Planet Tracker

FINANCIAL MARKETS ROADMAP FOR TRANSFORMING THE Global Food System

March 2023

A guide for the financial sector

CONTENTS

WHY READ THIS REPORT

The **global food system** is a significant source of **HARM** to the **climate**, to **nature** and to **society**

The global food system is a significant source of harm to the climate, to nature and to society. Unless it is transformed, financial institutions will be unable to meet their Net Zero ambitions and (more importantly) humanity will be unable to meets its ambitions to limit climate heating to +1.5°C by 2050, and to restore nature and achieve the UN's 17 Sustainable Development Goals (including 'zero hunger') before 2030. The financial consequences of this collective failure will be significant.

Private finance has a major role to play in supporting and driving the required transformation of the food system. We estimate nearly USD 9 trillion of private finance is currently supporting the global food system (63% of its estimated asset value of USD 14 trillion) and that private finance already has the capacity to provide c.USD 630 billion annually.

This report sets out **four food system transformation themes** that financial institutions should focus on to ensure they are aligning their capital and investment processes with the food system changes required:

- **Responsible supply chains**
- **Increase food system (true cost) efficiency**
- **Reduce pollution**
- **Sustainable product offerings**

Financial institutions should use these themes as the basis to construct a food system investment strategy to guide their capital allocation and engagement with companies and governments.

For those financial institutions that want to take immediate action we have identified **six Priority Actions** to achieve before 2030 that fit within our Four Themes framework and have the potential to significantly reduce the harms coming from the current food system. Financial institutions can undertake all six Priority Actions or select those that best fit their investment philosophies and portfolios.

Financial Institutions should aim to achieve these Priority Actions before 2030:

#1 Fully traceable supply chains
#2 Halve food loss and waste
#3 Stop deforestation
#4 Cut methane emissions by 45%
#5 Make agriculture/aquaculture systems regenerative
#6 Invest in alternative proteins

HOW THIS REPORT IS STRUCTURED

The Executive Summary provides a short overview of the key points in the report, presenting Planet Tracker's conclusions and recommendations, as well as a summary of the potential benefits. The supporting evidence and arguments are contained in the main body of the report and the appendices.

The main report starts on page 25 with a brief summary of the objective i.e. the characteristics of a sustainable food system.

The report includes a detailed discussion of the harms arising from the current food system in Appendix 1 and the disastrous trajectory it will take if a business-as-usual approach continues to be funded by private finance (in Appendix 2). For the benefit of financial institutions the first part of this report focuses on the findings from our analysis of the Planet Tracker food system database. This captures financial data for 400,000 food system companies from 160 countries, and overlays this with environmental and funding data to provide a comprehensive, bottom-up view of the relationship between finance and the food system's harmful planetary footprint.

The report then sets out the ways in which private finance should contribute to the required transformation of the global food system using the four food transformation themes framework. The report puts this private finance framework in the context of the broader work that has been done on transforming the food system based around three food system transformation pathways.

Finally, the report sets out the **six Priority Actions** in detail, explaining what needs to be done and the benefits for humanity (and for financial markets) of doing so.

Benefit for humanity

and for financial markets

EXECUTIVE SUMMARY

The objective – a transformed global food system

A sustainable food system is one that delivers food security and nutrition for all without breaching planetary boundaries, and that is economically, socially and environmentally sustainable (climate, nature and people-positive).

Building on this framework, a sustainable food system can be defined as one that is:

- **Resilient** – able to withstand and adapt to challenges (e.g. a changing climate, wars etc);
- **Efficient** – maximising outputs and minimising inputs and losses, while operating within the doughnut of planetary boundaries and the social foundation, and maintaining its natural capital base;
- **Effective** – providing sufficient nutritious, culturally appropriate, food to all of a growing population and supporting livelihoods and wellbeing.

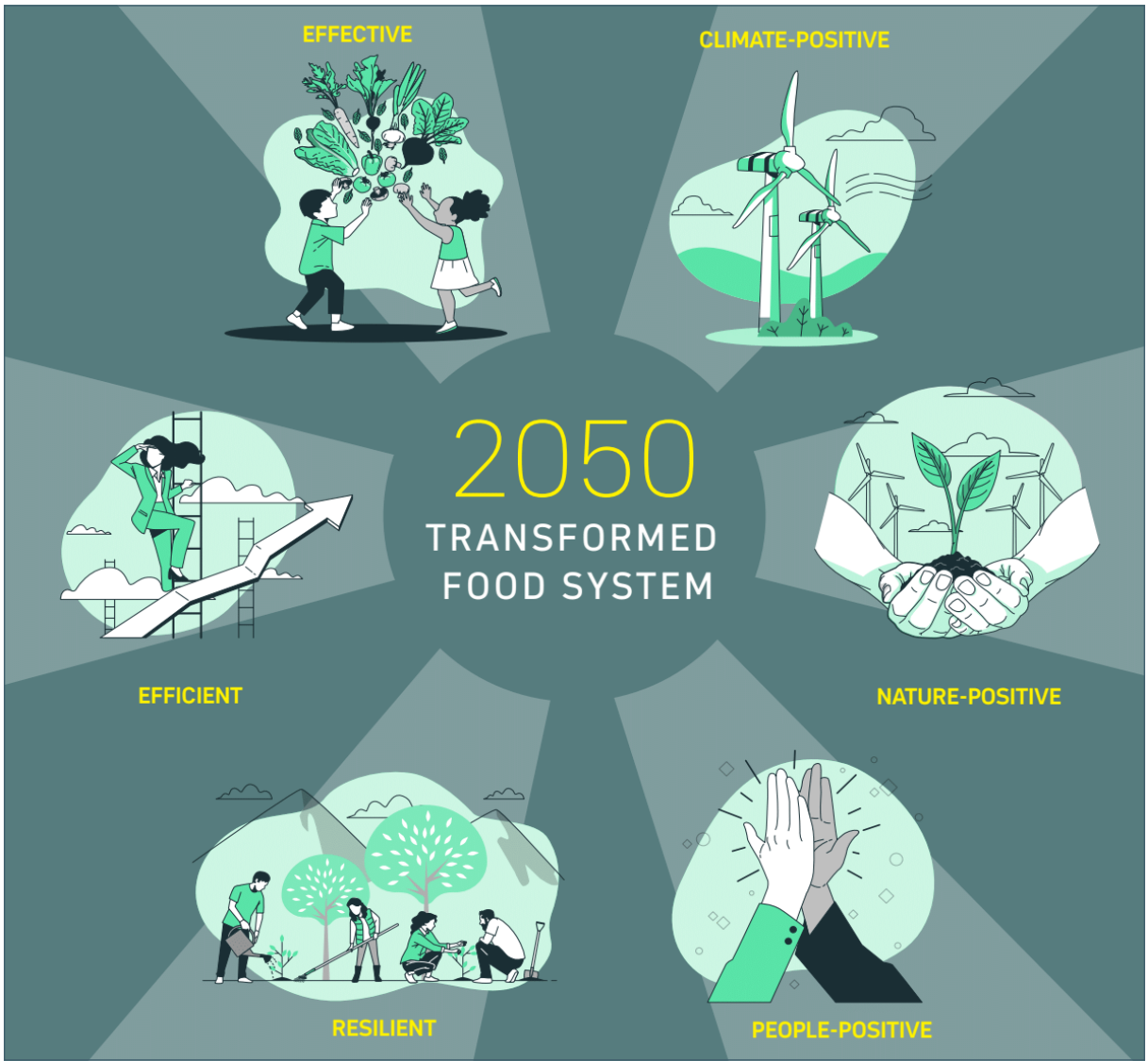


Figure 1: Characteristics of a sustainable food system in 2050. Source: Planet Tracker.

The environmental and funding footprint of the global food system

Planet Tracker has compiled a food system database that captures financial data for 400,000 food system companies from 160 countries, and overlays this with environmental and funding data to provide a comprehensive, bottom-up view of the relationship between finance and the food system's harmful planetary footprint – see Figure 2.

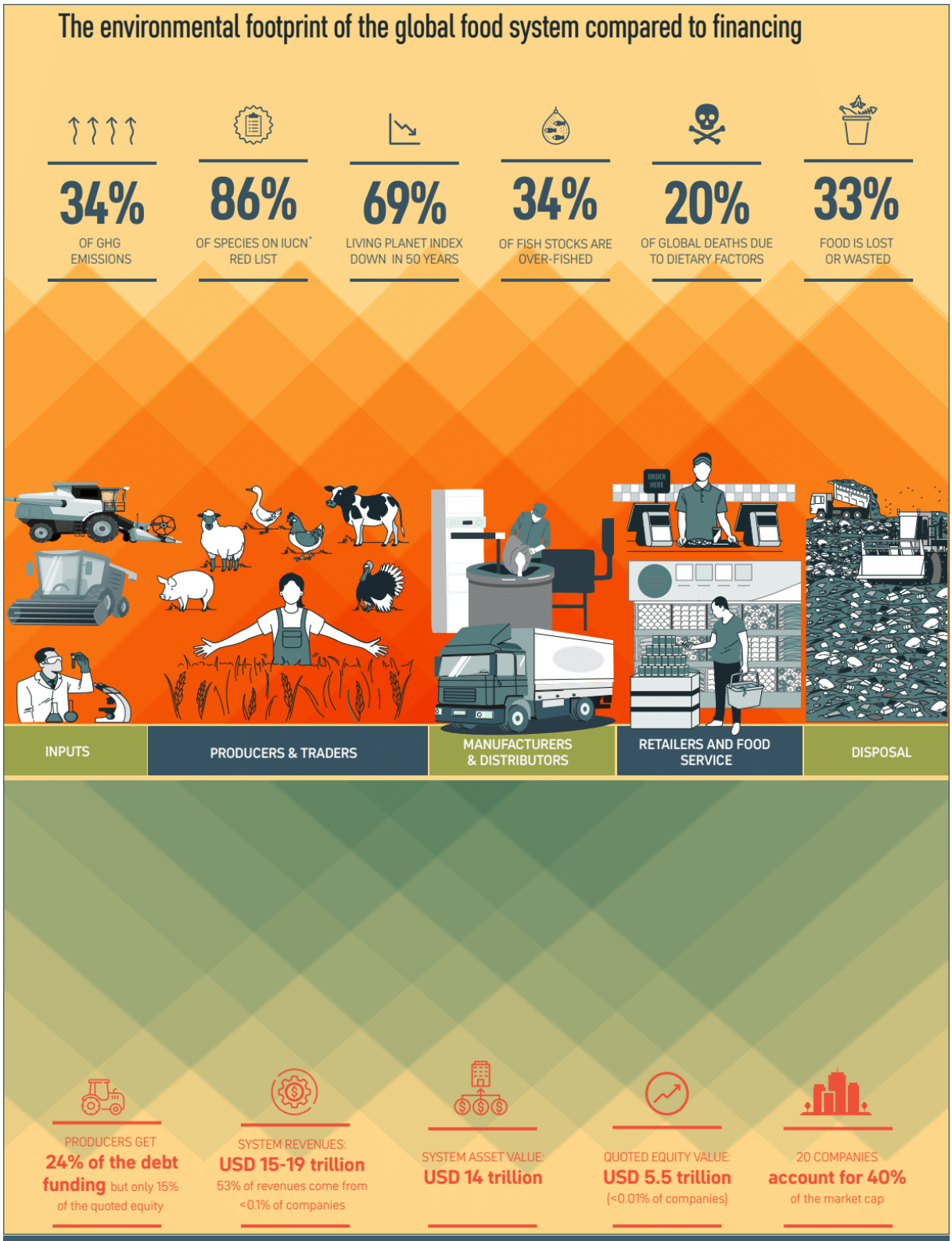


Figure 2: The environmental footprint of the global food system compared to financing. Source: Planet Tracker analysis.

