AXA Investment Managers

Investment Institute *Sustainability*

Feeding the world and protecting the planet:

A biodiversity and climate challenge for investors

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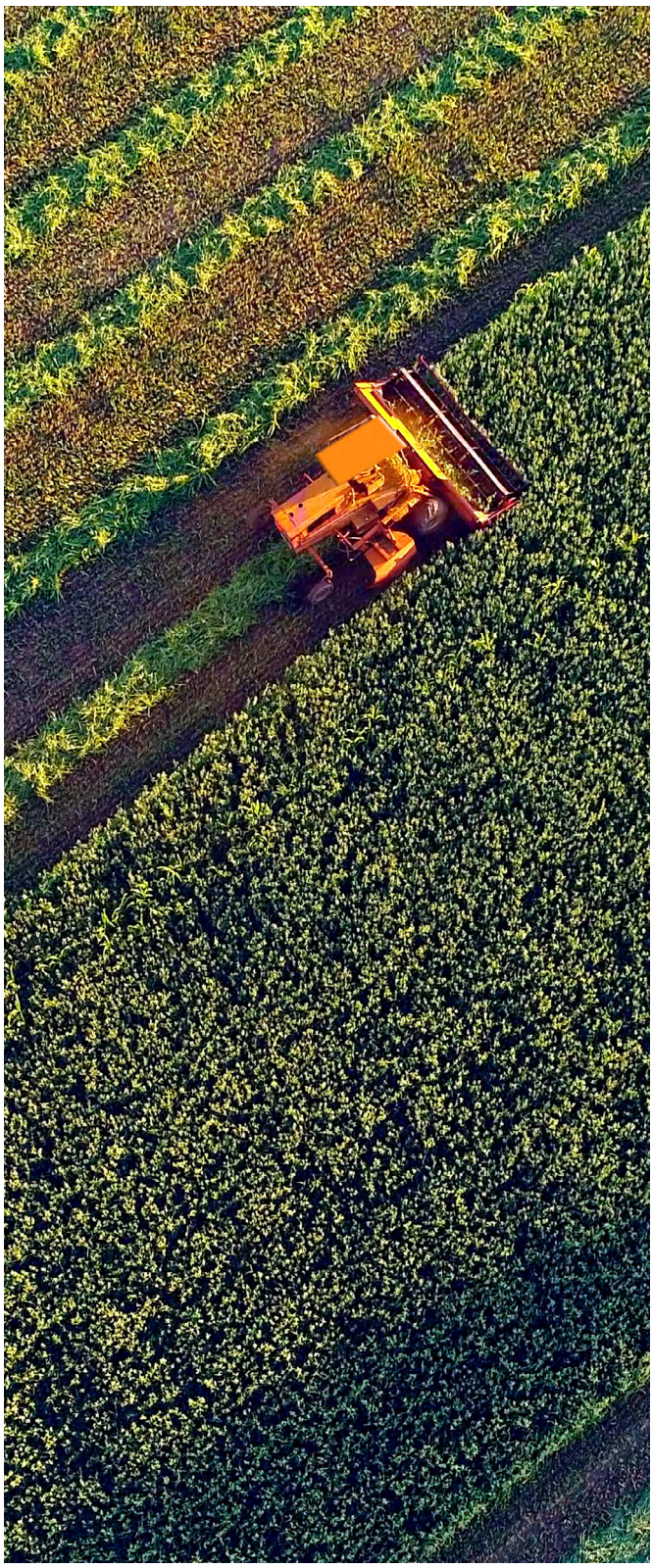
Liudmila Strakodonskaya,
AXA IM Core Responsible Investment Analyst

Olivier Eugène,
AXA IM Core Head of Climate Research

Highlights

- The global food industry is responsible for about 30% of the world's total greenhouse gas emissions and occupies a third of the Earth's total land surface. Its intensification presents challenges in terms of environmental risks, while its transition to more nature-positive business models presents an opportunity for investors willing to contribute to sustainable economies
- The climate and biodiversity challenges of the food sector are global. To properly identify and tackle these issues, investors should adopt a holistic value-chain approach, to spot problems and transformation opportunities at each step, from food production to distribution and consumption
- The global food industry is deeply complex and faces multiple environmental challenges. This means investors will need to use active engagement strategies, and targeted problem/solution analysis for each type of activity within the food value chain, to successfully encourage a sustainable food transition



The food industry reaches into every corner of our world. It starts with seed suppliers, fertilisers and tractor producers, continues with farmers and fishing communities, then shifts into processing and manufacturing before ending with retail customers, catering companies and restaurants.

It is high value and high impact. Food production and consumption are responsible for about 30% of the world's greenhouse gas emissions (GHGs).[1] Livestock farming and crops occupy almost half of all habitable land on earth and agriculture uses about 70% of our available freshwater.[2,3] Feeding eight billion human beings takes a heavy toll on the environment.

This challenge is made far more difficult by the interaction between biodiversity and climate. The agrifood sector is facing risks from both biodiversity loss (e.g., reduced crop diversity, reduced pest and disease control) and from the consequences of climate change such as the increased probability of extreme weather events. These risks threaten the resilience of global public food systems and, therefore, the viability of corporate operational strategies in this sector.

Production processes are exposed to physical risks – crop failure, water stress and others – based on how dependent they are on ecosystem services such as pollination or soil fertility. Food companies may also face transition risks if their business models are misaligned with new developments aimed at achieving a low-carbon and nature-positive economy. This can also generate direct financial and reputational risks with a rising demand for healthier food from consumers.

We believe that responsible investors who have, or are considering, commitments around climate and nature protection will be required to understand and assess these pressure points. Their goal should be to develop an investment and engagement strategy which helps protect against risks to companies involved in the food value chain and seeks to unearth opportunities as this theme gains momentum.

In this paper, we aim to map the climate and biodiversity impacts of what we eat. Then we present an engagement roadmap for the companies exposed to the food value chain and set out solutions those companies may introduce to contribute to the transition to more sustainable food production and consumption.

