and opportunities, to increase use and	- **Companies** to reduce risks in the supply chain, enhance environmental stewardship and improve the sustainability of their production. - **Investors** to rate the policies and performance of food and agriculture companies, and make appropriate decisions.	Can be used to assess and compare agrobiodiversity among countries, companies or projects. The team is also exploring how the tool can be used by financial sector to leverage investments for sustainable food systems. For example, it could help produce a baseline assessment of the status of agrobiodiversity in specific areas where interventions financed through bonds are planned and monitor progress.

[xliii] https://fastplatform.eu/whyfast#farmers
[xliv] https://www.agrobiodiversityindex.org/

	conservation of agrobiodiversity for sustainable food systems.	- **Governments and development partners**, to design and monitor policies and interventions and measure progress	
The TEEBAgriFood Framework	This framework evaluates all significant costs and benefits of agriculture and food systems, including their externalities, whether economically visible or invisible. The framework includes natural, human and social capital in addition to produced capital, and can be applied to a wide range of analyses – from policy scenarios, to different diets, to the accounts of society. A TEEBAgriFood assessment helps to understand where, along the food value chain, multiple costs as well as benefits are occurring.	Researchers, policymakers, farmers, companies and financiers	Companies in the food sector can use this framework to identify the main impacts and dependencies of their operations, and financiers can use it to differentiate between businesses.
Biodiversity Performance Tool (BPT) for the food sector[xlv] *for setting a biodiversity action plan and monitoring and reporting on results*	Supports understanding of the current biodiversity situation at farm level in order to propose an action plan to preserve or promote biodiversity. Tested on more than 70 farms, the tool is already operational.	Farmers, farm assessors, certifiers, product and quality managers of food companies, and standards agencies	Supports operationalisation of biodiversity criteria to select measures for a biodiversity action plan, and can be used in conjunction with the Biodiversity Monitoring System, which enables standards and food companies to monitor the biodiversity performance of certified farms and supplying farmers.
The Gold Standard for value-chain intervention[xlvi] *for companies that want to understand their scope 3 and value chain emissions, and*	Developed by Danone, Gold Standard, Livelihood Funds, Mars, the Science Based Targets initiative and TREES Consulting, enables reporting on emissions reductions on farms, to measure and	Private food companies, including retailers and buyers, as well as financiers looking to align incentives to net zero and manage scope 3 emissions.	Supports companies to calculate and reduce scope 3 GHG emissions and address value chain emissions.

[xlv] https://ec.europa.eu/environment/biodiversity/business/news/news-223_en.htm The tool is recommended among others by the recent publication by UN Environment Programme World Conservation Monitoring Centre (2020). Biodiversity Measures for Business: Corporate biodiversity measurement and disclosure within the current and future global policy context.

[xlvi] Danone, 2020, Gold Standard: https://www.goldstandard.org/sites/default/files/documents/2018_09_scope_3_guidance_testing_draft_v1pdf.pdf

manage carbon impact	manage 'scope 3' emissions, in alignment with the GHG Protocol.		
Biodiversity Monitor for Dairy Farming[xlvii] *full, specialised environmental monitoring and reporting framework for dairy farmers*	A tool that defines output-orientated KPIs to quantify biodiversity results and the influence of individual dairy farms to measure biodiversity on the farm and beyond, developed by WWF-Netherlands, Friesland Campina and Rabobank. Examples include percentage permanent grassland, protein produced by farmer, nitrogen in soils, kg ammonia emissions/ha etc.	Corporates, financiers, farmers in the dairy industry	Used to assess the performance and risks of the dairy sector with KPIs to quantify benefits to reward farmers that prioritise biodiversity.

[xlvii] http://biodiversiteitsmonitormelkveehouderij.nl/docs/Biodiversiteitsmonitor_engels.pdf

ENDNOTES

[1] WWF (2018). Living Planet Report. https://wwf.panda.org/knowledge_hub/all_publications/living_planet_report_2018/
IPBES (2019). Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. https://www.ipcc.ch/srccl/chapter/summary-for-policymakers/
Willett, Walter, Johan Rockström, Brent Loken, Marco Springmann, Tim Lang, Sonja Vermeulen, Tara Garnett, et al. (2019). Food in the Anthropocene: The EAT–Lancet Commission on Healthy Diets from Sustainable Food Systems. The Lancet 393, no. 10170: 447–92. https://doi.org/10.1016/S0140-6736(18)31788-4
[2] Croplife (2015). Agriculture: a $2.4 trillion industry worth protecting. https://croplife.org/news/agriculture-a-2-4-trillion-industry-worth-protecting/
[3] McKinsey (2015). Pursuing the global opportunity in food and agribusiness. https://www.mckinsey.com/industries/chemicals/our-insights/pursuing-the-global-opportunity-in-food-and-agribusiness#
[4] WRI (2021). Just 7 Commodities Replaced an Area of Forest Twice the Size of Germany Between 2001 and 2015. https://www.wri.org/blog/2021/02/global-deforestation-agricultural-commodities
[5] FAO (2020) The State of World Fisheries and Aquaculture 2020. http://www.fao.org/state-of-fisheries-aquaculture/en/
[6] IAASTD, the International Assessment of Agricultural Knowledge, Science and Technology for Development (2009). Agriculture at a crossroads. Agriculture at a Crossroads. https://www.unenvironment.org/resources/report/agriculture-crossroads-global-report
[7] Biovision Foundation for Ecological Development & IPES-Food (2020). Money Flows: What is holding back investment in agroecological research for Africa? https://www.agroecology-pool.org/moneyflowsreport/
[8] IPBES (2019). Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. https://www.ipcc.ch/srccl/chapter/summary-for-policymakers/
[9] IPBES (2016). The assessment report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services on pollinators, pollination and food production. https://www.ipbes.net/assessment-reports/pollinators
[10] Howard (2018). Global Seed Industry Changes Since 2013. https://philhoward.net/2018/12/31/global-seed-industry-changes-since-2013
[11] UN (2017). Report of the Special Rapporteur on the Right to Food. A/HRC/34/48. http://digitallibrary.un.org/record/861172
[12] WWF (2016). Living Planet Report 2016. Risk and resilience in a new era. https://wwf.panda.org/wwf_news/?282370/Living-Planet-Report-2016
[13] IPES-Food (2017). Too big to feed: Exploring the impacts of mega-mergers, concentration, concentration of power in the agri-food sector.
[14] USDA (2004). Have Seed Industry Changes Affected Research Effort? https://www.ers.usda.gov/amber-waves/2004/february/have-seed-industry-changes-affected-research-effort/
[15] Chatam House and Hoffman Centre for Sustainable Resource Economy (2019). Subsidies and Sustainable Agriculture: Mapping the Policy Landscape https://www.chathamhouse.org/sites/default/files/Subsidies%20and%20Sustainable%20Ag%20-%20Mapping%20the%20Policy%20Landscape%20FINAL-compressed.pdf
[16] Chatam House and Hoffman Centre for Sustainable Resource Economy (2019). Subsidies and Sustainable Agriculture: Mapping the Policy Landscape. https://www.chathamhouse.org/2019/12/subsidies-and-sustainable-agriculture-mapping-policy-landscape
[17] OECD (2018). More progress needed on reducing and redesigning agricultural support policies.
https://www.oecd.org/newsroom/more-progress-needed-on-reducing-and-redesigning-agricultural-support-policies.htm
[18] Chatam House and Hoffman Centre for Sustainable Resource Economy (2019). Subsidies and Sustainable Agriculture: Mapping the Policy Landscape. https://www.chathamhouse.org/2019/12/subsidies-and-sustainable-agriculture-mapping-policy-landscape
[19] New York Times (2020). The Money Farmers: How Oligarchs and Populists Milk the E.U. for Millions.
https://www.nytimes.com/2019/11/03/world/europe/eu-farm-subsidy-hungary.html
[20] WWF European Policy Office (2020). Big week for nature and climate in the EU. https://www.wwf.eu/?uNewsID=979441
[21] Agricultural Policy https://blogs.commons.georgetown.edu/cctp-638-mb1809/agricultural-policy/
[22] Nishimoto et al. 2019: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6718354/
[23] Trucost and UNPRI (2010). Universal ownership: Why environmental externalities matter to institutional investors. https://www.unpri.org/environmental-issues/universal-ownership-why-environmental-externalities-matter-to-institutional-investors/4068.article
[24] Trucost and TEEB (2013). Natural Capital at Risk - The top 100 Externalities of Business. https://www.trucost.com/trucost-news/teeb-business-coalition-study-shows-multi-trillion-dollar-natural-capital-risk-underlying-urgency-green-economy-transition-2/
[25] IPES-Food (2017). Unravelling the Food–Health Nexus: Addressing practices, political economy, and power relations to build healthier food systems. The Global Alliance for the Future of Food and IPES-Food.
[26] Tickler et al. 2018, Nature: https://www.nature.com/articles/s41467-018-07118-9
[27] IPBES-Special Report on climate change and land, Chapter 5: Food Security (2019) Food-Climate Report, Chapter 5: https://www.ipcc.ch/srccl/chapter/chapter-5/