* International Union for Conservation of Nature

Planet Tracker's food system database divides the food system into activity-based Segments and Nodes and allocates financial and environmental company metrics across these Nodes in line with the company's business activities – see Figure 3.

Figure 3: Food system Segments and Nodes. Source: Planet Tracker.

The funding provided by investors and banks is also split across the Segments and Nodes within the database to align with the company metrics. Our dataset contains c.17,300 investors and funders (banks and other providers of debt finance) providing c.USD 8.6 trillion of funding[1] to the companies in our database (63% of its estimated USD 14 trillion asset value), with the potential to provide annual funding of around USD 630 billion.

[1] Equities, bonds, and bank lending.

Figure 4 shows the mix of funding that is supporting this system, highlighting the importance of the equity markets, bank lending and retained profits.

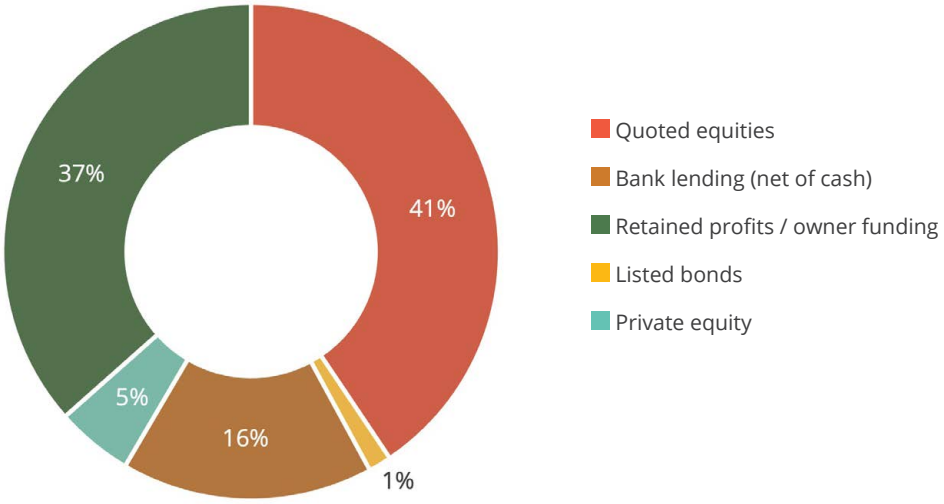


Figure 4: Global food system funding mix. Source: Planet Tracker analysis[2].

The majority of this funding is provided to companies in the manufacturers and distributors section of the food system – see Figure 5.

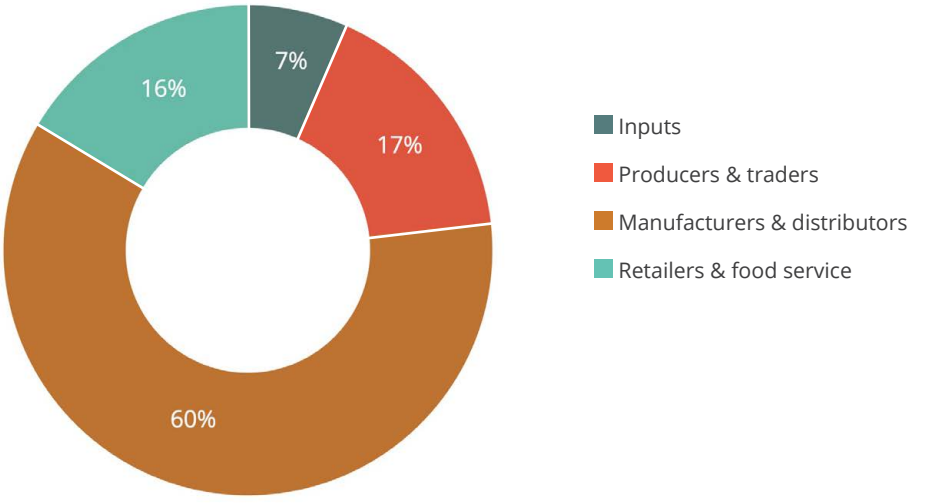


Figure 5: Distribution of external funding across the food system. Source: Planet Tracker analysis.

[2] NB: Bank lending is estimated based on an overall estimated debt figure less whatever is determined to be bond finance (so if bond finance is assumed to be higher, then bank lending will be assumed to be lower).

Financial analysis of the Planet Tracker food system database corroborates other studies that suggest that the majority of the profits in the system are captured by companies at the downstream end. Only 19% of the aggregate profits in the database are captured by producers and traders compared to 54% of the profits captured by food manufacturers and distributors as shown by Figure 6.*

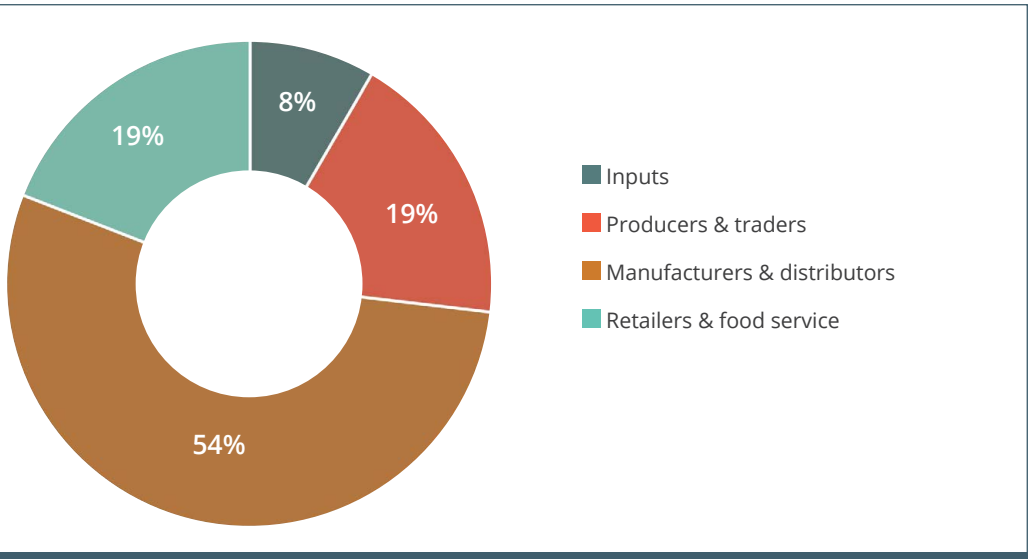


Figure 6: Distribution of profits across the global food system. Source: Planet Tracker analysis.*

Analysis of the GhG figures disclosed by the companies in our database shows that the environmental footprint of the food system separated from the funding and the profits since it is heaviest at the producer end of the supply chain – see Figure 7.

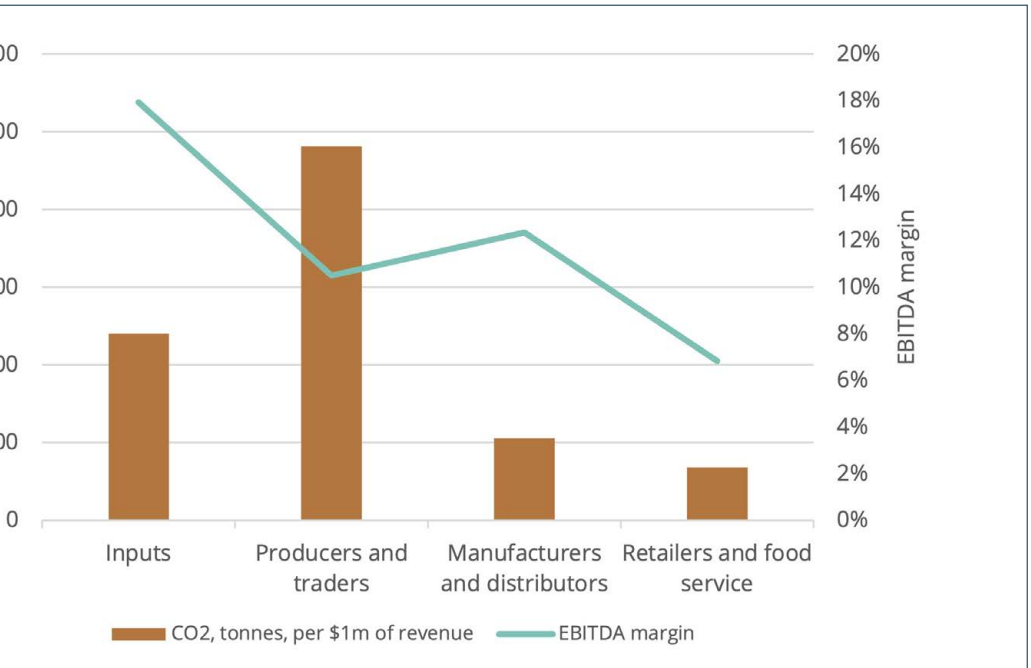


Figure 7: GhG intensity across the global food system supply chain. Source: Planet Tracker.

* An earlier version of this report incorrectly stated that 'Only 13% of the aggregate profits in the database are captured by producers compared to 47% of the profits captured by food retailers and food service companies'. This has been corrected.

What should the financial sector do?

Financial institutions need to deploy their firepower to support the transformation of the global food system.

The food system as a whole needs to follow three broad transformation pathways to achieve sustainability by 2050.

The **three transformation pathways** identified in this report are usually targeted at governments and policy makers, and describe the changes required at a systems level. As such, they provide an important context for financial institutions when deciding how best to support the required transformation of the global food system. However, financial institutions need greater detail and actions that can be implemented through their financial relationships with the companies they support.

The **four food system transformation themes** set out in this report provide financial institutions with the structure they need to develop policies and configure their investment and company engagement processes to ensure they are allocating capital in support of the food system transformation and mitigating the investment risks associated with the changes that will occur.

Finally, this report sets out **six priority actions** that provide financial institutions with a list of actions **that should be taken before 2030** if they wish to have an immediate impact to reduce the harms that the global food system is generating and a correspondingly beneficial contribution towards net zero lending or investment portfolios.

There are significant risks for financial institutions that fail to position themselves to take account of the inevitable changes that will impact the global food, but for those that seek to actively support and drive the required changes there are significant investment opportunities.