[1] How much of global greenhouse gas emissions come from food? Our World in Data, March 2021

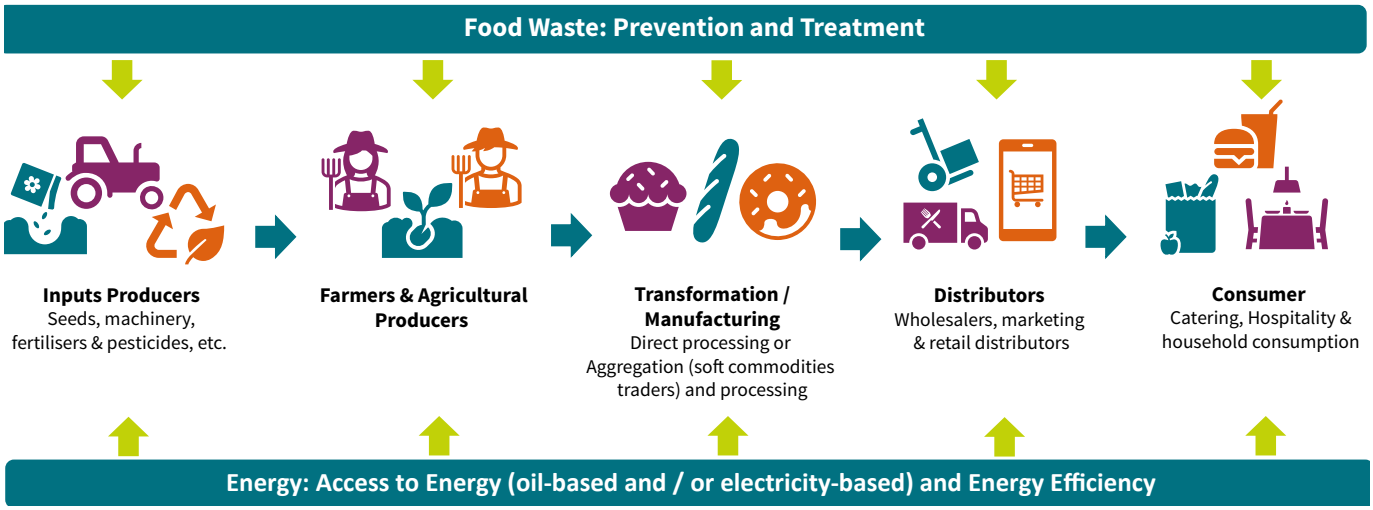
[2] Land Use, Our World in Data, September 2019

[3] Chart: Globally, 70% of Freshwater is Used for Agriculture, World Bank, March 2017

Challenges in the value chain

The climate and biodiversity challenges of the food sector are global. Therefore, to seek real change on the ground, we think investors should adopt a holistic, value-chain approach allowing them to spot issues and transformation opportunities at each step, from food production to distribution and consumption.

We have worked to retrace in detail this structure, starting with input products, and then sought to identify, step by step, the key climate and biodiversity-related issues for investors seeking to structure their approach to the transition to sustainable food:



Source: AXA IM

While different pillars of the food value chain can usually be associated with specific environmental issues, we noticed during our research that two challenges in particular are faced by all the agents of the food industry at each of its value-chain levels. These are: **Food waste** and **access to clean energy and its efficient use.**

In its 2019 flagship State of Food and Agriculture report, the Food and Agriculture Organization of the United Nations (UN FAO) focused on waste and loss along the food value chain.[4] It concluded that almost 14% of food produced was lost between the farm and the retail point.

This number is higher for more fragile or sensitive crops, such as fruits, vegetables, roots and tubers, and is slightly lower for meat production. Central and Southern Asia, North America and Europe show higher food loss rates than other regions.

Two impactful academic studies have also sought to quantify this problem. One study estimates a similar level for food loss at 14% and adds 9% from food wasted by retailers and consumers.[5] Another also factors in 9% of end-of-life waste.[6]

[4] The State of Food and Agriculture 2019, Food and Agriculture Organization of the United Nations, October 2019

[5] Reducing food's environmental impacts through producers and consumers, J. Poore and T. Nemecek, Science magazine, June 2018

[6] Food systems are responsible for a third of global anthropogenic GHG emissions, M. Crippa et al, Nature magazine, March 2021

According to these estimates, 20% to 25% of the food produced is not eaten. Assuming losses reflect roughly the food production mix (even though losses are slightly lower for higher intensity meat production), this suggests that up to a quarter of the GHG emissions from the value chain may have had no purpose.

Access to energy and energy consumption may contribute to food waste, namely food loss related to inadequate storage and transportation conditions. At the same time energy consumption and efficiency remains one of the key challenges for the global food industry.

The UN FAO estimates that energy is the main source of carbon dioxide (CO_2) for the food value chain, accounting for a third of its emissions.[7] Modern agriculture is an energy-intensive activity. Mechanisation means fuel consumption – primarily diesel – for equipment such as tractors or combine harvesters, while irrigation requires electricity to power pumps. There are large regional discrepancies, with richer countries relying more on mechanised and irrigated agriculture, consuming more energy. There is also a large energy footprint before the farm gate – for instance to produce GHG-intensive synthetic fertilisers – as well as after, through processing, distribution and retail, which consumes energy through transportation and refrigeration.

To combat these transversal issues successfully will likely require collaboration between all players in the food value chain. We think helping to embed that sense of shared responsibility towards a common goal could be a part of the role for responsible investors.

Common action requires a common understanding of the drivers at work, and of the particular climate and biodiversity issues associated with the food industry value chain.