[28] IPES-Food (2017). Unravelling the Food–Health Nexus: Addressing practices, political economy, and power relations to build healthier food systems. The Global Alliance for the Future of Food and IPES-Food.
[29] Boedeker et al. (2020). The global distribution of acute unintentional pesticide poisoning: estimations based on a systematic review/ BMC Public Health Journal, Springer Nature. Accessed: https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-020-09939-0

[30] IPES-Food (2017). Unravelling the Food–Health Nexus: Addressing practices, political economy, and power relations to build healthier food systems. The Global Alliance for the Future of Food and IPES-Food.
[31] IAASTD, the International Assessment of Agricultural Knowledge, Science and Technology for Development (2009). Agriculture at a crossroads. Agriculture at a Crossroads. https://www.unenvironment.org/resources/report/agriculture-crossroads-global-report
[32] HLPE (2019). Agroecological and other innovative approaches for sustainable agriculture and food systems that enhance food security and nutrition. A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security, Rome.
[33] Dasgupta, P. (2021). The Economics of Biodiversity: The Dasgupta Review. Headlines messages. (London: HM Treasury). https://www.gov.uk/government/publications/final-report-the-economics-of-biodiversity-the-dasgupta-review

[34] Munich Re (2020). Pandemics, climate change, cyber: Major risks of our time – Better preparation needed. https://www.munichre.com/en/company/media-relations/media-information-and-corporate-news/media-information/2020/2020-09-07-pandemics-climate-change-cyber.html

[35] Munich Re (2020). Tropical cyclones causing billions in losses dominate nat cat picture of 2019. https://www.munichre.com/en/company/media-relations/media-information-and-corporate-news/media-information/2020/causing-billions-in-losses-dominate-nat-cat-picture-2019.html

[36] IPBES (2019). Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. E. S. Brondizio, J. Settele, S. Díaz, and H. T. Ngo (editors). IPBES secretariat, Bonn, Germany.
[37] IPCC (2019). Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems. https://www.ipcc.ch/srccl/chapter/chapter-5/

[38] WEF (2020). The Global Risks Report 2020. https://www.weforum.org/reports/the-global-risks-report-2020
[39] WWF (2020). Living Planet Report. https://livingplanet.panda.org/
[40] The Network for Greening the Financial System (NGFS) (2019). A call for action: Climate change as a source of financial risk https://www.ngfs.net/sites/default/files/medias/documents/ngfs_first_comprehensive_report_-_17042019_0.pdf

[41] World Economic Forum (WEF), 2020, Global Risks Report, Nature Risk Rising: Why the Crisis Engulfing Nature Matters for Business and the Economy: https://www.weforum.org/reports/the-global-risks-report-2020
[42] Roxburgh, T., Ellis, K., Johnson, J.A., Baldos, U.L., Hertel, T., Nootenboom, C., and Polasky, S. (2020). Global Futures: Assessing the global economic impacts of environmental change to support policy-making. Summary report, January 2020. https://www.wwf.org.uk/globalfutures

[43] De Nederlandsche Bank (DNB) and PBL Netherlands Environmental Assessment Agency (2020). Indebted to nature: Exploring biodiversity risks for the Dutch financial sector. https://www.pbl.nl/en/news/2020/dnb-and-pbl-biodiversity-loss-is-a-source-of-financial-risk
[44] Stockholm resilience centre, (2020) the Nine Planetary Boundaries. Accessed: https://www.stockholmresilience.org/research/planetary-boundaries/planetary-boundaries/about-the-research/the-nine-planetary-boundaries.html

[45] Steffen et al. (2015). Planetary Boundaries: Guiding human development on a changing planet. Stockholm Resilience Centre. Science Vol. 347 no. 6223 https://www.stockholmresilience.org/research/research-news/2015-01-15-planetary-boundaries---an-update.html

[47] Campbell, B. M., D. J. Beare, E. M. Bennett, J. M. Hall-Spencer, J. S. I. Ingram, F. Jaramillo, R. Ortiz, N. Ramankutty, J. A. Sayer, and D. Shindell. (2017). Agriculture production as a major driver of the Earth system exceeding planetary boundaries. Ecology and Society 22(4):8. https://doi.org/10.5751/ES-09595-220408
[48] Metabolic (2017). Halving the Footprint of PRODUCTION AND CONSUMPTION. A Proposed Framework for Measurable Outcomes & Actions. https://wwfint.awsassets.panda.org/downloads/halvingfootprint_report_wwf_metabolic.pdf
[49] Only 37% of rivers longer than 1,000 kilometres remain free-flowing over their entire length (representing 41% of the global river volume), and only 23% flow uninterrupted to the ocean.
Grill, G., B. Lehner, M. Thieme, B. Geenen, D. Tickner, F. Antonelli, S. Babu, et al. (2019). Mapping the World's Free-Flowing Rivers. Nature 569, no. 7755 (May 2019): 215–21. https://doi.org/10.1038/s41586-019-1111-9.
50 IPBES (2018): The IPBES assessment report on land degradation and restoration. Montanarella, L., Scholes, R., and Brainich, A. (eds.). Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, Bonn, Germany. https://doi.org/10.5281/zenodo.3237392
[51] Poore, J., & Nemecek, T. (2018). Reducing food's environmental impacts through producers and consumers. Science (New York, N.Y.), 360(6392), 987–992. https://doi.org/10.1126/science.aaq0216

[52] IPBES (2018): The IPBES assessment report on land degradation and restoration. Montanarella, L., Scholes, R., and Brainich, A. (eds.). Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, Bonn, Germany. https://doi.org/10.5281/zenodo.3237392

[53] FAO and UNEP (2020). The State of the World's Forests 2020. Forests, biodiversity and people. Rome. https://doi.org/10.4060/ca8642en

[54] IPBES (2018): The IPBES assessment report on land degradation and restoration. Montanarella, L., Scholes, R., and Brainich, A. (eds.). Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, Bonn, Germany.https://doi.org/10.5281/zenodo.3237392

[55] WWF (2021). Deforestation fronts: Drivers and responses in a changing world. https://wwf.panda.org/discover/our_focus/forests_practice/deforestation_fronts_/

[56] FAO (2018). State of the World's Forests 2018. Rome. http://www.fao.org/documents/card/en/c/I9535EN/. Updated, in 2020, FAO (2020) shows the extend of biodiversity constrained within tropical forests: http://www.fao.org/state-of-forests/en/

[57] FAO and ITPS (2015). Status of the World's Soil Resources (SWSR) – Main Report. Food and Agriculture Organization of the United Nations and Intergovernmental Technical Panel on Soils, Rome, Italy.