This Roadmap is designed to be the start of the journey. Planet Tracker's work will continue to build on the four food transformation themes, and we intend to provide more detailed analysis and toolkits in the future to support financial institutions to implement the priority actions. However, the urgency of the linked climate and nature crises requires immediate action, and the financial sector's role in this is crucial.

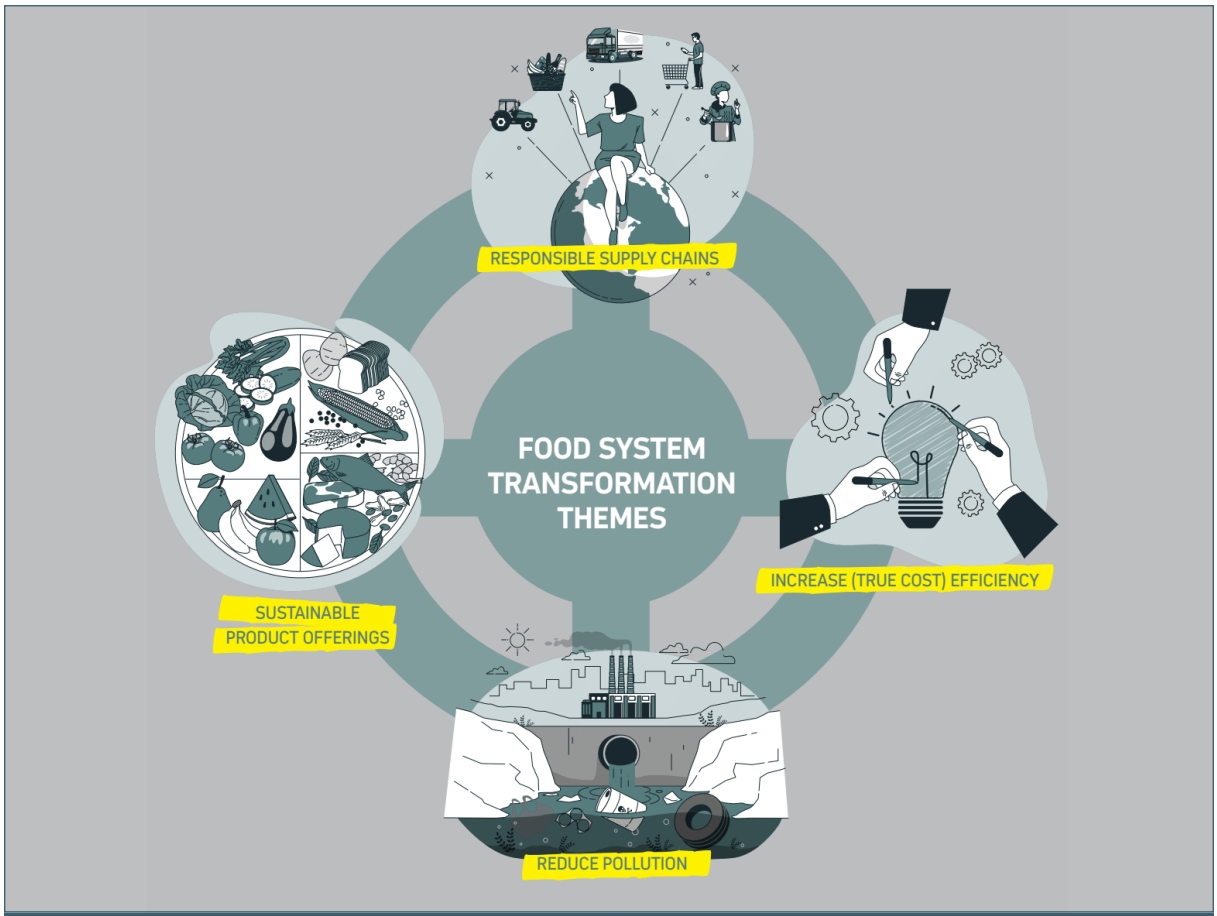


Figure 8: Four financial markets themes for food system transformation. Source: Planet Tracker.

Responsible supply chains

Many of the harms caused by the food system occur upstream in food production, but the demand that drives these harms is generated further downstream which is where the majority of the funding provided by the financial markets and lending banks is focused.

As a result, mitigating or preventing these harms will require actions to be transmitted up the supply chains involved and information about the effect of these actions will need to be transmitted back to the downstream actors responsible and to their funders. In addition to this, downstream companies will need to work with their peers to support upstream companies across supply chains and to transfer the capital, resources and knowledge required to enable sustainable transformation. Ultimately, the food system's problems are beyond any one company's capacity to solve so a focus on responsible supply chains will be essential.

The Kunming-Montréal Global Biodiversity Framework (GBF) has a 2030 target relating to transparent supply chains: 'Requiring transnational companies and financial institutions to monitor, assess, and transparently disclose risks and impacts on biodiversity through their operations, portfolios, supply and value chains',[i] so policy pressure can be expected to grow in this area.

Increase food system (true cost) efficiency

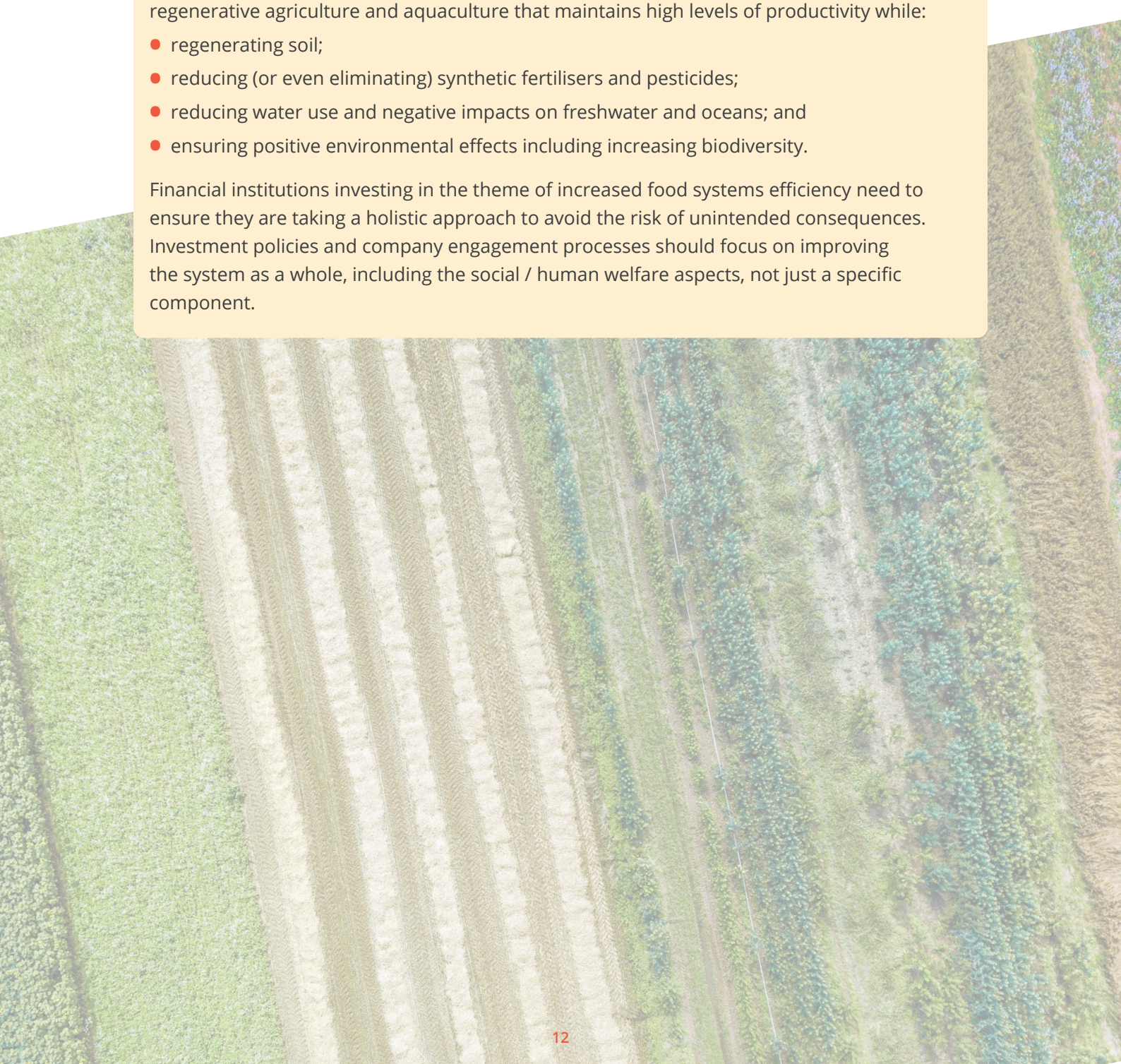
The global food system needs to produce more with less if it is to successfully feed a growing population without exceeding planetary boundaries. However this increase in efficiency needs to be measured based on the true cost of the system (including the costs of pollution, impact on biodiversity, etc):[ii]

1. Inputs with high economic, environmental and social costs need to be reduced;
2. Protein and calorie production and nutritional content must be increased without expanding or depleting the land or sea used; and
3. Loss and waste throughout the food system must be eliminated, including by making the system less linear and more circular by recycling products through the system.

In addition to the focus on efficiency, financial institutions should support moves to invest in regenerative agriculture and aquaculture that maintains high levels of productivity while:

- regenerating soil;
- reducing (or even eliminating) synthetic fertilisers and pesticides;
- reducing water use and negative impacts on freshwater and oceans; and
- ensuring positive environmental effects including increasing biodiversity.

Financial institutions investing in the theme of increased food systems efficiency need to ensure they are taking a holistic approach to avoid the risk of unintended consequences. Investment policies and company engagement processes should focus on improving the system as a whole, including the social / human welfare aspects, not just a specific component.



Reduce food system pollution

The food system is the source of a significant proportion of the pollution poisoning the ecosystems on which humanity depends for its survival including :

- Anthropogenic GhG emissions (including gases with very high climate heating effects such as methane and nitrous oxide);
- Nitrogen and phosphorous run-off;
- Pesticide leakage;
- Particulate air pollution;
- Antimicrobial resistance through excess use of antibiotics; and
- Plastic pollution.

The benefits of cutting pollution are obvious and in many cases the actions required have the potential to be self-funding over time because the pollution represents an unnecessary drain on the resources of the businesses concerned.

As a result, there is a strong link between this theme and the theme of increased efficiency and financial institutions can support actions that address both at the same time.

Financial institutions that wish to focus on the theme of reducing food system pollution need to ensure that they are taking a holistic, systems-based approach so that they can avoid the potential negative consequences of actions that appear positive when considered in isolation[3].

[3] Food losses vs plastic packaging is one example of a potential conflict – the argument being that plastic packaging reduces food losses in the system. The issue is complex but there is a significant risk that promoters of plastic packaging use food loss as an excuse without the evidence to support their defence of plastic (and without weighing the total systems costs of plastic pollution against the total systems costs of food loss).