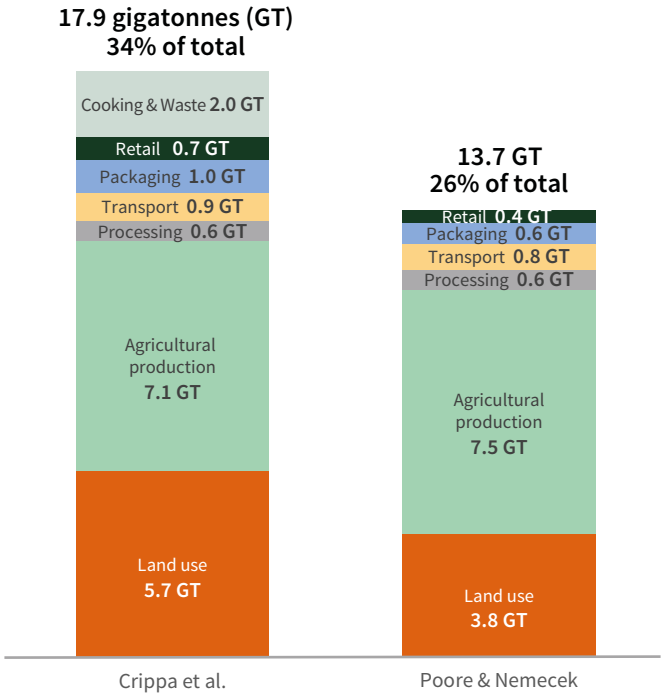
[7] Agrifood chains, UN FAO, retrieved April 2023

Global food industry:
Climate-related challenges

The Intergovernmental Panel on Climate Change (IPCC) published a special report on climate change and land degradation in 2019, where it combined several studies measuring GHG emissions along the entire food value chain. Data for 2007-2016 suggested food ecosystem emissions represented between 21% and 37% of total global GHG emissions.[8]

The following graphic shows a breakdown of sources of emissions along the food value chain, according to two studies with slightly different methodologies. With those elements accounted for, we can conclude that emissions throughout the full food value chain represent a good 30% of total anthropogenic emissions.

GHG emissions from the food system



Source: Crippa et al., Poore and Nemecek; AXA IM

A large proportion of emissions come from animal husbandry, i.e., feeding and raising animals to feed people, while the overall footprint of growing crops to feed livestock and the land needed to raise it is very large. The UN FAO estimates 33% of croplands are used to for livestock feed production.[9]

There are some clear conclusions we can draw from these data points. Most emissions in the food system come from food production itself; the second-largest source is change in land use, typically deforestation to grow crops or herd grazing – and although emissions after food leaves the farm are somewhat dwarfed by the first two categories, they remain non-negligible.

A unique trait of the food value chain is that CO_2 accounts for only half of its GHG emissions, compared to three quarters for global emissions. Methane and nitrous oxide, two gases with a much stronger effect on global warming, are responsible for the other half.[10] Methane comes mostly from enteric fermentation from ruminant animals – cows, sheep and goats – and from rice paddies (organic fermentation in water), while nitrous oxide is largely generated by the microbial degradation of nitrogen fertilisers.[11] In one analysis, methane accounts for 35% of food system emissions, and nitrous oxide for 10%.[12] By contrast, methane makes up 17% of global GHG emissions and nitrous oxide 6%.

The very strong warming effects of those gases warrant specific attention from investors. Methane packs a lot of warming punch, but it also has a short lifespan in the atmosphere.[13] This means that if investors can encourage emissions reduction plans at methane-exposed companies, it may well deliver rapid positive results.

[8] Special Report: Climate Change and Land, IPCC, 2019

[9] Livestock and Landscapes, UN FAO, 2012

[10] According to the IPCC, a molecule of methane warms the atmosphere 28 times more than a molecule of CO_2, while it is 273 times for a molecule of nitrous oxide.

[11] Enteric fermentation is a digestive process by which microorganisms break down feed into simpler molecules that animals can absorb. Methane is produced in the rumen (a multi-chamber stomach) as microbial fermentation takes place.

[12] Food systems are responsible for a third of global anthropogenic GHG emissions, M. Crippa et al, Nature magazine, March 2021

[13] Methane has an average lifespan of 12 years, compared to several centuries for CO_2.

Uneven emissions

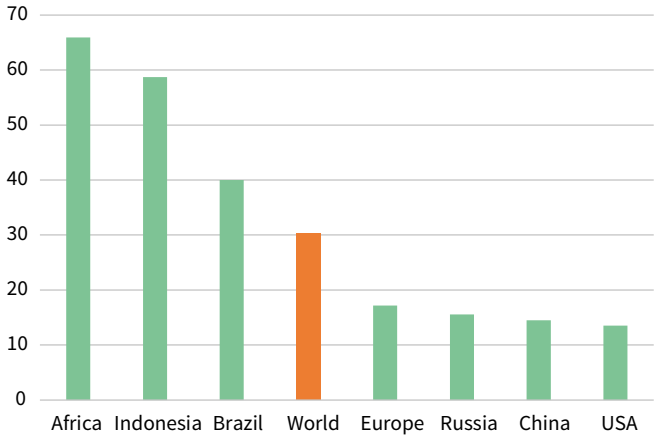
Another striking feature of agricultural production is the large differences in GHG footprint. Simply put, animals have a much larger impact than plants. One UN FAO study from 2020 showed that cows used for meat and milk accounted for more than half of emissions from farming – add in other ruminant animals and that figure rises to 70%.

For investors seeking to analyse the impact of their portfolio holdings there are some key lessons to draw. Academic studies and the UN FAO broadly agree that animal proteins have a much higher GHG footprint than vegetal proteins. This largely comes from the large land footprint needed to grow feed crops and to provide pasture, and from enteric fermentation. But there can also be large differences for the same product depending on region and practices.

The UN FAO's intensity indicator shows GHG emissions per kilogram of product and in the graphic below we can see that the intensity measure for cattle meat highlights stark differences between large beef-producing areas.

In the same data set, the UN FAO indicates the average intensity for rice and cereals are far lower, in fact beef is 27 times more GHG-intensive than rice and 168 times more than cereals.

GHG intensity for cattle meat



Source: UN FAO; AXA IM. Units are kg of CO_2 equivalent per kg of product.

An academic study of close to 40,000 farms made a similar point about intensity but drilled down to deliver an estimate of how much protein was produced for each kilo of GHG and including all value chain emissions. Their conclusion was that protein from beef production was deeply inefficient when set against that from wheat or rice.[14]

Interestingly, the analysis also underlines the large variation of intensities within a product category. Most often, the median is lower than the mean, which implies there are several high-intensity producers which weigh heavily on the average intensity. The range is especially high for beef, farmed fish and rice, and is relatively low for cash crops such as wheat and maize. This is clearly of immediate interest to any investor seeking to moderate the climate and biodiversity impacts of companies in their portfolios. It also implies that careful analysis of those individual impacts, and subsequent adjustments to portfolios may be able to deliver outsize positive effects, when set against a reliance on 'average' data.