[58] Dasgupta, P. (2021). The Economics of Biodiversity: The Dasgupta Review. Headlines messages. (London: HM Treasury): https://www.gov.uk/government/publications/final-report-the-economics-of-biodiversity-the-dasgupta-review

[59] FAO and ITPS (2015). Status of the World's Soil Resources (SWSR) – Main Report. Food and Agriculture Organization of the United Nations and Intergovernmental Technical Panel on Soils, Rome, Italy

[60] FAO (2017). World's most comprehensive map showing the amount of carbon stocks in the soil launched. http://www.fao.org/news/story/en/item/1071012/icode/

[61] EU Soil Data Centre: Factsheet nr.3 organic matter decline. Link: https://esdac.jrc.ec.europa.eu/projects/SOCO/FactSheets/ENFactSheet-03.pdf

[62] Hoekstra, Arjen Y., and Mesfin M. Mekonnen. 'The Water Footprint of Humanity.' Proceedings of the National Academy of Sciences 109, no. 9 (February 28, 2012): 3232–37. https://doi.org/10.1073/pnas.1109936109.

[63] Tickner, D., Opperman, J. J., Abell, R., Acreman, M., Arthington, A. H., Bunn, S. E., Cooke, S. J., Dalton, J., Darwall, W., Edwards, G., Harrison, I., Hughes, K., Jones, T., Leclère, D., Lynch, A. J., Leonard, P., McClain, M. E., Muruven, D., Olden, J. D., … Young, L. (2020). Bending the Curve of Global Freshwater Biodiversity Loss: An Emergency Recovery Plan. BioScience, 70(4), 330–342. https://doi.org/10.1093/biosci/biaa002

[64] Human Settlements, Industries and Agriculture are the primary sources of water pollution and water quality degradation. Food and Agriculture Organization (FAO) of the United Nations Rome; International Water Management Institute (IWMI) on behalf of the Water Land and Ecosystems research program, Colombo, 2017: Water pollution from agriculture: a global review: http://www.fao.org/3/a-i7754e.pdf

[65] World Economic Forum (2019). This is how many animals we eat each year. https://www.weforum.org/agenda/2019/02/chart-of-the-day-this-is-how-many-animals-we-eat-each-year/

[66] IPBES (2018): The IPBES assessment report on land degradation and restoration. Montanarella, L., Scholes, R., and Brainich, A. (eds.). Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, Bonn, Germany. 744 pages. https://doi.org/10.5281/zenodo.3237392

[67] The Guardian (2017). Meat industry blamed for largest-ever 'dead zone' in Gulf of Mexico. https://www.theguardian.com/environment/2017/aug/01/meat-industry-dead-zone-gulf-of-mexico-environment-pollution

[68] Food and Agriculture Organization (FAO) of the United Nations Rome; International Water Management Institute (IWMI) on behalf of the Water Land and Ecosystems research program, Colombo, 2017: Water pollution from agriculture: a global review: http://www.fao.org/3/a-i7754e.pdf

[69] IPBES (2019). Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. https://www.ipcc.ch/srccl/chapter/summary-for-policymakers/

[70] WWF (2020). Living Planet Report. https://livingplanet.panda.org/

[71] FAO Agrobiodiversity: http://www.fao.org/3/y5609e/y5609e02.htm

[72] FAO (2019). The State of the World's Biodiversity for Food and Agriculture. Bélanger J & Pilling D (eds) Rome: FAO Commission on Genetic Resources for Food and Agriculture

[73] Bhandari et al. (2017) Assessment of genetic diversity in crop plants – an overview. MedCrave: https://medcraveonline.com/APAR/assessment-of-genetic-diversity-in-crop-plants---an-overview.html#:~:text=Genetic%20diversity%20is%20the%20base,%2C%20large%20seed%2C%20etc.)

[74] Sánchez-Bayo, F., & Wyckhuys, K. A. G. (2019). Worldwide decline of the entomofauna: A review of its drivers. Biological Conservation, 232, 8–27. https://doi.org/10.1016/j.biocon.2019.01.020

[75] WWF (2020). More pollinators, fewer pandemics — a food system for the next normal. João Campari, Global Food Practice Leader. https://medium.com/@WWF/more-pollinators-fewer-pandemics-a-food-system-for-the-next-normal-e5da6ea73d02

[76] Maxwell, S. L., Fuller, R. A., Brooks, T. M., & Watson, J. E. M. (2016). Biodiversity: The ravages of guns, nets and bulldozers. Nature News, 536(7615), 143. https://doi.org/10.1038/536143a

[77] UNEP (2016). Food Systems and Natural Resources. A Report of the Working Group on Food Systems of the International Resource Panel. Westhoek, H, Ingram J., Van Berkum, S., Özay, L., and Hajer M.

[78] Verhoeven, Jos T. A., and Tim L. Setter. "Agricultural Use of Wetlands: Opportunities and Limitations." Annals of Botany 105, no. 1 (January 1, 2010): 155–63. https://doi.org/10.1093/aob/mcp172.

[79] Terrestrial bird and mammal species. Freshwater species analysis based on data from https://www.iucnredlist.org/search/stats. Accessed 07.01.2021.