Sustainable product offerings

The sustainable product offerings theme focuses on the food manufacturers, retailers and food service companies. These businesses are responsible for shaping food environments[4] that drive the desires stimulated among food consumers and the demands made on food producers.

This downstream part of the food system is where the majority of financial capital is focused and so this theme is an essential component for any financial institution wishing to support the transformation of the food system through their investment policies and company engagement processes.

Within this theme there are a number of topics that financial institutions should concentrate on including:

- Sustainable 'food product architecture' – redesigning products to
  - ensure the underlying raw materials can be produced with a reduced nature and climate impact; and
  - improve their nutritional content, and taste, and to reduce chemical additives and levels of fat, salt and sugar;
- Reconfiguring 'food choice architecture'[5] to encourage consumers to choose food products that are better for them and the planet;
- Reducing waste by food service companies and consumers;
- Developing methods for recycling unconsumed food and other food system waste products so that the system becomes more circular;
- Sustainable packaging and transport; and
- Supply chain traceability.

As with many aspects of the food system's required transformation, companies will struggle to achieve sustainable product offerings without having clear visibility of, and control over, their supply chains. Consequently, there is a strong link between this theme and the theme of responsible supply chains, particularly for businesses that wish to profit by offering traceable products to their customers.

[4] 'Food environment' is the physical, economic, political and socio-cultural context in which consumers engage with the food system to make their decisions about acquiring, preparing and consuming food. Companies can influence it via a variety of channels focused on 'price, place, and promotion' (including packaging, store location, discounts for retailers and/or consumers, etc.),

[5] Food choice architecture encompasses all the aspects of a food product that will influence a consumer's behaviour when choosing that product. It is the food version of choice architecture (Nudge, Thaler and Sunstein, 2008).

Cross-cutting themes

Financial institutions should consider the following cross-cutting themes when configuring their investment policies and engagement approach:

- **Just transition** – financial institutions should ensure their approach to the transformation process upholds human rights and labour standards to ensure that as far as possible no-one is permanently disadvantaged as a result.
- **Company lobbying** – financial institutions should ensure that lobbying by companies (and their industry groups) is consistent with their public statements and supports the required transformation.
- **Engagement with governments** – financial institutions should engage with governments to ensure the regulatory environment supports the required transformation.

Six priority actions the finance sector should take

These actions have been selected from the wider range of possibilities supported by the four food system transformation themes based on:

- the size of the potential benefit,
- the immediacy of their beneficial impact,
- the extent to which they lie within the power of financial institutions to have an effect, and
- the extent to which they align with existing initiatives that financial institutions can leverage.

The six priority actions are:

#1 Require fully traceable supply chains

#2 Halve food loss and waste

#3 Stop deforestation

#4 Cut methane emissions by 45%

#5 Make agriculture/aquaculture systems regenerative

#6 Invest in alternative proteins

Financial Institutions should aim to achieve these Priority Actions before 2030.

2030

The Priority Actions are summarized below. The reasons why each Priority Action has been selected and details of the expected benefits are set out on the main body of this report. The actions are not completely independent of each other and will often be complementary.

In relation to each Priority Action (and the issue(s) the action targets) financial institutions should:

- **Question** - incorporate the target issue into pre-funding due diligence questionnaires/ processes and investment decisions;
- **Evaluate** - link funding costs / investment evaluation to the target issue;
- **Engage** - engage proactively with investees to encourage them to address the target issue in their own operations and in those of their suppliers;
- **Debate** – extend the engagement process to encourage policy makers, industry bodies and peers to address the target issue;
- **Reduce** – reduce their exposure to investees that are failing to take action; and
- **Report** - establish clear portfolio assessment, monitoring and reporting processes so that they can evaluate the extent to which their capital is being deployed to address the target issue and to be held accountable.

Financial Institutions should also encourage collaboration within sectors and along supply chains to mitigate specific harms.

PRIORITY ACTION #1
require fully traceable supply chains before 2030

Investors and banks funding companies towards the downstream end of the food supply chain (manufacturers, wholesalers, retailers, and food service companies) should assess the extent to which their portfolio companies in these Nodes have fully traceable supply chains.

We recommend the following questions should be included in pre-funding due diligence questionnaires and when meeting company managements:

1. What traceability systems are currently in place at the company?
2. What is their scope, precision, breadth, and depth?
3. How interoperable are the company's traceability systems with those of suppliers and clients? (for example, in the context of seafood, do they use GDST[6] standards?)
4. What prevents the company from implementing robust traceability solutions on 100% of its products?
5. How much would the required investment cost and what would be the financial benefits to become 100% traceable?
6. How can investors and lenders support the transition towards being 100% traceable?

Sovereign bond investors should engage with governments to encourage the requirement for end-to-end food supply chain traceability particularly in relation to products that carry a high risk of environmental and/or social harms (for example deforestation, child labour, etc).

[6] Global Dialogue on Seafood Traceability

PRIORITY ACTION #2
halve food loss and waste before 2030[7]

Financial institutions should:

- Establish a clear investment due diligence approach that gathers data on food loss and waste from prospective investee companies and establishes clear criteria for including that information in the investment decision.
- Engage proactively with companies at the upstream end of the supply chain (through to the food manufacturers) to encourage them to address food loss and waste in their own operations and in those of their suppliers.
- Engage proactively with food retailers and food service companies to encourage them to take steps to reduce food waste through their own operations and in the hands of consumers.
- Engage proactively with food retail and food service companies to ensure that (in addition to reducing the absolute amount of food waste) they maximise the usage of food waste through such means as composting, using waste as a source of bioenergy, etc.
- Reduce their holdings of, or loans to, food system companies that do not have a clear focus on reducing food loss and waste and shift their capital to those that do.
- Establish clear portfolio assessment, monitoring and reporting processes so that they can evaluate the extent to which their capital is being deployed in support of reducing food loss and waste and be held to account for their actions.

Sovereign bond investors should engage with governments to encourage them to introduce policies and laws that aim to tackle food loss and waste as well as removing incentives that may encourage the opposite behaviour.

[7] 'Food loss' refers to losses in food production, and manufacturing; 'food waste' refers to food that is ready for consumption but wasted instead of being consumed

PRIORITY ACTION #3
stop deforestation before 2030

Efforts to eliminate deforestation are more likely to be successful when placed in this wider context as part of a food systems transformation strategy.

What should financial institutions do themselves?

Financial institutions should implement the following policies[8] to address deforestation risk in their investment/lending portfolios:

- Publicly commit to ensuring zero gross deforestation of all natural forest ecosystems (legal and illegal) in their investment/lending portfolios.
- Reinforce the commitment by publishing regular, timely action plans and progress updates.
- Specifically target deforestation-linked emissions in their 'net zero' plans.
- Actively engage with and support initiatives such IFACC[8A], to move funding away from deforestation linked activities.
- Make the financing of companies operating in agriculture production contingent on comprehensive zero deforestation policies that include time-bound requirements for monitoring and transparency.

What should they require of their investments?

- Require portfolio companies to proactively report on deforestation-linked CO_2 emissions in their supply chains.
- Require upstream companies (producers and traders) to disclose the location of their production facilities and volumes produced as a condition of funding.
- Require portfolio companies to purchase only products that are certified as deforestation free.

[8] 'Global Canopy's Deforestation-Free Finance initiative includes a Finance Sector roadmap that recommends the key steps needed for financial institutions to eliminate commodity-driven deforestation, conversion, and associated human rights abuses from their portfolio within four years of beginning the process.'

[8A] Innovative Finance for the Amazon, Cerrado and Chaco (IFACC)

PRIORITY ACTION #4
cut agri-methane emissions by 45% before 2030

What should financial institutions do themselves?

Sovereign bond investors should:

- Engage with governments that are already signatories to the Global Methane Pledge (which aims to reduce methane emissions by at least 30% by 2030 compared to 2020 levels) to urge them to explicitly include reducing animal protein production as a methane reduction strategy[9].
- Engage with signatories to the pledge to encourage, detailed, separate sector-based targets and milestones to ensure the 2030 goals are achieved.
- Set deadlines for investments in sovereign instruments of the three largest emitters of methane which did not commit to the Global Methane Pledge (China, Russia and India[10]) to sign the pledge or at least set targets that will put their methane emissions on a path consistent with the pledge.

Banks and investors in equities and corporate bonds should:

- Allocate their capital away from industrial animal protein production towards alternative protein producers.
- Engage with food system companies further down the supply chain to encourage them to shift their production portfolios away from industrial animal protein production and to engage with their customers to encourage a shift in demand and consumption in the same direction.
- Restrict new financing to producers which have not committed to reducing methane emissions from their production of animal proteins and link financing to quantitative production-related methane emissions reduction targets.
- Ensure new financing polices are in alignment with The Global Methane Pledge.
- Assess the aggregate methane footprint of their portfolios and report annually.

What should they require of their investments?

- Require investee food systems companies to provide comprehensive data regarding production in terms of volumes and locations[11].
- Require portfolio companies (particularly meat and dairy producers) to consistently and comprehensively report their methane emissions separately from other GhGs, including Scope 3.
- Require investees in downstream Nodes (ingredient producers and traders, food manufacturers, retail, and food service) to set targets for their animal protein supply chains to: quantify Scope 3 emissions by 2025 and align with the Global Methane Pledge by setting targets to reduce emissions by 2030.

Given the very heavy methane footprint of the industrial meat producers[12] investors should consider divesting their holdings in these companies unless their engagement efforts provide a clear indication of money being spent to move towards more sustainable alternatives. Similarly, lenders should divert funds or at least charge a premium to compensate for the significant risk that industrial meat production assets will become stranded as government policies and consumer preferences shift.

[9] The Global Methane Pledge currently only refers to 'seeking abatement of agricultural emissions through technology innovation as well as incentives and partnerships with farmers.'

[10] The USA ranks as #3 behind China and India and ahead of Russia, but the USA has signed the pledge.

[11] This information is extremely valuable for basic investment analysis and risk assessment even without taking into account the sustainability reporting benefit.

[12] For example, see 'Emissions Impossible: how big meat and dairy are heating up the planet' published by the Changing Markets Foundation and Institute for Agricultural and Trade Policy (2022).

PRIORITY ACTION #5
make agriculture/aquaculture systems regenerative before 2030

What should financial institutions do themselves?

Equity investors may find their holdings of companies at the producer end of the food system form a smaller part of their portfolios than companies in the manufacturing and distribution Nodes. This means their focus will need to be on indirectly influencing producers via their customers further down the supply chain.

Conversely, banks are more likely to have direct relationships with companies involved in agricultural[13] production and so should aim to directly influence their behaviour.

Financial institutions should:

- Reduce their holdings of, or loans to, agricultural production companies that do not have a clear focus on applying regenerative agricultural techniques and shift their capital to those that do.
- Engage proactively with investee companies to encourage them to adopt regenerative techniques in their own operations or with respect to their suppliers.
- Establish effective monitoring systems so that any cases of environmental and/or social harms resulting from extractive agricultural practices will be identified quickly.
- Disinvest from any companies that appear to be deliberately taking an extractive approach to food production (i.e. where there is clear evidence of environmental and/or social harms).
- Establish clear portfolio assessment, monitoring and reporting processes so that they can evaluate the extent to which their capital is being deployed in support of regenerative agriculture and be held to account for their actions.
- Establish strong due diligence processes to ensure that they can distinguish greenwashing from genuine regenerative agricultural practices.