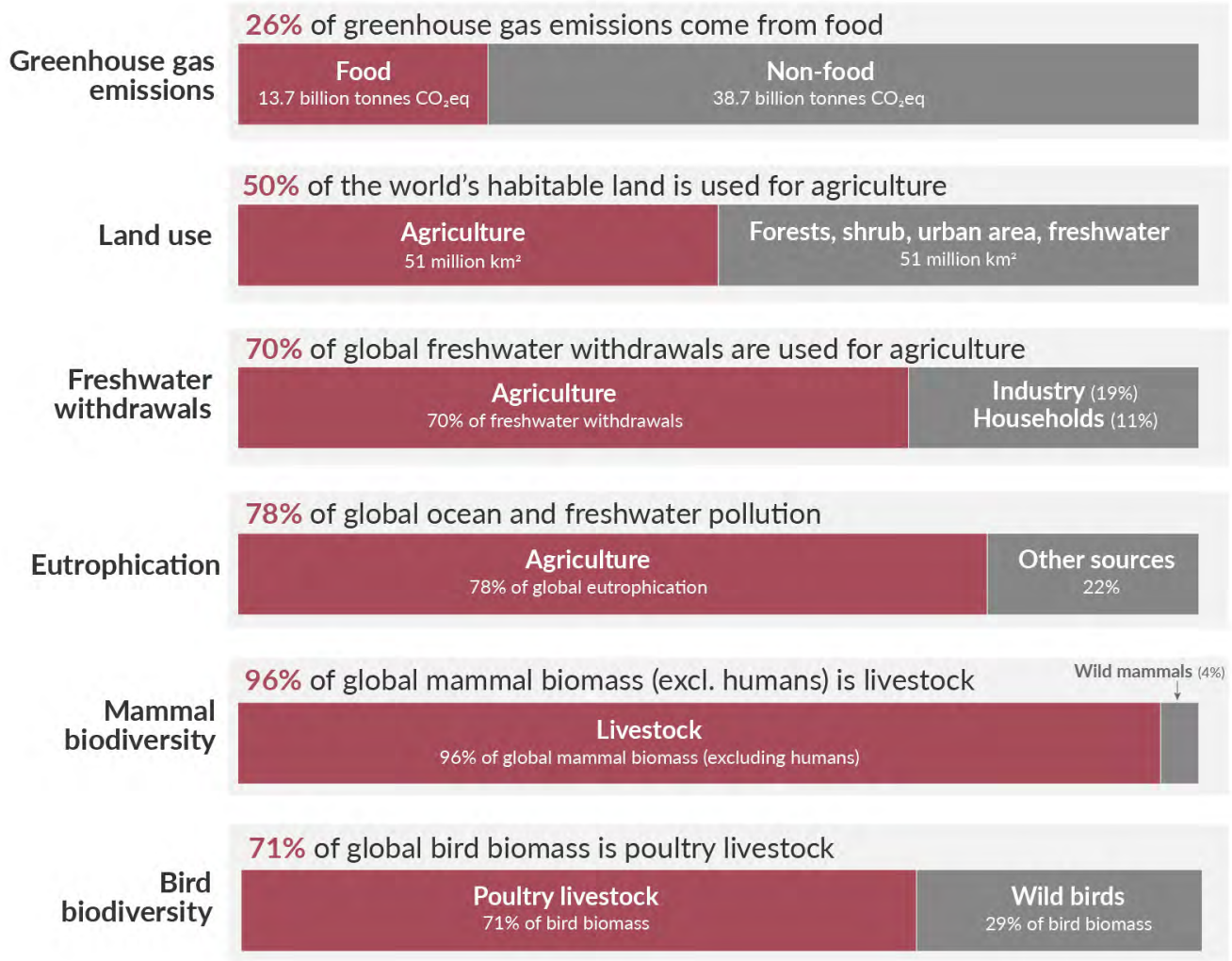
[14] Reducing food's environmental impacts through producers and consumers, J. Poore and T. Nemecek, Science magazine, June 2018

Global food industry:
Nature-related challenges

About half of the Earth's habitable land surface is used for agriculture, which is the cause of almost 90% of global deforestation and accounts for almost 70% of water consumption.[15, 16] Together with the broad problem of biodiversity loss and modification of ecosystems and landscapes, these impacts show the scale of the problem that intensive agricultural practices present today.

Agriculture is the world's largest industry – employing more than one billion people and generating over $1.3trn worth of food annually[17] – the transition to a future sustainable model that protects and preserves biodiversity and works to mitigate the damage of climate change is therefore a truly systemic challenge.

The environmental impacts of food and agriculture



Source: Poore and Nemecek (2018); UN FAO; UN Aquastat; Bar-On et al. (2018). Our World in Data

[15] COP26: Agricultural expansion drives almost 90 percent of global deforestation, UN FAO, November 2021

[16] Liquid assets: Why water stress should be a priority for responsible investors, AXA IM, December 2022

[17] Impact of Sustainable Agriculture and Farming Practices (worldwildlife.org)

The agrifood sector is a significant contributor to biodiversity loss. Agricultural activities at every stage of the value chain generate pressures on natural capital driving ecosystems degradation.[18] Identifying clearly how each of the segments of the industry value chain impacts biodiversity is highly important not only to mitigate the issue (and thus the risk for investors), but also to develop concrete solutions allowing effective transition to a sustainable food model.

The 2019 Global Assessment Report from the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) showed that the collapse of terrestrial biodiversity is primarily due to changes in land use, mainly for agriculture and the production of animal products. At the same time, the intensification of agriculture has doubled the consumption of water and pesticides – and tripled that of fertiliser. Three-quarters of agricultural use of soil is intended for the breeding of animals and the production of cereals for their food.