[80] Tilman, D., Clark, M., Williams, D. R., Kimmel, K., Polasky, S., & Packer, C. (2017). Future threats to biodiversity and pathways to their prevention. Nature, 546(7656), 73–81. https://doi.org/10.1038/nature22900
[81] Yinon M. Bar-On, Rob Phillips, Ron Milo (2018). The biomass distribution on Earth. Proceedings of the National Academy of Sciences Jun 2018, 115 (25) 6506-6511; DOI: 10.1073/pnas.1711842115
[82] WWF and PWC (2019). Nature is too Big to Fail: https://www.pwc.ch/en/publications/2020/nature-is-too-big-to-fail.pdf
[83] IPCC 2019 Headline statements https://www.ipcc.ch/sr15/resources/headline-statements/
[84] IPBES (2019). Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. https://www.ipcc.ch/srccl/chapter/summary-for-policymakers/
[85] IPCC (2019). Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems. https://www.ipcc.ch/srccl/chapter/chapter-5/
[86] WWF (2020). Bending the Curve: The Restorative Power of Planet-Based Diets. Loken, B. et al. WWF, Gland, Switzerland. https://www.worldwildlife.org/press-releases/bending-the-curve-the-restorative-power-of-planet-based-diets
[87] Griscom, B. W., Adams, J., Ellis, P. W., Houghton, R. A., Lomax, G., Miteva, D. A., Schlesinger, W. H., Shoch, D., Siikamäki, J. V., Smith, P., Woodbury, P., Zganjar, C., Blackman, A., Campari, J., Conant, R. T., Delgado, C., Elias, P., Gopalakrishna, T., Hamsik, M. R., … Fargione, J. (2017). Natural climate solutions. Proceedings of the National Academy of Sciences, 114(44), 11645–11650. https://doi.org/10.1073/pnas.1710465114
[88] The Network for Greening the Financial System (NGFS) (2019). A call for action: Climate change as a source of financial risk.
[89] The Network for Greening the Financial System (NGFS) (2020). Overview of Environmental Risk Analysis by Financial Institutions https://www.ngfs.net/en/overview-environmental-risk-analysis-financial-institutions
[90] Indebted to nature: Exploring biodiversity risks for the Dutch financial sector. https://www.pbl.nl/en/news/2020/dnb-and-pbl-biodiversity-loss-is-a-source-of-financial-risk
[91] Caldecott, B., N. Howarth, and P. McSharry. 2013. “Stranded Assets in Agriculture: Protecting Value from Environment-Related Risks.” Smith School of Enterprise and the Environment, University of Oxford.
[92] ShareAction (2020). Point of No Returns. https://shareaction.org/wp-content/uploads/2020/06/ShareAction-Biodiversity-Report-Final.pdf
[93] WWF Norway (2019). Naturrisiko: Tap av naturmangfold som finansiell risiko. https://www.wwf.no/dyr-og-natur/naturtap-og-finansiell-risiko
[94] WWF (2019). The Nature of Risk. A Framework for Understanding Nature-related Risk to Business. https://wwf.panda.org/?352751
[95] Intercontinentalcry (2017). Court issues ruling in world’s first 'right of nature' lawsuit. https://intercontinentalcry.org/court-issues-ruling-worlds-first-rights-nature-lawsuit/
[96] Mongabay (2019). Investors warn soy giants of backlash over deforestation in South America. https://news.mongabay.com/2019/03/investors-warn-soy-giants-of-backlash-over-deforestation-in-south-america/
[97] New York Times (2020). Roundup Maker to Pay $10 Billion to Settle Cancer Suits. https://www.nytimes.com/2020/06/24/business/roundup-settlement-lawsuits.html
[98] Financial Times, 2013: Horsemeat scandal sheds light on tastes: https://www.ft.com/content/7b6700d0-8bfa-11e2-8fcf-00144feabdc0
[99] Forest Trends (2014). Consumer Goods and Deforestation. https://www.forest-trends.org/publications/consumer-goods-and-deforestation/
[100] PRI, Ceres (2017). PRI and Ceres open collaborative engagement on deforestation to global investors. https://www.unpri.org/pri-and-ceres-open-collaborative-engagement-on-deforestation-to-global-investors/350.article
[101] WWF (2019). The Nature of Risk. A Framework for Understanding Nature-related Risk to Business. https://wwf.panda.org/?352751
[102] Rabobank (2020). Commitments on Sustainable Agriculture. https://www.rabobank.com/en/images/rabobanks-commitment-sustainable-agriculture-and-forests.pdf
[103] European Soil Data Center (2004). Land abandonment. https://esdac.jrc.ec.europa.eu/public_path/shared_folder/projects/DIS4ME/issues/issue_land_abandonment.htm
[104] Montgomery R. David (2012). Dirt, the erosion of civilizations. https://www.ucpress.edu/book/9780520272903/dirt
[105] Suweis, Samir, Joel A. Carr, Amos Maritan, Andrea Rinaldo, and Paolo D’Odorico. “Resilience and Reactivity of Global Food Security.” Proceedings of the National Academy of Sciences, May 8, 2015. https://doi.org/10.1073/pnas.1507366112
[106] LLoyds (2015). Food System Shock: The Insurance Impacts of Acute Disruption to Global Food Supply.
[107] Swiss Re Corporate Solutions (2019). Casualty Risk Trends in the Food Industry: https://corporatesolutions.swissre.com/dam/jcr:9d755c50-0d20-4201-9b6c-0158cab9b1c6/casualty-risk-trends-food-industry.pdf
[108] Caldecott, B., N. Howarth, and P. McSharry. 2013. “Stranded Assets in Agriculture: Protecting Value from Environment-Related Risks.” Smith School of Enterprise and the Environment, University of Oxford.
[109] WEF (2020). The Global Risks Report 2020. https://www.weforum.org/reports/the-global-risks-report-2020
One of the top 5 risk identified is of “Major biodiversity loss and ecosystem collapse (terrestrial or marine)”.
[110] Reuters (2020). World government debt to hit record $53 trillion this year - S&P Global. https://www.reuters.com/article/uk-markets-global-debt/world-government-debt-to-hit-record-53-trillion-this-year-sp-global-idUKKBN20E2I5
[111] WWF and Ninety One (2020). Climate & Nature Sovereign Index: Introducing a framework for a clear assessment of environmental risk. https://www.wwf.org.uk/sites/default/files/2020-07/Climate_%26_Nature_Sovereign_White_Paper.pdf
[112] Quote by Paul Dickinson, Carbon Disclosure Project.

[113] Zhao, Chuang, Bing Liu, Shilong Piao, Xuhui Wang, David B. Lobell, Yao Huang, Mengtian Huang, et al. “Temperature Increase Reduces Global Yields of Major Crops in Four Independent Estimates.” Proceedings of the National Academy of Sciences 114, no. 35 (August 29, 2017): 9326–31. https://doi.org/10.1073/pnas.1701762114

[114] Vogel, Elisabeth, Markus G. Donat, Lisa V. Alexander, Malte Meinshausen, Deepak K. Ray, David Karoly, Nicolai Meinshausen, and Katja Frieler. “The Effects of Climate Extremes on Global Agricultural Yields.” Environmental Research Letters 14, no. 5 (May 2019): 054010. https://doi.org/10.1088/1748-9326/ab154b

[115] Defra (2013). A Methodology for Estimating Economic Impacts of Extreme Weather Events on Agriculture

[116] FAO, Climate Smart Agriculture: http://www.fao.org/climate-smart-agriculture/en/

[117] Reuters (2020). Unilever sets 1 billion euro sales target for meat, dairy alternatives. https://www.reuters.com/article/us-unilever-outlook-plantbased/unilever-sets-1-billion-euro-sales-target-for-meat-dairy-alternatives-idUSKBN27Y001

[118] Forbes (2020). The World’s Largest Meat Seller Embraces Plant-Based Proteins As Pandemic Demand Surges. https://www.forbes.com/sites/chloesorvino/2020/06/18/the-worlds-largest-meat-seller-embraces-plant-based-proteins-as-pandemic-demand-surges/?sh=253021823e1e

[119] FAO http://www.fao.org/soils-portal/soil-degradation-restoration/global-soil-health-indicators-and-assessment/soil-heath-biological-and-chemical/en/

[120] Project Drawdown: https://www.drawdown.org/solutions/abandoned-farmland-restoration

[121] IPBES (2018): The IPBES assessment report on land degradation and restoration. Montanarella, L., Scholes, R., and Brainich, A. (eds.). Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, Bonn, Germany.