Sovereign bond investors should engage with governments to ensure agricultural policies and subsidies support regenerative agricultural practices and that policies and subsidies incentivising extractive agricultural practices are abandoned rapidly.

What should they require of their investments?

Companies that are funded or are seeking funding should be required to:

- Disclose information about their current agricultural practices (or those of their suppliers) with sufficient granularity to enable a portfolio view of the extent to which regenerative agriculture is being funded (or not).
- Disclose financial information and timelines for regenerative agriculture investment plans (including their supply chains where relevant) and the expected mitigations that will result with respect to climate, nature and people. Companies that are downstream from the food producers and traders should be required to set out their plans for collaborating with peers and with suppliers to encourage the adoption of regenerative agricultural practices.

[13] Agriculture in this context includes aquaculture and other systems such as regenerative livestock grazing.

PRIORITY ACTION #6
invest in alternative proteins

In the context of this Roadmap we define 'alternative proteins' as all types of protein production that does not involve traditional livestock techniques.

What should financial institutions do themselves?

- Engage with governments to ensure regulatory frameworks encourage the development of alternative proteins.
- Allocate their capital away from industrial animal protein production towards alternative protein producers.
- Engage with food system companies further down the supply chain to encourage them to shift their production portfolios away from industrial animal protein production and to engage with their customers to encourage a shift in demand and consumption in the same direction.

What should they require of their investments?

- Require investee food systems companies to provide comprehensive data regarding production of traditional and alternative protein types in terms of volumes and locations[14].
- Engage with investees directly involved in animal protein production to encourage them to shift their production to alternative protein sources.
- Engage with investees in downstream Nodes (ingredient producers and traders, food manufacturers, retail, and food service) to set time-framed targets for shifting their product portfolios away from industrial meat and dairy towards alternatives.
- Require investees in downstream Nodes (ingredient producers and traders, food manufacturers, retail, and food service) to report on their lobbying activities and disclose the steps they are taking to create food environments that support the development and sale of products based on alternative proteins.

[14] This information is extremely valuable for basic investment analysis and risk assessment even without taking into account the sustainability reporting benefit.

Illustrating the benefits

Calculating a quantified estimate of the benefits of transforming the global food system is extremely difficult. The FLAG[15] Guidance published by the Science Based Targets initiative includes estimated benefits of 12 Gt CO_2e[16] from a range of transformative food system actions.

Using a similar basis (but a much more simplistic approach) we estimate that five of the six Priority Actions we recommend could reduce food systems emissions by approximately 10 Gt CO_2e, nearly 60% of the food system's current 17.9 GtCO_2e footprint – see figure 9 – and reduce humanity's overall GhG footprint by a fifth – see Figure 10.

We are not able to estimate a GhG benefit from Priority Action #1 – fully traceable supply chains – but we can estimate an economic benefit.

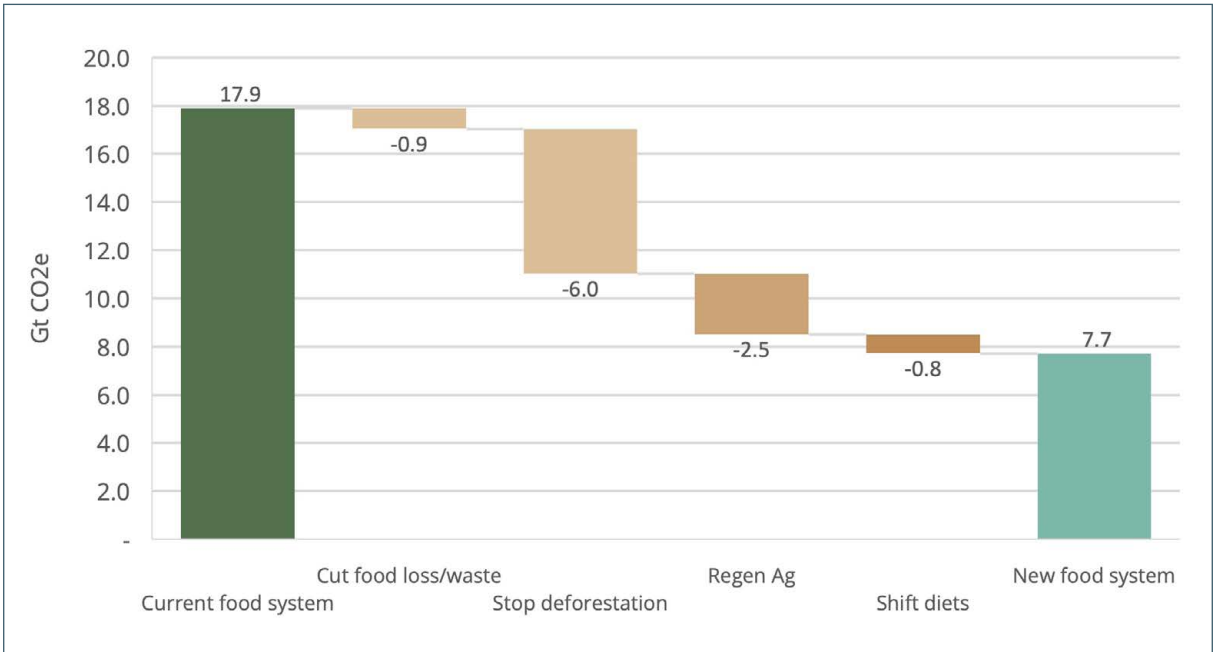


Figure 9: Illustration of the GhG reductions associated with five of Planet Tracker's six Priority Actions. Source: Planet Tracker analysis based on Roe et al. NB Carbon sequestration in soil is used to illustrate the potential of a shift to regenerative agriculture. 'Shift diets' approximately captures the benefits of cutting methane and shifting to alternative protein sources.

[15] Forests, Land, And Agriculture

[16] Carbon dioxide equivalent – a measure that enables comparison between different greenhouse gases and aggregation of emissions figures

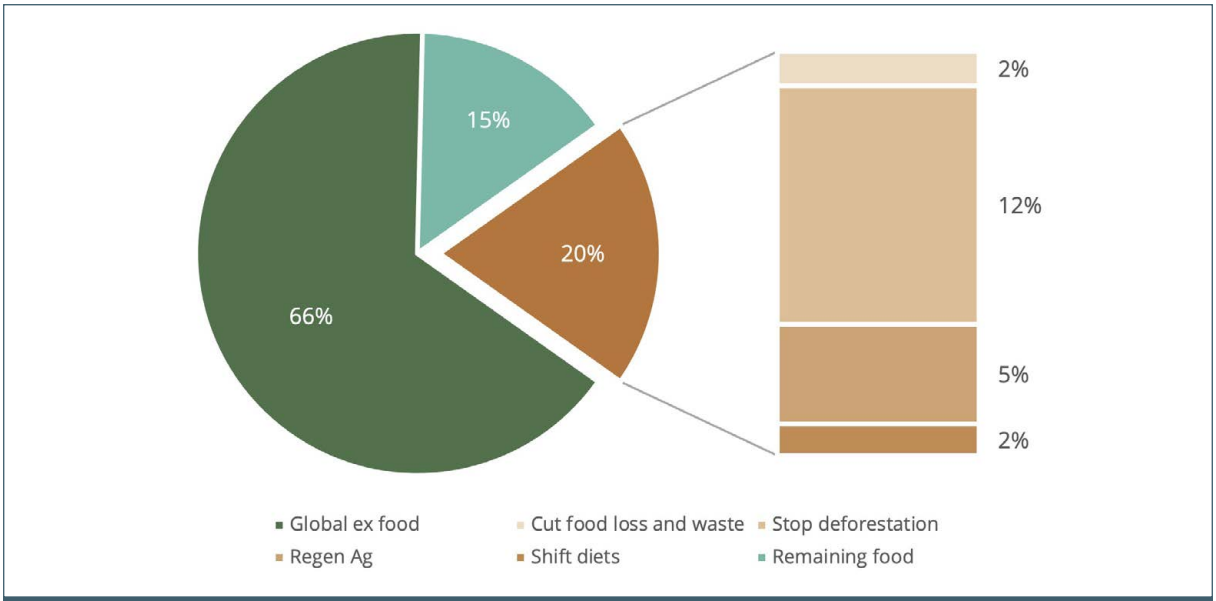


Figure 10: Illustration of the potential benefits of five of Planet Tracker's six Priority Actions. Source: Planet Tracker. NB The estimated benefit from carbon sequestration in soil is used to illustrate the potential of a shift to regenerative agriculture. 'Shift diets' approximately captures the benefits of cutting methane and shifting to alternative protein sources

The value of the economic benefits is potentially huge. FOLU's Growing Better report includes estimates for the benefit of a variety of actions to transform the global food system. Their framework does not precisely match ours but Figure 11 illustrates the trillion-dollar scale of the benefits associated with the six priority actions we recommend (five are based on FOLU's analysis, and one - supply chain traceability – is based on Planet Tracker's estimate).

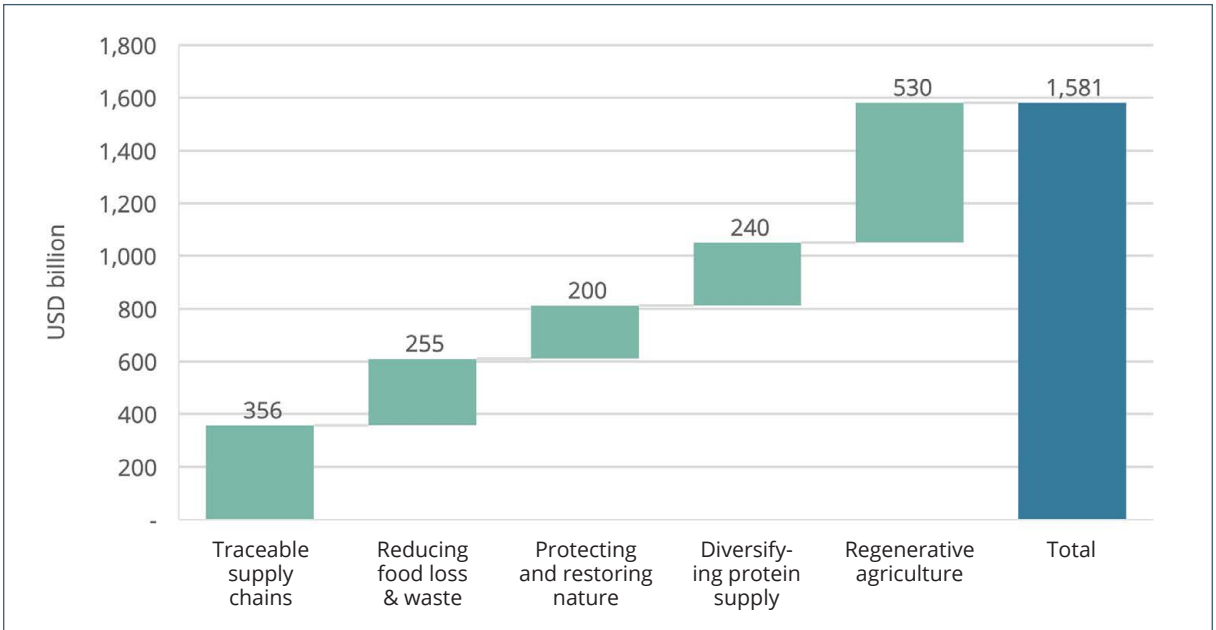


Figure 11: Illustration of the scale of economic benefits associated with Planet Tracker's six Priority Actions. Source: Planet Tracker analysis based on FOLU estimates.NB Diversifying Protein Supply also captures the benefits associated with reducing methane emissions

Downside risks of business as usual

A 2022 report by Race to Zero[iii] highlights that if food system transition risks are unmitigated, individual firms at the centre of the global food supply system could lose up to 26% of their value, with a sector average hit of over 7% compared to a BAU scenario.