It may seem logical that to satisfy the diet of a growing world population, it is enough to bring new land into cultivation. However, we must consider that land is a finite resource. The world's habitable land equates to about 106 million km² and this will vary little in the coming century, if not fall due to the rise in the level of the oceans because of climate change.[19]

Upstream pressures on biodiversity

There are four main biodiversity pressure points from so-called 'upstream' agriculture – that is, inputs and producers. These are change of land use (land occupation, transformation and soil erosion); overconsumption of natural resources – new production trends; water pollution from fertilisers and pesticides; and air pollution.

Change of land use

The livestock sector is by far the most significant in terms of land use. Grazing occupies more than 25% of the Earth's land surface, while fodder production requires about one-third of all arable land.[20,21] With increasing overgrazing, soil compaction and soil erosion from livestock activities comes degradation of local ecosystems, with native habitat destruction and fragmentation having an extreme effect on the presence and healthy development of local species.

Soil erosion results from a combination of factors – climate, agriculture and livestock. Growing crops has a greater impact on soil than livestock farming; the former can mean destruction of the plant cover and sometimes make soil erosion worse – something as simple as ploughing up and down a slope, rather than across it, can have negative effects. Conversely, the impact of livestock on soils can be considered more important in terms of its geographical extent, due to the greater proportion of rangelands compared to crops in arid zones.

Moreover, the need to expand and occupy more land for agriculture and grazing actively contributes to deforestation. Agriculture now occupies a third of the global land area.[22] And according to FAO, more than half of forest loss worldwide is due to conversion of forest into cropland, whereas livestock grazing is responsible for almost 40% of forest loss.[23] Today, the forest areas reclaimed by agriculture are located in South America and Africa, which raises questions about the preservation of natural biodiversity in those regions and the world.

Turning to the oceans, the 2019 IPBES report found that industrial fishing is the main cause of ocean decline as fleets cover 55% of the seas, often illegally or unregulated.

[18] The agrifood sector contributes to all five direct drivers of biodiversity loss as defined by the IPBES. These are: Land use change; climate change;

[19] Land Use, Our World in Data, September 2019

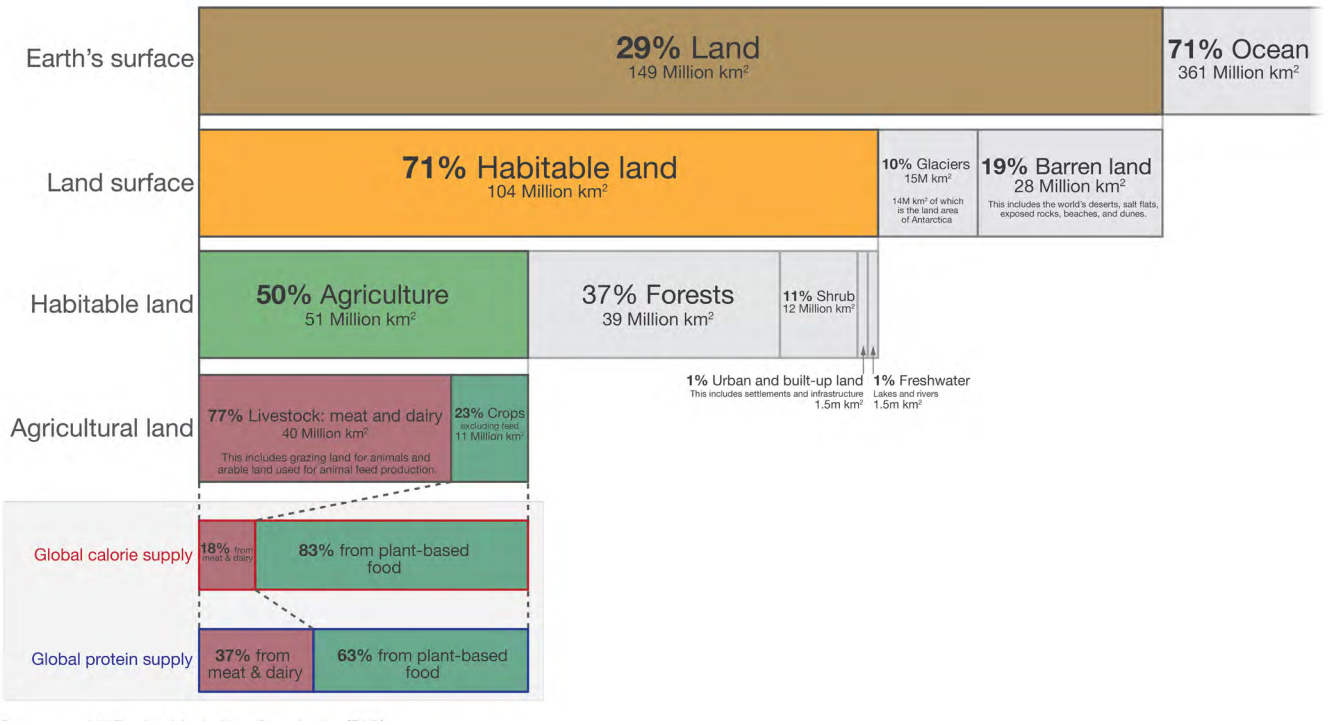
[20] Land use in agriculture by the numbers, UN FAO, May 2020

[21] Sustainable agricultural development for food security and nutrition: What roles for livestock? UN FAO, July 2016

[22] Land use in agriculture by the numbers, UN FAO, May 2020

[23] COP26: Agricultural expansion drives almost 90 percent of global deforestation, UN FAO, November 2021

Global land use for food production



Source: UN FAO, Our World in Data, November 2019

Overconsumption of natural resources

Food production accounts for more than 70% of global water consumption. In regions with scarce water resources, the amount of water used for animal production could easily exceed that used to meet human food needs. It is estimated that to produce one litre of milk it takes 990 litres of water if the whole value chain is accounted for.[24]

The sheer number of animals bred for food also poses a threat to the Earth's biodiversity. Livestock (mostly cows and pigs) makes up about 60% of the biomass of all mammals, and the area they occupy today was once the habitat of wildlife.[25] Livestock breeding and increasing food production globally are the main causes of natural habitat conversion into agricultural land; the resulting habitat loss is identified as a main threat to 85% of all species described in the IUCN's Red List.[26,27]