[122] FAO and ITPS (2015). Status of the World’s Soil Resources (SWSR). http://www.fao.org/documents/card/en/c/c6814873-efc3-41db-b7d3-2081a10ede50/

[123] The Network for Greening the Financial System (NGFS) (2020). Overview of Environmental Risk Analysis by Financial Institutions https://www.ngfs.net/en/overview-environmental-risk-analysis-financial-institutions

[124] Larbodière, L., Davies, J., Schmidt, R., Magero, C., Vidal, Arroyo Schnell, A., Bucher, P., Maginnis, S., Cox, N., Hasinger, O., Abhilash, P.C., Conner, N., Westerberg, V., Costa, L. (2020). Common ground: restoring land health for sustainable agriculture. Gland, Switzerland: IUCN.

[125] Iizumi, Toshichika, and Rota Wagai. “Leveraging Drought Risk Reduction for Sustainable Food, Soil and Climate via Soil Organic Carbon Sequestration.” Scientific Reports 9, no. 1 (December 24, 2019): 19744. https://doi.org/10.1038/s41598-019-55835-y.

[126] UN (2017). Report of the Special Rapporteur on the Right to Food. A/HRC/34/48. http://digitallibrary.un.org/record/861172

[127] European Environmental Agency (2019). Signals 2019, land and soil in Europe. https://www.eea.europa.eu/publications/eea-signals-2019-land

[128] Food and Agriculture Organization of the United Nations (FAO), United Nations: https://www.weforum.org/agenda/2018/10/once-neglected-these-traditional-crops-are-our-new-rising-stars

[129] Caldecott, B., N. Howarth, and P. McSharry. 2013. “Stranded Assets in Agriculture: Protecting Value from Environment-Related Risks.” Smith School of Enterprise and the Environment, University of Oxford.

[130] University of Arkansas, Division of agriculture, 2020: https://www.uaex.edu/environment-nature/ar-invasives/

[131] Lin, B.B., 2011. Resilience in agriculture through crop diversification: adaptive management for environmental change. BioScience, 61(3), pp.183-193.

[132] Reuters (2019). Climate change to blame as bark beetles ravage central Europe's forests. https://www.reuters.com/article/us-centraleurope-environment-barkbeetle-idUSKCN1S21LA

[133] Johsson et al. (2019) Levels of forest ecosystem services depend on specific mixtures of commercial tree species. Nature. https://www.nature.com/articles/s41477-018-0346-z

[134] Felton, Adam, Urban Nilsson, Johan Sonesson, Annika M. Felton, Jean-Michel Roberge, Thomas Ranius, Martin Ahlström, et al. “Replacing Monocultures with Mixed-Species Stands: Ecosystem Service Implications of Two Production Forest Alternatives in Sweden.” Ambio 45, no. Suppl 2 (February 2016): 124–39. https://doi.org/10.1007/s13280-015-0749-2

[135] The International Herbicide-Resistant Weed Database. www.weedscience.org The International Survey of Herbicide Resistant Weeds is a collaborative effort between weed scientists in over 80 countries.

[136] UN (2017). Report of the Special Rapporteur on the Right to Food. A/HRC/34/48. http://digitallibrary.un.org/record/861172

[137] Jørgensen, Peter Søgaard, Athena Aktipis, Zachary Brown, Yves Carrière, Sharon Downes, Robert R. Dunn, Graham Epstein, et al. “Antibiotic and Pesticide Susceptibility and the Anthropocene Operating Space.” Nature Sustainability 1, no. 11 (November 2018): 632–41. https://doi.org/10.1038/s41893-018-0164-3.

[138] WHO (2020). Antibiotic resistance. https://www.who.int/news-room/fact-sheets/detail/antibiotic-resistance

[139] EASAC (2018). Opportunities for soil sustainability in Europe. Report by the European Academies’ Science Advisory Council (EASAC). https://easac.eu/news/details/latest-easac-report-on-soil-sustainability-publicly-launched/

[140] UN (2017). Report of the Special Rapporteur on the Right to Food. A/HRC/34/48. http://digitallibrary.un.org/record/861172

[141] Global Panel on Agriculture and Food Systems for Nutrition (2020). Future Food Systems: For people, our planet, and prosperity. London, UK. https://www.glopan.org/foresight2/

[142] IPBES (2018): The IPBES assessment report on land degradation and restoration. Montanarella, L., Scholes, R., and Brainich, A. (eds.). Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, Bonn, Germany. 744 pages. https://doi.org/10.5281/zenodo.3237392

[143] EASAC (2018). Opportunities for soil sustainability in Europe. Report by the European Academies’ Science Advisory Council (EASAC). https://easac.eu/news/details/latest-easac-report-on-soil-sustainability-publicly-launched/

[144] FAO (2018). More People, More Food, Worse Water? A Global Review of Water Pollution from Agriculture. https://www.unwater.org/water-pollution-from-agriculture-a-global-review/
[145] Howden N.J.K., Burt T.P., Mathias S.A., Worrall F. and Whelan M.J. (2011) Modelling long-term diffuse nitrate pollution at the catchment-scale: data, parameter and epistemic uncertainty. Journal of Hydrology 403, 337–351
[146] Meter, K. J. V., Basu, N. B., Veenstra, J. J., & Burras, C. L. (2016). The nitrogen legacy: Emerging evidence of nitrogen accumulation in anthropogenic landscapes. Environmental Research Letters, 11(3), 035014. https://doi.org/10.1088/1748-9326/11/3/035014
[147] McKinsey (2020). Agriculture and climate change. Reducing emissions through improved farming practices.

[148] Fertilisers Europe. https://www.fertilizerseurope.com/fertilizers-in-europe/how-fertilizers-are-made/
[149] Caldecott, B., N. Howarth, and P. McSharry. 2013. "Stranded Assets in Agriculture: Protecting Value from Environment-Related Risks." Smith School of Enterprise and the Environment, University of Oxford.
[150] Chrispim, M. C., Scholz, M., & Nolasco, M. A. (2019). Phosphorus recovery from municipal wastewater treatment: Critical review of challenges and opportunities for developing countries. Journal of Environmental Management, 248, 109268. https://doi.org/10.1016/j.jenvman.2019.109268
[151] Egle, L., Rechberger, H., Krampe, J., & Zessner, M. (2016). Phosphorus recovery from municipal wastewater: An integrated comparative technological, environmental and economic assessment of P recovery technologies. Science of The Total Environment, 571, 522–542. https://doi.org/10.1016/j.scitotenv.2016.07.019
[152] Global Panel on Agriculture and Food Systems for Nutrition (2020). Future Food Systems: For people, our planet, and prosperity. London, UK. https://www.glopan.org/foresight2/
[153] IPBES (2016). The assessment report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services on pollinators, pollination and food production. https://www.ipbes.net/assessment-reports/pollinators