Their analysis covered 40 of the largest and most influential food and agriculture companies collectively worth USD 2.2 trillion and employing nearly 8 million people, selected from the 2021 WBA Food and Agriculture Benchmark's list of 350 influential food and agriculture companies.

The loss across the food companies selected would equate to USD 152 billion. The Race to Zero report concludes that all of this loss is avoidable if the company and sector-specific mitigating actions[17] they recommend are taken.

[17] These mitigating actions relate to the specific companies and their position in the supply chain but are consistent with our framework

FINANCIAL MARKETS

ROADMAP

FOR TRANSFORMING THE

Global Food System

THE OBJECTIVE: A SUSTAINABLE FOOD SYSTEM

A **sustainable food system** delivers **food security** and **nutrition** for **ALL**

According to the FAO, a sustainable food system is a food system that delivers food security and nutrition for all in such a way that the economic, social and environmental bases to generate food security and nutrition for future generations are not compromised.

This means that: it is profitable throughout (economic sustainability); it has broad-based benefits for society (social sustainability); and it has a positive or neutral impact on the natural environment (environmental sustainability).[iv]

Building on this framework, a sustainable food system can be defined as one that is:

- **Resilient** – able to withstand and adapt to challenges (e.g. a changing climate, wars etc);
- **Efficient** – maximising outputs and minimising inputs and losses, while operating within the doughnut of planetary boundaries and the social foundation, and maintaining its natural capital base;
- **Effective** – providing sufficient nutritious, culturally appropriate, food to all of a growing population and supporting livelihoods and wellbeing.

Figure 12 summarises the characteristics of a sustainable food system.

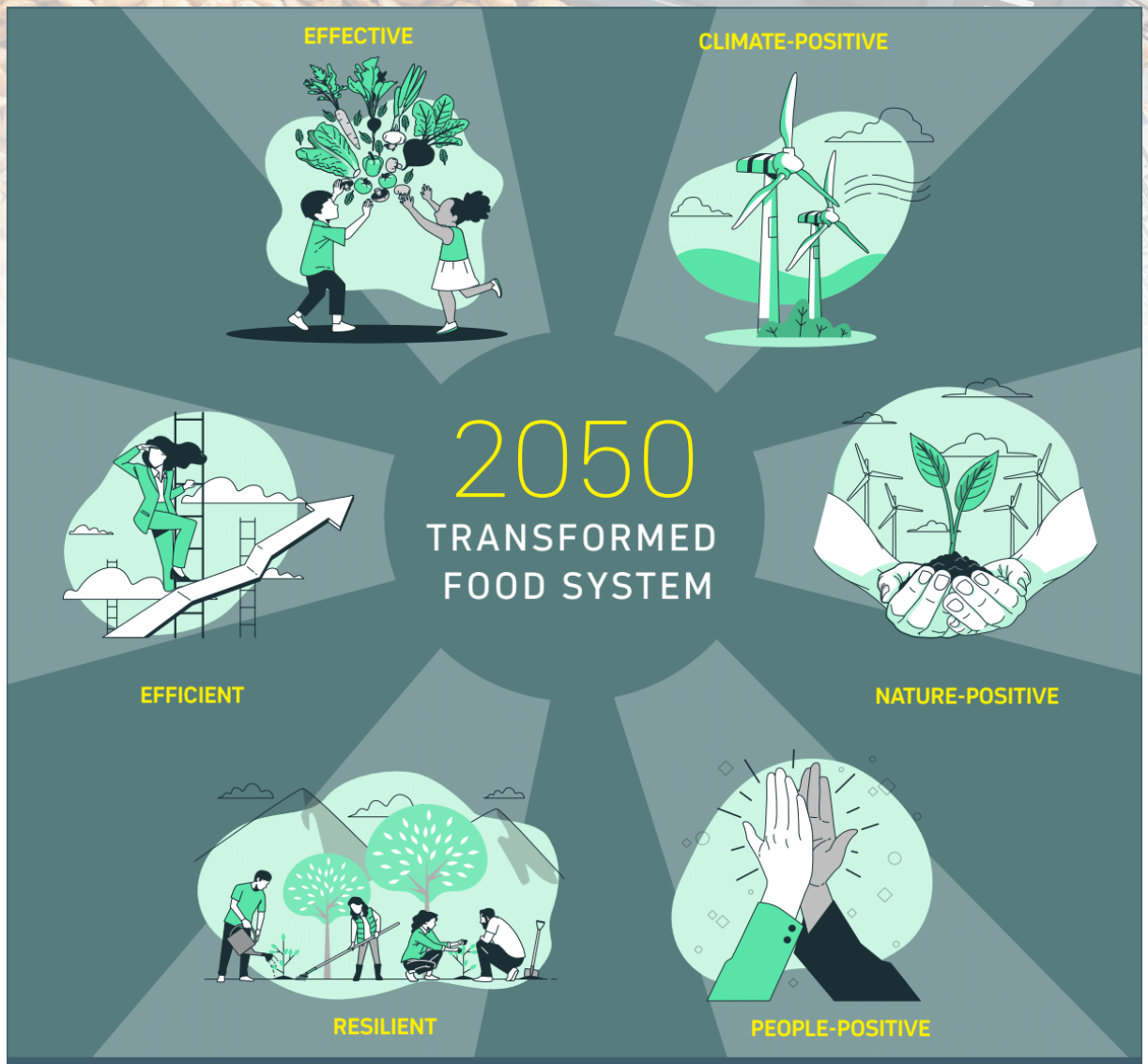


Figure 12: Characteristics of a sustainable food system in 2050. Source: Planet Tracker.

In this report we explain the importance of private finance in achieving the required transformation of the food system and the role that financial institutions should play in this process.

THE GLOBAL FOOD SYSTEM FRAMEWORK

Planet Tracker's Financial Markets Roadmap for transforming the global food system fits within the broader body of work being done by a number of organisations on the global food system, its impact on climate, nature, and society, and the changes required.

As one example, Figure 13 shows the analysis framework from the FS-TIP Food Systems Analysis Toolkit developed by the Food System Transformative Integrated Policy (FS-TIP) initiative[18]. The FS-TIP Food Systems Analysis Toolkit aims to enable the user to generate a 'systematic, thorough and comprehensive picture of a national food system.'

The Planet Tracker Financial Markets Roadmap is taking a more focused approach, concentrating on the financial sector and the role that financial institutions have to play in the required transformation of the food system. However, it is important that any actions by the finance sector are taken in the broader context of the food system as a whole.

In the FS-TIP Food Systems Analysis framework 'Finance and Capital' is shown as one of ten 'external drivers', emphasising the point that the finance sector cannot drive the required changes without a number of these other drivers pushing in the same direction. However, we estimate the finance sector has invested over USD 5 trillion via listed equities and trillions more via private equity and debt funding (including bank loans). The impact of deploying this capital in support of transforming the food system would therefore be considerable, and the risks to the financial institutions providing this funding if they are unprepared for the changes to the food system will be high[19].

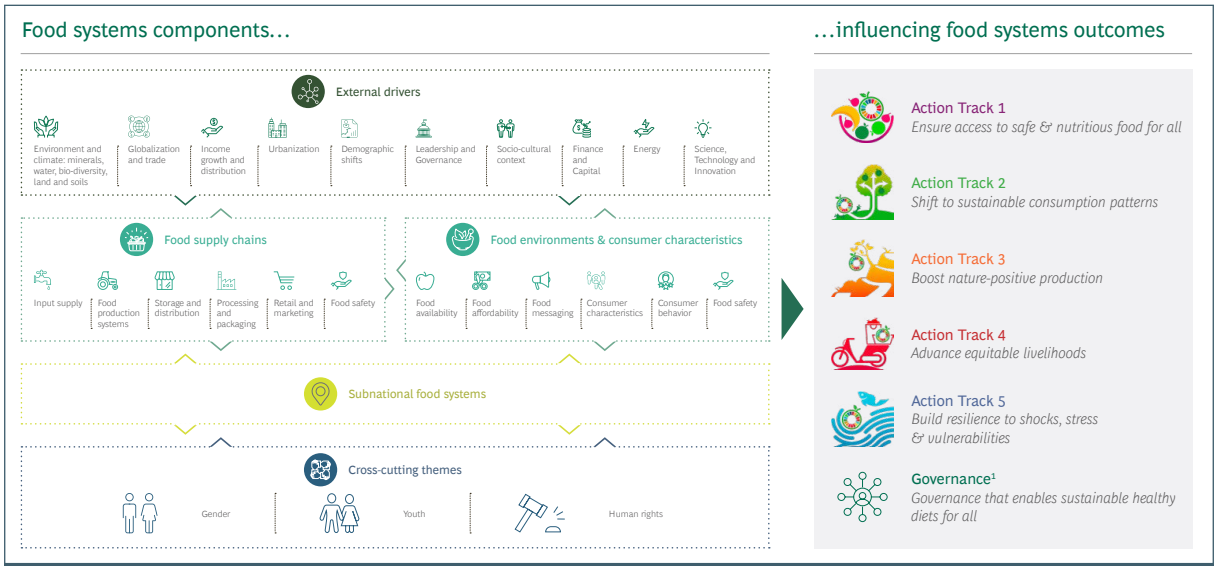


Figure 13: The global food system framework. Source: Food System Transformative Integrated Policy (FS-TIP) initiative, Food Systems Analysis Toolkit: Adapted from the Food Systems Dashboard, the Food systems Decision-Support Toolbox; HLPE; and FS-TIP research.[v]

[18] The FS-TIP initiative has been funded by the Rockefeller Foundation and the International Development Research Centre (IDRC). It is a coalition of partner institutions, including Tony Blair Institute, APHRC, Akademiya2063, AGRA, BCG and IFPRI supporting select national governments in Africa to embark on a food system transformation journey. The main purpose of the project is to support select national governments in Africa in the development of an ambitious policy agenda that can be implemented to achieve sustainable, healthy diets for all their citizens.