The world's livestock production is based on about 40 animal species, with only a handful providing most of the meat, milk and eggs. Nearly a third of fish stocks are overfished, and more than half have reached their sustainable limit.[28]

The diversity of plant species is also under threat. Of some 6,000 plant species cultivated for food, fewer than 200 contribute substantially to global food output, and only nine account for 66% of total crop production, among them maize and rice.[29]

With such high concentration in terms of the number of species cultivated comes another problem – keeping the yield at its highest level. One way this is addressed is through genetically modified organisms (GMOs), where certain species are thus reproduced with enhanced

[24] Livestock's long shadow, UN FAO, 2006

[25] Humans and Big Ag Livestock Now Account for 96 Percent of Mammal Biomass, EcoWatch, May 2018. The biomass distribution on Earth, Proceedings of the National Academy of Sciences of the United States of America, May 2018

[26] The IUCN Red List of Endangered Species, International Union for Conservation of Nature and Natural Resources, February 2022

[27] Losing their homes because of the growing needs of humans, WWF, retrieved April 2023

[28] The biodiversity that is crucial for our food and agriculture is disappearing by the day, UN FAO, February 2019

[29] The biodiversity that is crucial for our food and agriculture is disappearing by the day, UN FAO, February 2019

characteristics. That might suggest that an investor could look to GMOs as a way to address the effects of biodiversity loss. However, the use of GMOs brings additional challenges:

- GMOs are often engineered to be herbicide resistant. But farmers may then use more herbicides than necessary, polluting the environment. Herbicides are often produced by the same firm that provides the seeds the farmer sows, creating a supply chain dependency. And given most genetically modified plants are sterile; farmers need to buy new seeds every year to continue growing crops
- The effects can be short-lived. Insects can develop a tolerance or resistance to the GMO protein introduced to plants, while there can also be an unintentional, undesired impact on insects that are beneficial to the natural ecosystem, such as bees
- The introduced gene may encode a new, unknown, and allergenic protein, posing potential allergy risks to humans

Concentration in the seed market: Three agrochemical companies – Bayer, Corteva and Syngenta – together control over 50% of the global seed market, while the 10 largest companies account for around 70% of the market.[30]

Such limited number of suppliers can potentially lead to the concentration of research and development on a limited number of seed varieties. At present 40% of the research carried out by the private sector is concentrated on a single species – maize.[31] This could also represent a barrier to entry for new companies and can mean anti-competitiveness that can lead to massive price increases for seeds.

Another threat comes from antibacterial resistance. This can cover issues like antibiotic resistance, antiviral resistance and resistance to antiparasitics and is mainly driven by the misuse and overuse of antimicrobials for species enhancement – antibiotics for cattle breeding, for instance. This can bring direct threats to biodiversity and human health.[32] Investors could benefit from focused discussions with food companies to assess whether they have a formal position on the use of such substances in their products and how they work with their supply chain to effectively manage related risks.

Water and air pollution

Livestock breeding is considered the single largest sectoral source of water pollutants – primarily animal waste, antibiotics, hormones, tannery chemicals, fertilisers and pesticides used for forage crops, and eroded pasture sediments.

According to some research in the US, livestock and farming forage crops for animals to eat can be responsible for 37% of the use of pesticides, 50% of the use of antibiotics, and one-third of nitrogen and phosphorus loads to freshwater resources.[33] The sector also generates nearly two-thirds of anthropogenic ammonia, largely through animal faeces, which contributes significantly to acid rain and the acidification of ecosystems.

Volatilisation of ammonia – where nitrogen in soil changes into ammonia, and escapes into the atmosphere – is a key contributor to air pollution. In Europe the agriculture sector remains responsible for more than 90% of the total ammonia emissions.[34]

[30] The dangerous concentration of the seed market, Public Eye, retrieved April 2023
[31] The dangerous concentration of the seed market, Public Eye, retrieved April 2023
[32] Antimicrobial resistance, World Health Organization, November 2021
[33] Impacts de l'élevage sur l'environnement, Conservation Nature, retrieved April 2023
[34] Archive:Agri-environmental indicator - ammonia emissions, Eurostat, May 2018

Midstream and downstream pressures on biodiversity

Most manufacturing processes cause, to varying degrees, GHG emissions, waste and pollution, which all can have impacts on ecosystems. When it comes to food manufacturing the main impacts are still those related to the 'upstream' – resources production. But the 'midstream' part of the value chain is responsible for transforming our food from agricultural products into something that can be eaten – including processed foods. Research suggests that the unhealthiest foods in many cases would have the highest environmental impact.[35]

Overconsumption of resources

It is impossible to create a perfect food system, so overproduction is baked in – the alternative is unthinkable – but overconsumption is correlated to that and brings problems of its own. We have more food today but is it of better quality? Consumers tend to overeat ultra-processed foods, thanks to their convenience and highly palatable ingredients (including additives) that arguably never quite seem to fill us up. Many highly-processed foods are relatively low in fibre and nutrients – one study found that subjects who ate an ultra-processed diet for two weeks ate on average 500 more calories a day than those put onto a diet consisting of unprocessed food.[36]

However, processing food may still have its advantages, namely, to reduce food waste in case of fresh perishable products. One study found that waste from processed fruit and vegetables is around 14% lower than that of fresh fruit and vegetables, and wastage of processed fish and seafood is 8% lower.[37] Beyond that, processed food may contribute to food security.

Still, the challenge for companies in the food industry – and for responsible investors – is to ensure the scale and quality of production matches as closely as possible what is required to ensure safe and healthy nutrition for all. And this all takes place in a quite complex context of global consumption trends – consumers eating more means overproduction escalates – that increase the pressure on natural capital. This brings with it higher greenhouse gas emissions, increased use of packaging – which contributes to plastic pollution – and more.

Packaging and plastics pollution

Food packaging requires resources like energy, water, chemicals, petroleum, minerals, wood and fibres. Its production can generate greenhouse gases, heavy metals pollution and particulate emissions, as well as wastewater and/or sludge containing toxic contaminants.