[154] FAO and ITPS (2015). Status of the World's Soil Resources (SWSR) – Main Report. Food and Agriculture Organization of the United Nations
and Intergovernmental Technical Panel on Soils, Rome, Italy
[155] UN (2017). Report of the Special Rapporteur on the Right to Food. A/HRC/34/48. http://digitallibrary.un.org/record/861172
[156] For example, in the US the levels of permitted residues of Glyphosate, one of the most used pesticides, are 100 times higher than in grain directly fed to humans. https://www.ecfr.gov/cgi-bin/text-idx?SID=2c85909360c7c5aff63ddd1447545d6a&mc=true&node=se40.24.180_1364&rgn=div8
[157] WWF (2020). More pollinators, fewer pandemics — a food system for the next normal. João Campari, Global Food Practice Leader, WWF. https://medium.com/@WWF/more-pollinators-fewer-pandemics-a-food-system-for-the-next-normal-e5da6ea73d02
[158] Rohr et al. 2019, National Institute of Biotechnology Information. Emerging human infectious diseases and the links to global food production: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7091874/
[159] FAIRR (2020). An Industry Infected: Animal agriculture in a post-COVID world. https://www.fairr.org/article/industry-infected/
[160] O'Callaghan-Gordo, C., & Antó, J. M. (2020). COVID-19: The disease of the anthropocene. Environmental Research, 187, 109683. https://doi.org/10.1016/j.envres.2020.109683
[161] Weiss, R., McMichael, A. Social and environmental risk factors in the emergence of infectious diseases. Nat Med **10,** S70–S76 (2004). https://doi.org/10.1038/nm1150
[162] UN (2020). Unite human, animal and environmental health to prevent the next pandemic – UN Report. https://www.unenvironment.org/news-and-stories/press-release/unite-human-animal-and-environmental-health-prevent-next-pandemic-un
[163] Larbodière, L., Davies, J., Schmidt, R., Magero, C., Vidal, Arroyo Schnell, A., Bucher, P., Maginnis, S., Cox, N., Hasinger, O., Abhilash, P.C., Conner, N., Westerberg, V., Costa, L. (2020). Common ground: restoring land health for sustainable agriculture. Gland, Switzerland: IUCN.
[164] European Union (2020). Farm to Fork Strategy. https://ec.europa.eu/food/farm2fork_en
[165] UK's Green Finance Strategy. https://www.gov.uk/government/publications/green-finance-strategy
[166] TCFD (2017). Implementing the Recommendations of the Task Force on Climate-Related Financial Disclosures. https://www.fsb-tcfd.org/publications/
[167] TCFD (2017). Implementing the Recommendations of the Task Force on Climate-Related Financial Disclosures. https://www.fsb-tcfd.org/publications/

[168] New Zealand's government (2019). Action on agricultural emissions. https://www.mfe.govt.nz/consultation/action-agricultural-emissions

[169] Corporate Knights (2020). Where's the beef tax? https://www.corporateknights.com/channels/energy/wheres-the-beef-tax-16062096/
[170] EASAC (2018). Opportunities for soil sustainability in Europe. Report by the European Academies' Science Advisory Council (EASAC). https://easac.eu/news/details/latest-easac-report-on-soil-sustainability-publicly-launched/

[172] Dasgupta, P. (2021). The Economics of Biodiversity: The Dasgupta Review. Headlines messages. (London: HM Treasury). https://www.gov.uk/government/publications/final-report-the-economics-of-biodiversity-the-dasgupta-review

[173] Project Drawdown (2020). The Drawdown Review. Climate Solutions for a New Decade. https://drawdown.org/solutions/table-of-solutions
[174] Food and Land Use Coalition (2019). Growing Better: Ten Critical Transitions to Transform Food and Land Use. https://www.foodandlandusecoalition.org/global-report/
[175] The New Climate Economy (2018). Unlocking the Inclusive Growth Story of the 21st Century: Accelerating Climate Action in Urgent Times. The 2018 report of the global commission on the economy and the climate. https://newclimateeconomy.report/2018/

[176] Berners-Lee, M., Kennelly, C., Watson, R. and Hewitt, C.N., (2018). Current global food production is sufficient to meet human nutritional needs in 2050 provided there is radical societal adaptation. Elem Sci Anth, 6(1), p.52. DOI: http://doi.org/10.1525/elementa.310

[177] Willett, Walter, Johan Rockström, Brent Loken, Marco Springmann, Tim Lang, Sonja Vermeulen, Tara Garnett, et al. (2019). Food in the Anthropocene: The EAT–Lancet Commission on Healthy Diets from Sustainable Food Systems. The Lancet 393, no. 10170: 447–92. https://doi.org/10.1016/S0140-6736(18)31788-4

[178] Dasgupta, P. (2021). The Economics of Biodiversity: The Dasgupta Review. Headlines messages. (London: HM Treasury). https://www.gov.uk/government/publications/final-report-the-economics-of-biodiversity-the-dasgupta-review

[179] HLPE (2019). Agroecological and other innovative approaches for sustainable agriculture and food systems that enhance food security and nutrition. A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security, Rome.

[180] Non exhaustive reference here: https://www.iatp.org/blog/201906/new-un-report-agroecology-climate-food-security-and-human-rights

[181] IAASTD, the International Assessment of Agricultural Knowledge, Science and Technology for Development (2009). Agriculture at a crossroads. Agriculture at a Crossroads. https://www.unenvironment.org/resources/report/agriculture-crossroads-global-report

[182] Leippert, F., Darmaun, M., Bernoux, M. and Mpheshea, M. 2020. The potential of agroecology to build climate-resilient livelihoods and food systems. Rome. FAO and Biovision. https://doi.org/10.4060/cb0438en

[183] Poux, X., Aubert, P.-M. (2018). An agroecological Europe in 2050: multifunctional agriculture for healthy eating. Findings from the Ten Years For Agroecology (TYFA) modelling exercise, Iddri-AScA, Study N°09/18, Paris, France, 74 p.

[184] Larbodière, L., Davies, J., Schmidt, R., Magero, C., Vidal, Arroyo Schnell, A., Bucher, P., Maginnis, S., Cox, N., Hasinger, O., Abhilash, P.C., Conner, N., Westerberg, V., Costa, L. (2020). Common ground: restoring land health for sustainable agriculture. Gland, Switzerland: IUCN.

[185] SystemIQ (2020). Regenerating Europe's soils: Making the economics work: https://www.systemiq.earth/wp-content/uploads/2020/01/RegeneratingEuropessoilsFINAL.pdf

[186] Ibid.

[187] See e.g. Food and Land Use Coalition (2019). Growing Better: Ten Critical Transitions to Transform Food and Land Use. https://www.foodandlandusecoalition.org/global-report/

[188] EEA (2020). Water and agriculture: towards sustainable solutions. EEA Report No 17/2020. https://www.eea.europa.eu/highlights/agricultural-policy-needs-to-secure

[189] WBCSD (2019). The Business Case for Investing in Soil Health. World Business Council for Sustainable Development. https://www.wbcsd.org/Programs/Food-and-Nature/Food-Land-Use/Scaling-Positive-Agriculture/Resources/The-Business-Case-for-Investing-in-Soil-Health

[190] EASAC (2018). Opportunities for soil sustainability in Europe. Report by the European Academies' Science Advisory Council (EASAC). https://easac.eu/news/details/latest-easac-report-on-soil-sustainability-publicly-launched/

[191] UN (2017). Report of the Special Rapporteur on the Right to Food. A/HRC/34/48. http://digitallibrary.un.org/record/861172

[192] Ponisio Lauren C., M'Gonigle Leithen K., Mace Kevi C., Palomino Jenny, de Valpine Perry, & Kremen Claire. (2015). Diversification practices reduce organic to conventional yield gap. Proceedings of the Royal Society B: Biological Sciences, 282(1799), 20141396. https://doi.org/10.1098/rspb.2014.1396

[193] Van Zanten, H. H. E., Van Ittersum, M. K., & De Boer, I. J. M. (2019). The role of farm animals in a circular food system. Global Food Security, 21, 18–22. https://doi.org/10.1016/j.gfs.2019.06.003