[19] We discuss the funding of the food system in more detail later in this report.

PLANET TRACKER'S GLOBAL FOOD SYSTEM NODE FRAMEWORK

Using the FS-TIP broad framing illustrated above, this analysis focuses on the role of private financial flows into the food system.

The harms attributable to the global food system are often location-specific and driven by particular business activities, therefore the food system view must incorporate how the financial industry interacts with the system. Effective solutions must be tailored to be relevant to specific parts of the food system.

To help investors to focus their efforts we have broken the global food system into activity-based 'Nodes' – see Figure 14[20].

Figure 14: Food system Nodes. Source: Planet Tracker.

[20] We define our Nodes according to NAICS (North American Industry Classification System) which applies six-figure codes to a wide variety of economic activities. Companies classify their business activities using this coding system and report the results. We use the reported codes to apportion business finances, environmental footprint and funding to each of the Nodes according to the NAICS activities the companies disclose. Details of our methodology and analysis are available on request.

Waste disposal – the missing Node

Our Node structure is linear, not circular, to reflect the structure of the global food system itself, where recycling and the capture and reuse of food waste is still very limited in most parts of the world.

The structure of the NAICS[21] system we use to support our analysis of company activities and their environmental footprints does not allow us to identify food waste as a separate category in the waste system and company disclosures are not sufficiently granular to capture the companies involved in the final stage of the food system. As a result, we have not been able to include any data for this Node in the current version of our database[22] and so this specific Node is excluded from the analysis that follows. However, the larger companies throughout the food system disclose information about their own waste management activities, so we are able to provide analysis of that on a Node-by-Node basis.

Seafood is included

IFAD[23] estimates that in 2015, seafood accounted for about 17 per cent of animal protein consumed globally, and provided about 3.2 billion people with almost 20 per cent of their average per capita intake of animal protein.[vi] IFAD also reported that ***'Aquaculture now provides around half the fish for direct human consumption and is set to grow further; but capture fisheries continue to make essential contributions to the food and nutrition security of poor people and is often their most important source of fish (Belton and Haraksingh Thilsted, 2018). Since 1961, the annual global growth in fish consumption has been twice as high as population growth, demonstrating that the fisheries sector is crucial for a world without hunger and malnutrition.'***

Our database includes companies linked to seafood but from a financial perspective the companies that are focused on seafood are generally smaller than the companies linked to other food sources and constitute a small proportion of the overall population of our database (in line with the food system as a whole).

[21] NAICS (North American Industry Classification System) – see previous footnote.

[22] Planet Tracker's food system database captures data from over 400,000 food system companies – see Appendix 5 for more details.

[23] IFAD – International Fund for Agricultural Development.

FUNDING THE GLOBAL FOOD SYSTEM – OVERVIEW

This section will explore our analysis of the types of private sector funding that are supporting the food system and the types of companies make up the food system.

This report is focused on the private sector funding of the global food system and so excludes public sector finance. We briefly explore the role the public sector finance can play in the transformation of the food system later in this report – see page 113.

We estimate the overall value of the global food system could be as high as USD 14 trillion, supported by private finance (equity and debt) totalling USD 8.6 trillion.

Figure 15 shows the mix of funding that is supporting this system, highlighting the importance of the equity markets, bank lending and retained profits.

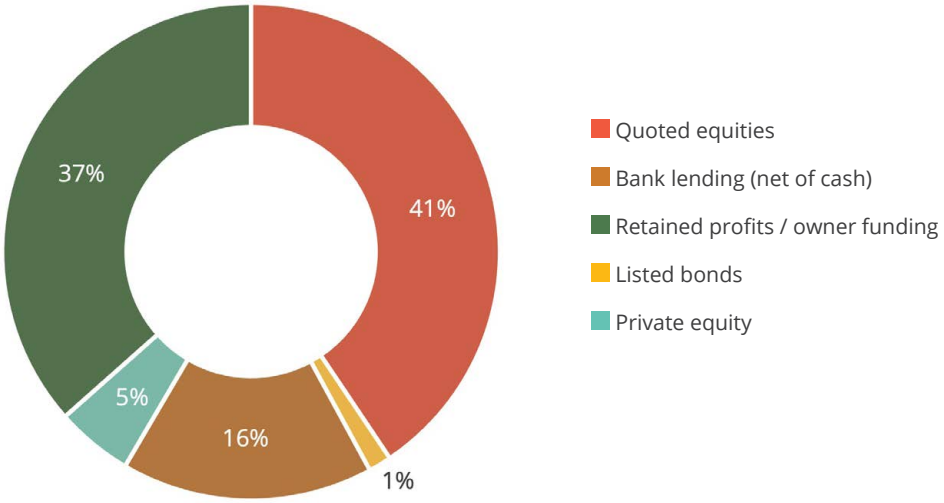


Figure 15: Global food system funding mix. Source: Planet Tracker analysis[25].

Public companies dominate the global food system

Investors are responsible for providing equity capital worth USD 5.5 trillion through the public markets to fund the global food system.[vii]

Our system value estimate of USD 14 trillion implies that a further USD 8 trillion of funding must come from private equity, bank debt, entrepreneurs and retained profits.

[24] Refer to the Planet Tracker blog: How much is your food worth?

[25] NB: Bank lending is estimated based on an overall estimated debt figure less whatever is determined to be bond finance (so if bond finance is assumed to be higher, then bank lending will be assumed to be lower).

Fewer than 0.001% of the companies in the global food system (c. 4,000) are publicly listed, but they account for half of the aggregate system value and over a quarter of the aggregate system revenues.[viii] In addition, our analysis shows that the bulk of remaining USD 8 trillion in funding will be provided to the largest companies in the system.

Clearly, financial institutions providing debt and equity finance to these larger companies have an outsize opportunity to influence change in the system.

Bond holdings are likely to be understated

It is hard to get comprehensive data about bond issuance and investor holdings but we have identified bonds worth c.USD 200 billion issued by companies across the global food system.

Given that corporate bonds constitute c.20% of the typical global investment portfolio,[ix] compared to equities which constitute 44%, one might expect bond issuance by food system companies to amount to c. USD 2.8 trillion, implying that we have succeeded in identifying only one tenth of the bonds issued.

Bank finance is the opaque elephant

Data regarding the funding provided by banks to their customers is hard to come by. Banking relationships by their nature are confidential and neither the banks nor their customers provide data on how much money is being lent or borrowed on a named counterparty basis (unlike equities, where investors are required to declare their holdings).

Planet Tracker's analysis of the food system and how it is funded has revealed that banks have provided funding worth USD 4.9 trillion over the last ten years to companies in our food system universe. Given the data challenges noted above, we believe this amount significantly understates the total amount lent over the last 10 years.

Our analysis suggests that a 'typical' food system company has a funding mix that is 30% gross debt. As noted above, if our estimate of the overall value of the food system (USD 14 trillion) is correct that would imply that the total gross debt currently owed by food system companies amounts to USD 3.9 trillion.

However, this debt figure will be offset by cash holdings – we estimate the net debt (gross debt less cash) supporting the global food system is USD 2.2 trillion.

Other non-public market funding sources

The balance of the non-public market funding (USD 5.5 trillion) will come from retained profits and non-public equity.[26]

Since private equity funds constitute around 5% of global investment assets under management[x], we would expect them to provide a similar proportion of funding to the food system, implying a maximum investment value of USD 0.67 trillion (5% x 13.4trillion).

Based on that estimate, the balance of the non-public market funding (USD 4.8 trillion) will come from retained profits and entrepreneurial equity investment (owner/managers).

[26] i.e. equity finance provided by owner-entrepreneurs and by private equity funds established to invest in smaller, growing, businesses before they list their share on the public markets.

FUNDING THE GLOBAL FOOD SYSTEM – NODE ANALYSIST

This section outlines how private sector funding for the food system is distributed across the Nodes and the mix of debt and equity within that.

Overall distribution of funding by Node

Our dataset contains c.17,300 investors and funders (banks and other providers of debt finance) providing c.USD 8.6 trillion of funding[27] to the companies in our database. When considered in aggregate, the majority of external funding is provided to companies in the manufacturing and distribution section of the food system – see Figure 16.

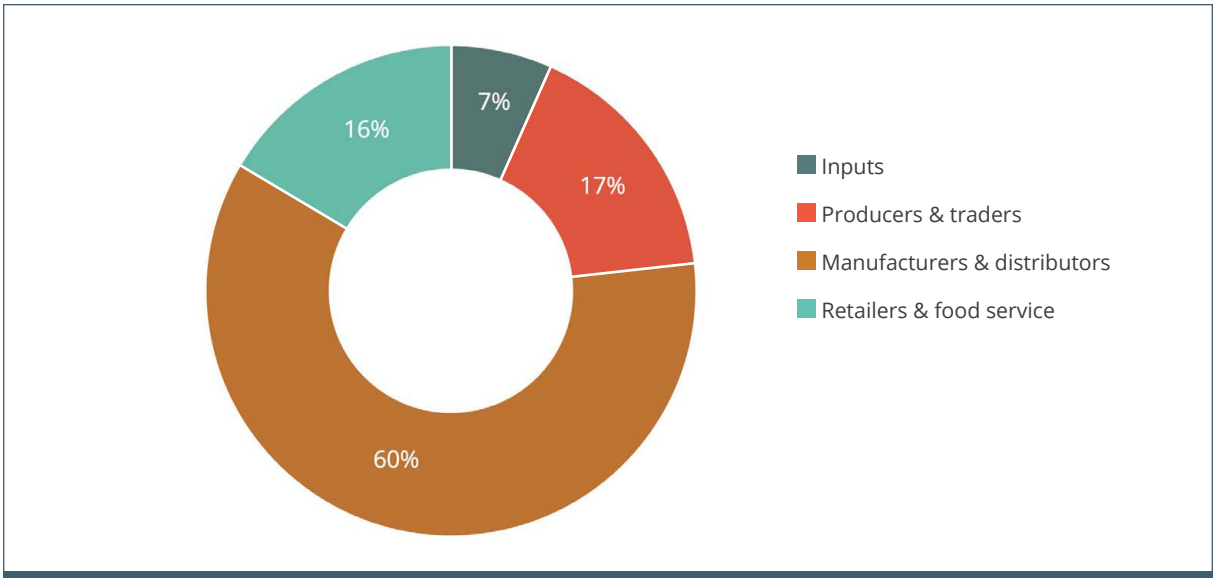


Figure 16: Distribution of external funding across the food system Nodes. Source: Planet Tracker analysis.

The funding provided to the quoted companies in the global food system is predominantly weighted to the downstream end of the food system. Food manufacturing and distribution, plus food retail and food service account for 76% of total food system funding (debt and equity combined) – see Figure 17.

[27] Equities, bonds, and bank lending.