About two-thirds of all packaging produced is used for food, and unfortunately, most packaging is designed as single-use, and typically thrown away rather than reused or recycled.[38] According to the US Environmental Protection Agency, food and food packaging materials make up almost half of all municipal solid waste.[39]

Ultra-processed food tends to have more packaging than minimally processed and unprocessed foods – which has implications for the environment in terms of production, transportation and waste. More than 70% of packaged foods in the US are classified as ultra-processed food and represent about 60% of all calories consumed by Americans.[40]

Globally, the failure to account for the environmental cost of food production and fairly represent it in food pricing is one of the major challenges to be addressed at each step of the food value chain, including downstream (distributors, retailers, and consumers). Biodiversity protection is eventually a matter of our global eating habits.

[35] Multiple health and environmental impacts of foods, National Library of Medicine, October 2019

[36] Ultra-Processed Diets Cause Excess Calorie Intake and Weight Gain: An Inpatient Randomized Controlled Trial of Ad Libitum Food Intake, Cell Metabolism magazine, May 2019

[37] Reducing food's environmental impacts through producers and consumers, Science magazine, June 2018

[38] The FoodPrint of Food Packaging, FoodPrint, November 2019

[39] The Environmental Impact of Food Packaging, FoodPrint, October 2018

[40] Feeling anxious or blue? Ultra-processed foods may be to blame, ScienceDaily, August 2022

What can investors do to drive a sustainable transformation?

Understanding these pressure points is the first step. It should give investors the tools to play their role in this transition by asking the right questions to food industry companies and by supporting sustainable solutions in each of the areas where we have identified problems. That said, not all the pillars of the value chain may be immediately visible to all investors and the areas in which they are able to take action may differ depending on the company and the investors' exposure to that company.

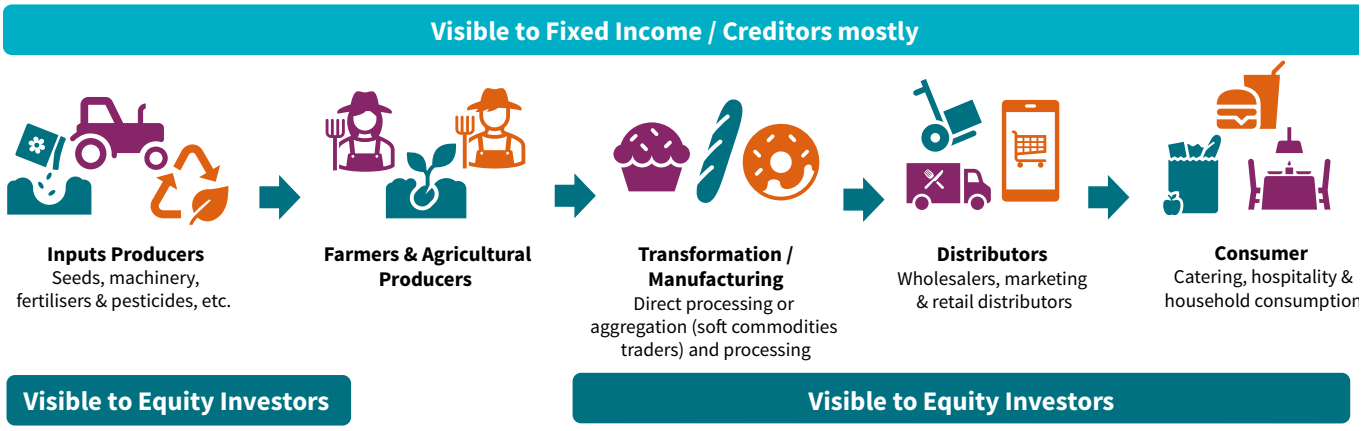
For example, investors in listed equities could have sight of, and be able to engage with, input producers, manufacturers, retailers and distributors across the food industry. However, as we have seen, most of the natural resource use and environmental impacts that take place along food value chains occur at the primary production stage through practices such as farming crops, raising livestock and fishing. So how can investors play their part in addressing GHG emissions and biodiversity loss, if most of them do not have a direct exposure via listed markets to those producers?

Investor visibility through the value chain

Farms, orchards, livestock pastures and animals are most often owned and operated by individuals or small companies and are not listed on stock markets. There are a few exceptions, for instance large palm oil companies listed on Asian stock markets, but it can nonetheless be difficult to instigate dialogue perhaps due to language barriers or a lack of experience around engagement with investors. It may well be that equity investors will have only an indirect influence via engagement with manufacturers and distributors. Any concerted engagement strategies should account of this, in our view.

Bond holders, and especially credit investors, however, may have a broader exposure to the food industry, as actors along the food value chain use banking credit lines and/or bonds issuance.

Globally, and with focused research, we think investors can give themselves visibility and levers of action, first on input producers, large food and beverage companies, grain and commodity processors and traders, retailers and certain catering or restaurant chains. This means that engagement dialogue would then be structured around so-called 'Scope 3' risks (indirect impacts from a company's supply chain and customers) and opportunities for the companies engaged with by investors, without direct discussions taking place with the farming segment.[41] This is exactly the position we are taking in this paper, and we propose a corresponding engagement approach on the following pages.



Source: AXA IM

[41] Scope 3 refers to indirect impacts from a company's supply chain and customers. Scope 1 and 2 relate to direct impacts from production and resources use. Studies have shown that about three-quarters of food and beverage company GHG emissions are Scope 3. (CDP Technical Note: Relevance of Scope 3 Categories by Sector, CDP, April 2022)

Active engagement with global food industry:

Reducing climate and biodiversity impacts and encouraging development of sustainable solutions

As we have seen, more than 70% of emissions are generated before the farm gate, and most of the biodiversity impacts also occur there. While this means that significant efforts must be focused on this link of the value chain, there are also roles to play within broader technological changes and from consumers.

In our view, there are three fundamental questions that are key to the transformation of the industry:

What types of food will we produce and consume? Here, we should tackle the species cultivated (input producers and farmers), the transformations taking place for individual ingredients (manufacturers) and the eventual choices made by consumers (see purple sections in the table below).