[194] https://waterriskfilter.panda.org/

[195] EEA (2020). Water and agriculture: towards sustainable solutions. EEA Report No 17/2020. https://www.eea.europa.eu/highlights/agricultural-policy-needs-to-secure

[196] WWF (2020). Bending the Curve: The Restorative Power of Planet-Based Diets. Loken, B. et al. WWF, Gland, Switzerland. https://www.worldwildlife.org/press-releases/bending-the-curve-the-restorative-power-of-planet-based-diets

[197] FAO (2018) FAO Director General calls for reduced meat consumption. Accessed: https://www.fcrn.org.uk/research-library/fao-director-general-calls-reduced-meat-consumption

[198] WHO (2020). Obesity and overweight. https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweightt and FAO (2020). State of Food Security and Nutrition in the World. http://www.fao.org/news/story/en/item/1297810/icode/

[199] Berners-Lee, M., Kennelly, C., Watson, R. and Hewitt, C.N., (2018). Current global food production is sufficient to meet human nutritional needs in 2050 provided there is radical societal adaptation. Elem Sci Anth, 6(1), p.52. DOI: http://doi.org/10.1525/elementa.310

[200] Khoury CK, Bjorkman AD, Dempewolf H, Ramírez-Villegas J, Guarino L, Jarvis A, Rieseberg LH and Struik PC (2014). Increasing homogeneity in global food supplies and the implications for food security. PNAS 111(11): 4001-4006. https://www.pnas.org/content/111/11/4001

[201] Willett, Walter, Johan Rockström, Brent Loken, Marco Springmann, Tim Lang, Sonja Vermeulen, Tara Garnett, et al. (2019). Food in the Anthropocene: The EAT–Lancet Commission on Healthy Diets from Sustainable Food Systems. The Lancet 393, no. 10170: 447–92. https://doi.org/10.1016/S0140-6736(18)31788-4

[202] WWF, Knorr (2019). Future 50 Foods Report: https://www.wwf.org.uk/sites/default/files/2019-02/Knorr_Future_50_Report_FINAL_Online.pdf

[203] WWF (2020). WWF Position on Healthy and Sustainable Diets. https://wwf.panda.org/discover/our_focus/food_practice/sustainable_diets/

[204] Poore, J., & Nemecek, T. (2018). Reducing food's environmental impacts through producers and consumers. Science (New York, N.Y.), 360(6392), 987–992. https://doi.org/10.1126/science.aaq0216

[205] WRI (2018). Animal-based Foods are More Resource-Intensive than Plant-Based Foods. https://www.wri.org/resources/charts-graphs/animal-based-foods-are-more-resource-intensive-plant-based-foods
[206] Springmann, M., Clark, M., Mason-D'Croz, D., Wiebe, K., Bodirsky, B. L., Lassaletta, L., Vries, W. de, Vermeulen, S. J., Herrero, M., Carlson, K. M., Jonell, M., Troell, M., DeClerck, F., Gordon, L. J., Zurayk, R., Scarborough, P., Rayner, M., Loken, B., Fanzo, J., … Willett, W. (2018). Options for keeping the food system within environmental limits. Nature, 562(7728), 519. https://doi.org/10.1038/s41586-018-0594-0
[207] Springmann, M., Godfray, H. C. J., Rayner, M., & Scarborough, P. (2016). Analysis and valuation of the health and climate change cobenefits of dietary change. Proceedings of the National Academy of Sciences. https://doi.org/10.1073/pnas.1523119113
[208] Shepon, A., Eshel, G., Noor, E., & Milo, R. (2018). The opportunity cost of animal based diets exceeds all food losses. Proceedings of the National Academy of Sciences, 115(15), 3804–3809. https://doi.org/10.1073/pnas.1713820115
[209] WRI (2016). Sustainable Diets: What You Need to Know in 12 Charts. https://www.wri.org/blog/2016/04/sustainable-diets-what-you-need-know-12-charts
[210] WWF (2020). Bending the Curve: The Restorative Power of Planet-Based Diets. Loken, B. et al. WWF, Gland, Switzerland. https://www.worldwildlife.org/press-releases/bending-the-curve-the-restorative-power-of-planet-based-diets
[211] Griscom, B. W et al. (2017). Natural climate solutions. Proceedings of the National Academy of Sciences, 114(44), 11645–11650. https://doi.org/10.1073/pnas.1710465114
[212] The Climate Economy (2018). Unlocking the Inclusive Growth Story of the 21st Century: Accelerating Climate Action in Urgent Times. The 2018 report of the global commission on the economy and the climate. https://newclimateeconomy.report/2018/
[213] Project Drawdown (2020). The Drawdown Review. Climate Solutions for a New Decade. https://drawdown.org/solutions/table-of-solutions
[213] Food and Land Use Coalition (2019). Growing Better: Ten Critical Transitions to Transform Food and Land Use. https://www.foodandlandusecoalition.org/global-report/
[214] The Climate Economy (2018). Unlocking the Inclusive Growth Story of the 21st Century: Accelerating Climate Action in Urgent Times. The 2018 report of the global commission on the economy and the climate. https://newclimateeconomy.report/2018/
[215] Still unpublished as per current date
[216] SystemIQ (2020). Regenerating Europe's soils: Making the economics work: https://www.systemiq.earth/wp-content/uploads/2020/01/RegeneratingEuropessoilsFINAL.pdf
[217] Ibid.
[218] Ibid.
[219] Ibid.
[220] Pieper, M., Michalke, A., & Gaugler, T. (2020). Calculation of external climate costs for food highlights inadequate pricing of animal products. Nature Communications, 11(1), 6117. https://doi.org/10.1038/s41467-020-19474-6
[221] Some references: Carbon Brief (2020). Interactive: What is the climate impact of eating meat and dairy? https://interactive.carbonbrief.org/what-is-the-climate-impact-of-eating-meat-and-dairy/; WRI (2016). Animal-based Foods are More Resource-Intensive than Plant-Based Foods. https://www.wri.org/resources/charts-graphs/animal-based-foods-are-more-resource-intensive-plant-based-foods
[222] Clark, M.A., Springmann, M., Hill, J. and Tilman, D., 2019. Multiple health and environmental impacts of foods. Proceedings of the National Academy of Sciences, 116(46), pp.23357-23362. https://www.pnas.org/content/116/46/23357
[223] Dasgupta, P. (2021). The Economics of Biodiversity: The Dasgupta Review. Headlines messages. (London: HM Treasury). https://www.gov.uk/government/publications/final-report-the-economics-of-biodiversity-the-dasgupta-review
[224] Croatan Institute (2019). Soil Wealth. Investing in Regenerative Agriculture across Asset Classes. http://www.croataninstitute.org/soilwealth
[225] Planet Tracker (2020). Growing for Profit. https://www.greenfinanceplatform.org/research/growing-profit
[226] WWF (2020). First Things First: Avoid, Reduce … and only after that–Compensate. https://wwf.panda.org/discover/our_focus/forests_practice/climate_change_and_forest/?362819/First-Things-First-Avoid-Reduce--and-only-after-thatCompensate
[227] TCFD (2017). Implementing the Recommendations of the Task Force on Climate-Related Financial Disclosures. https://www.fsb-tcfd.org/publications/
[228] TCFD (2020). Status Report 2019. https://www.fsb.org/2019/06/task-force-on-climate-related-financial-disclosures-2019-status-report/
[229] https://tnfd.info/
[230] OnePlanetNetwork (2018). Technical report on existing methodologies & tools for biodiversity metrics. https://www.oneplanetnetwork.org/resource/technical-report-existing-methodologies-tools-biodiversity-metrics
[231] EU Business @ Biodiversity Platform: https://ec.europa.eu/environment/biodiversity/business/index_en.htm
[232] EU Business @ Biodiversity (2021). ASSESSMENT OF BIODIVERSITY MEASUREMENT APPROACHES FOR BUSINESSES AND FINANCIAL INSTITUTIONS. https://ec.europa.eu/environment/biodiversity/business/assets/pdf/EU%20B@B%20Platform%20Update%20Report%203_FINAL_1March2021.pdf
[233] Ibid.
[234] Finance for Biodiversity (2020). https://www.financeforbiodiversity.org/about-the-pledge/
[235] https://encore.naturalcapital.finance/en
[236] De Nederlandsche Bank (DNB) and PBL Netherlands Environmental Assessment Agency (2020). Indebted to nature: Exploring biodiversity risks for the Dutch financial sector. https://www.pbl.nl/en/news/2020/dnb-and-pbl-biodiversity-loss-is-a-source-of-financial-risk
[237] Natural Capital Finance Alliance and PricewaterhouseCoopers (2018). Integrating Natural Capital in Risk Assessments: A step-by-step guide for banks. Geneva, Oxford and London.
[238] https://encore.naturalcapital.finance/en/map

[239] https://www.impactobservatory.com/

[241] IPBES (2019). Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. E. S. Brondizio, J. Settele, S. Díaz, and H. T. Ngo (editors). IPBES secretariat, Bonn, Germany.
[242] Dasgupta, P. (2021). The Economics of Biodiversity: The Dasgupta Review. Headlines messages. (London: HM Treasury). https://www.gov.uk/government/publications/final-report-the-economics-of-biodiversity-the-dasgupta-review
[243] EASAC (2018). Opportunities for soil sustainability in Europe. Report by the European Academies' Science Advisory Council (EASAC). https://easac.eu/news/details/latest-easac-report-on-soil-sustainability-publicly-launched/
[244] WRI (2014). Indicators of Sustainable Agriculture: A Scoping Analysis. https://www.wri.org/resources/data-sets/food-indicators
[245] EEA (2020). Water and agriculture: towards sustainable solutions. EEA Report No 17/2020. https://www.eea.europa.eu/highlights/agricultural-policy-needs-to-secure
[246] UNCCD (2020). 2020 Desertification and Drought Day. https://www.unccd.int/actions17-june-desertification-and-drought-day/2020-desertification-and-drought-day
[247] World Resources Institute (2017). How Can Restoring Degraded Landscapes Deliver Financial Returns?. https://www.wri.org/blog/2017/05/how-can-restoring-degraded-landscapes-deliver-financial-returns
[248] WWF (2020). First Things First: Avoid, Reduce … and only after that–Compensate. https://wwf.panda.org/discover/our_focus/forests_practice/climate_change_and_forest/?362819/First-Things-First-Avoid-Reduce--and-only-after-thatCompensate
[249] https://www.4p1000.org/
[250] https://ec.europa.eu/info/business-economy-euro/banking-and-finance/sustainable-finance/eu-taxonomy-sustainable-activities_en
[251] www.cbd.int/meetings/COP-15
[252] The SDGs serve as internationally agreed targets that will need to be translated into concrete corporate commitments: http://www.fao.org/sustainable-development-goals/en/
[253] OECD, FAO (2018). OECD and FAO call for responsible investment in agriculture. https://www.oecd.org/corporate/fao-and-oecd-call-for-responsible-investment-in-agriculture.htm
[254] UNPRI (2015). Responsible investment in farmland. https://www.unpri.org/farmland/responsible-investment-in-farmland/716.article
[255] OECD-FAO Guidance for Responsible Agricultural Supply Chains. https://www.oecd.org/daf/inv/investment-policy/rbc-agriculture-supply-chains.htm
[256] Global Reporting Initiative. https://www.globalreporting.org/
[257] Global Reporting Initiative. Sector Standard Project for Agriculture, Aquaculture, and Fishing. https://www.globalreporting.org/standards/standards-development/sector-standard-project-for-agriculture-aquaculture-and-fishing/
[258] Science Based Targets: https://sciencebasedtargets.org/
[259] Science-Based Targets for Nature Initial Guidance for Business. https://sciencebasedtargetsnetwork.org/resources/guidance/
[260] World Benchmarking Alliance (2020). Assessing the world's 350 most influential food and agriculture companies on their commitments. https://www.worldbenchmarkingalliance.org/publication/food-agriculture/
[261] https://www.unpri.org/
[262] Other investor initiatives that follow this model include the Net Zero Asset Owners Alliance and UNEP FI.
[263] https://www.fairr.org/index/
[264] https://ec.europa.eu/environment/biodiversity/business/index_en.htm
[265] OP2B website: https://www.danone.com/content/dam/danone-corp/danone-com/medias/media-othernews-en/2019/corporatepressreleases/PR_One_Planet_Business_for_Biodiversity_23092019.pdf
[266] Consumer Goods Forum: https://www.theconsumergoodsforum.com/
[267] WBCSD (2019). The Business Case for Investing in Soil Health. World Business Council for Sustainable Development. https://www.wbcsd.org/Programs/Food-and-Nature/Food-Land-Use/Scaling-Positive-Agriculture/Resources/The-Business-Case-for-Investing-in-Soil-Health
[268] BCG (2020). Biodiversity in Agriculture Makes Gains in the Boardroom. https://www.bcg.com/publications/2020/business-benefits-of-biodiversity-in-agriculture
[269] EU Business @ Biodiversity (2021). Assessment of ASSESSMENT OF BIODIVERSITY MEASUREMENT APPROACHES FOR BUSINESSES AND FINANCIAL INSTITUTIONS. https://ec.europa.eu/environment/biodiversity/business/assets/pdf/EU%20B@B%20Platform%20Update%20Report%203_FINAL_1March2021.pdf
[270] AXA (2020). Iceberg Data Lab and I care & Consult selected to provide first of its kind biodiversity impact measurement tool for investors.
[271] ASN Bank (2020). Net positive effect on biodiversity in 2030. https://www.asnbank.nl/over-asn-bank/duurzaamheid/biodiversiteit/biodiversity-in-2030.html
[272] Prè Sustainability (2021). Biodiversity is the next global challenge. https://pre-sustainability.com/solutions/consulting/sustainable-companies/biodiversity-assessment/
[273] Presentation of the Global Biodiversity Score GBS for financial institutions (GBSFI): https://www.mission-economie-biodiversite.com/event/presentation-of-the-gbsfi?event_date=2021-01-21
Carbon4 Finance biodiversity footprint database using the Global Biodiversity Score: https://ec.europa.eu/environment/biodiversity/business/assets/pdf/case-studies/Case%20study%2013_GBS%20BIA_final.pdf

[275] IUCN. Species Threat Abatement and Recovery (STAR) Metric. https://www.iucn.org/regions/washington-dc-office/our-work/species-threat-abatement-and-recovery-star-metric
[276] https://www.ibat-alliance.org/
[277] Global Map of Environmental and Social Risks in Agro-Commodity Production (GMAP). https://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/company-resources/gmap
[278] https://trase.earth/
[279] https://trase.finance/
[280] https://accountability-framework.org

Working to sustain the natural world for the benefit of people and wildlife.

together possible

wwf.no