How will we produce and consume food? Here, we should look at the transition to more sustainable agricultural practices (farmers) but also to more environmentally-efficient manufacturing and the reduction of food waste at every stage of the value chain (see orange sections in the table below).

Where will we produce and consume food? Here, we should look at the interplay between the locations of production and consumption, the trading patterns of raw and processed food, and sourcing by transformers and retailers (see green sections in the table below).

We think that if investors can successfully tackle these three fundamental questions it will create the conditions for better management of how we produce and consume food – the aim being to create a balance between the need to ensure healthy diets for all and the urgency to decrease the climate and biodiversity impact of the food industry.

The table below summarises our previous conclusions in terms of climate and biodiversity issues and risks specific to each level of the global food value chain and highlights at the same time highlights possible solutions that can help drive the transitions of each of the food value chain segments towards low-carbon and nature-positive business models and practices.

Based on this mapping of challenges and potential solutions, we think it is possible to identify and formulate an active engagement strategy. This should allow investors to capture many of the fundamental questions to ask companies in the food value chain and help management to address biodiversity and climate challenges in their industry. We have also identified several solutions investors may want to support while engaging with food companies.

Biodiversity engagement points for investors in the food value chain

		Value chain sector				
		Inputs Producers (equipment, fertilisers, seeds)	Farmers & Agricultural Producers	Transformation / Manufacturing	Distributors	Consumer / Catering & Hospitality
Themes	Energy	Shift to renewables; access to energy and energy efficiency				
	Waste	Better logistics / "waste shaming"				
	Climate	Decarbonisation of engines	Livestock management		Stores proximity	
		Green fertilisers				
	Biodiversity loss	Right application of fertilisers	Pollution prevention and control	Packaging, plastics		
		Seeds variety (GMO share) and support small producers	Variety of species cultivated			
	Combined/ other		Sustainable farming & fishing practices	Sustainable sourcing		
			Localisation	Environmentaly efficient operations		Choice of diet / menu
				Level of food transformation and nutritious value		

Key engagement questions

We propose here a short list of questions that investors should ask companies in the food value chain. They are deliberately broad in an effort to encompass the various links in the chain and to cover the what, how and where. Each subject could be refined into more targeted questions. For instance, the sustainable sourcing of sensitive crops like coffee or cocoa easily warrants dedicated engagement, and the issue of waste and loss is clearly different when addressed by a farmer, a trader, retail companies or restaurants.

1. How can you reduce GHG emissions from energy needs in own operations, be it for equipment, processes, or buildings?
2. What are the best practices in terms of the use of fertilisers, pesticides and other chemical and pharmaceutical substances, and can you further improve them in your own activities or in your supply chain?
3. What are the levers and actions to reduce waste and food loss in your operations and with your suppliers and customers?
4. What is your policy against deforestation and ecosystems conversion?
5. What is your sustainable sourcing policy and how do you ensure that it is properly applied?
6. What is your policy in terms of meat sourcing, notably relating to livestock management?
7. What is your policy in terms of GMO and the variety of species cultivated?
8. Do you have a policy to reduce the volume and nature of packaging, notably plastics?
9. How do you support local sourcing and small producers?
10. How do you integrate nutrient values and diet balance in your product offering?

Solutions and levers to act

There are many ways for companies and farmers to act to reduce both climate and biodiversity impacts of the global food industry. Some of those actions are practical and technologically mature; others however relate more to consumer behaviours and to broader cultural and social norms. We think responsible investors may be able to reduce risks to their portfolios and encourage long-term resilience within the food industry, and the wider economy, if they push for companies to take some of these important measures.

Protecting forests and natural habitats. Actors in the food sector should commit to stopping deforestation and the degradation of natural habitats, in their own operations and along their value chains. Public policies penalising poor behaviours and practices are also likely to escalate, posing new risks.

Changing agricultural practices. There is a wide range of impact levels from farm to farm, hence sharing best practice can yield environmental benefits. Regenerative farming, cover cropping, (plants which among other things slow erosion, improve soil health and increase biodiversity), and agroecology – applying the ecological principals in farming – as well as less and better use of fertilisers, chemicals and pharma products, are some of those practices. While those changes can make sense almost everywhere, there are however often specific local constraints that would necessitate tailor-made solutions.

Decarbonise energy. This is not solely a food value chain problem, of course, but the industry would benefit from cleaner engines for large equipment and from expanded use of renewable electricity supply. Ensuring access to clean energy is also an important driver of the industry transition to more sustainable practices.

Reducing waste and loss. We have seen that up to 25% of the food produced ends up wasted or lost. Lowering this number would benefit the environment, by reducing GHG emissions and pressures on land ecosystems. There are many levers to pull; among the key ones are:

- Improving logistics and distribution: Swifter access to the markets, better storage and better refrigeration, to reduce losses prior to the end consumption

- Changing consumer behaviours: Easier said than done, but there is too much food ending up wasted (at home or in restaurants)

Sustainable sourcing. Manufacturers and distributors should develop sourcing policies that integrate sustainability, including strong environmental criteria, as well as social elements. Progress should be made on traceability to reach farm/field level of visibility within the supply chains, when necessary. Environmental and social actions should then be adapted to local challenges and constraints. End-consumers should be encouraged to change their buying patterns and select sustainably sourced and local or seasonal food products.

Changing diets. Most studies highlight the imbalance in the way humans eat, not only excess calorie intake (alongside lingering undernourishment in parts of the world), but also a food mix too heavily skewed to protein and meat. The generic advice is clear: Less meat, more fibre.

The World Resource Institute has published a study where they put it very simply:

1. Reduce overconsumption of calories

2. Reduce overconsumption of protein by reducing consumption of animal-based foods

3. Reduce consumption of beef specifically

The challenge here is first and foremost a social and cultural one. Changing behaviours, social codes and food traditions may turn out to be more difficult than changing agricultural practices.

[42] The State of Food Security and Nutrition in the World, UN FAO, 2022

[43] Shifting diets for a sustainable future, World Resources Institute, April 2016

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