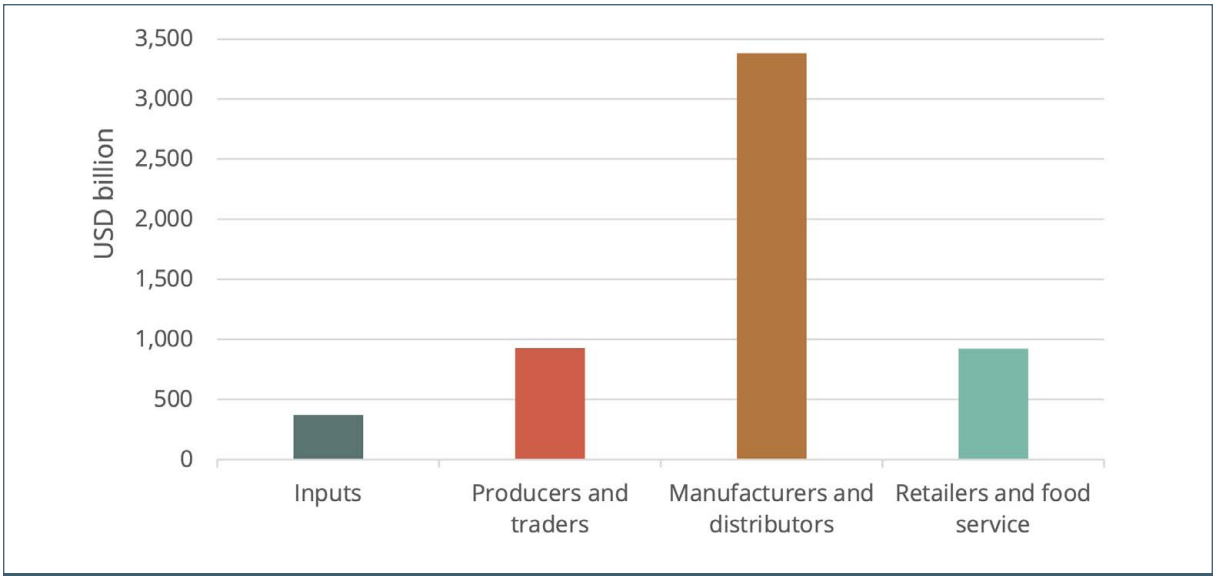


Figure 17: Food system funding by Node (estimated external funding provided to quoted companies). Source: Planet Tracker.

Analysing leverage by Node

Producers and traders receive the greatest proportion of debt funding (34%) and so have the lowest proportion of equity funding (66%), in contrast to the manufacturers and distributors where the equity funding accounts for 77% of the total – see Figure 18.

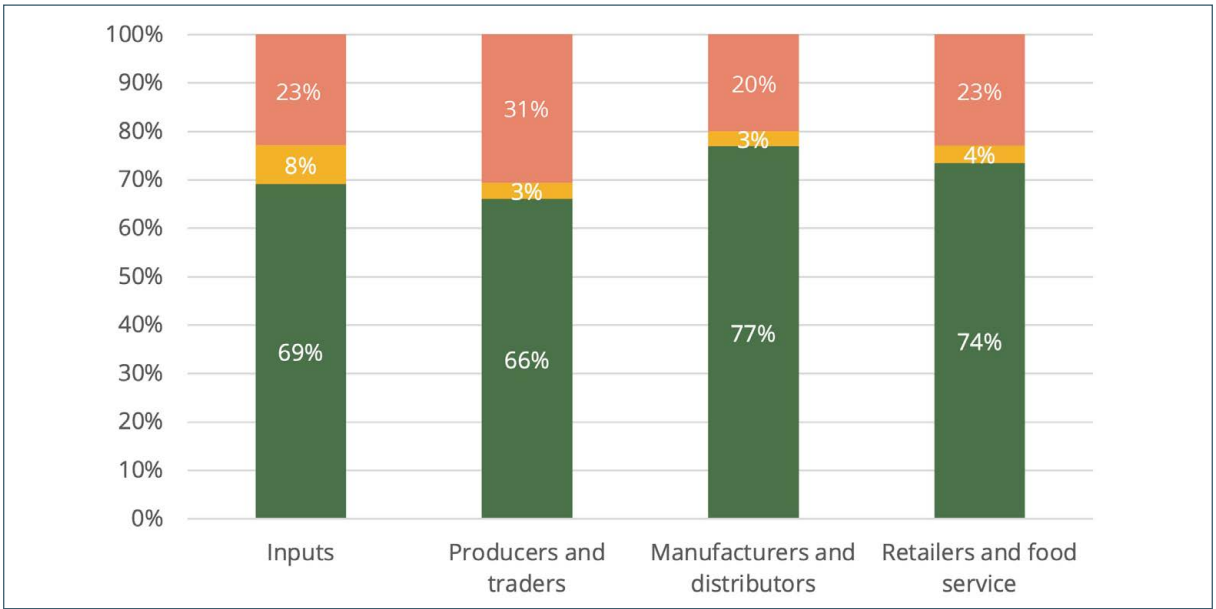


Figure 18: Funding type, Equity, Bond or Debt Financing by Node. Source: Planet Tracker.

Equity funders and debt funders have different relationships with companies, but both have the ability to influence company behaviour through qualitative and quantitative actions, such as discussions with management or linking funding terms to sustainability performance.

ENVIRONMENTAL HARMS – NODE ANALYSIS

This section summarises the harms caused by the food system and Planet Tracker's analysis of these harms on a Node by-Node basis.

System-level overview

The global food system has a very heavy carbon footprint, a strongly negative impact on nature, and is failing to achieve what should be regarded as its core aim: to provide the growing population of the world in a just and equitable way with sufficient nutrition to ensure their health and wellbeing while remaining within planetary boundaries.

The global food system is a key driver behind the breaching of a number of the Stockholm Resilience Centre's 'planetary boundaries', highlighting the extent to which a transformation of the food system is critical to the future health of humanity. The food system is at least partially responsible for the boundary breaches that have already occurred in relation to biosphere integrity, climate change, biochemical flows (nitrogen and phosphorus), and land system change.

But it could also be argued that the food system is having an impact on the other five boundaries as well: stratospheric ozone depletion is potentially impacted by nitrous oxide arising from nitrogen fertilizer use; ocean acidification is also potentially increased by nitrogen fertilizer run-off and by the CO_2 released by the food system; and atmospheric aerosol loading will be impacted by crop residue burning and fires set to clear land.

Freshwater use is not yet regarded as having exceeded its planetary boundary but agriculture accounts for 70% of global usage,[xi] and there are plenty of examples where water resources are already under stress as a result of agricultural demands. The final boundary (Novel Entities) includes the effect of plastic pollution and has not been quantified yet, but the food system is clearly one of the drivers behind much of the plastic pollution that is occurring.

When looked at through the Doughnut framework developed by Dr Kate Raworth, potentially all of the shortfalls below the social foundation will be influenced by the global food system and could be alleviated by transforming aspects of the food system – see Figure 19.

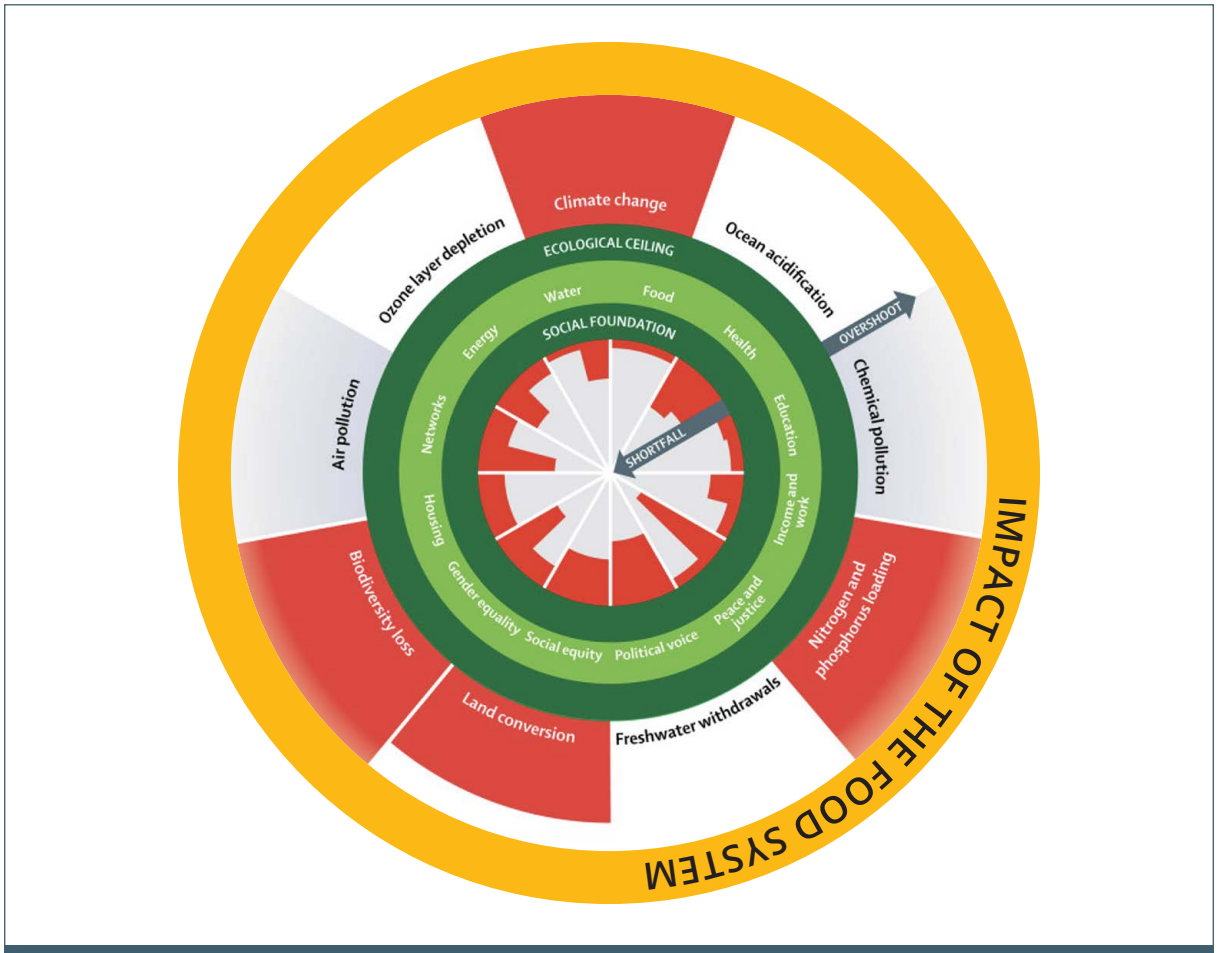


Figure 19: Doughnut economics, the Food System and the Nine Planetary Boundaries. Source: Planet Tracker, adapted from A Doughnut for the Anthropocene: humanity's compass in the 21st century, Raworth K 2017, The Lancet. Note – the 'impact of the food system' illustrated on this chart refers to the planetary boundaries, not the social foundation.

For more information on the global food system's harmful footprint refer to Appendix 1: The global food system's harmful footprint on page 115.

Methodology for Node analysis of company sustainability disclosures

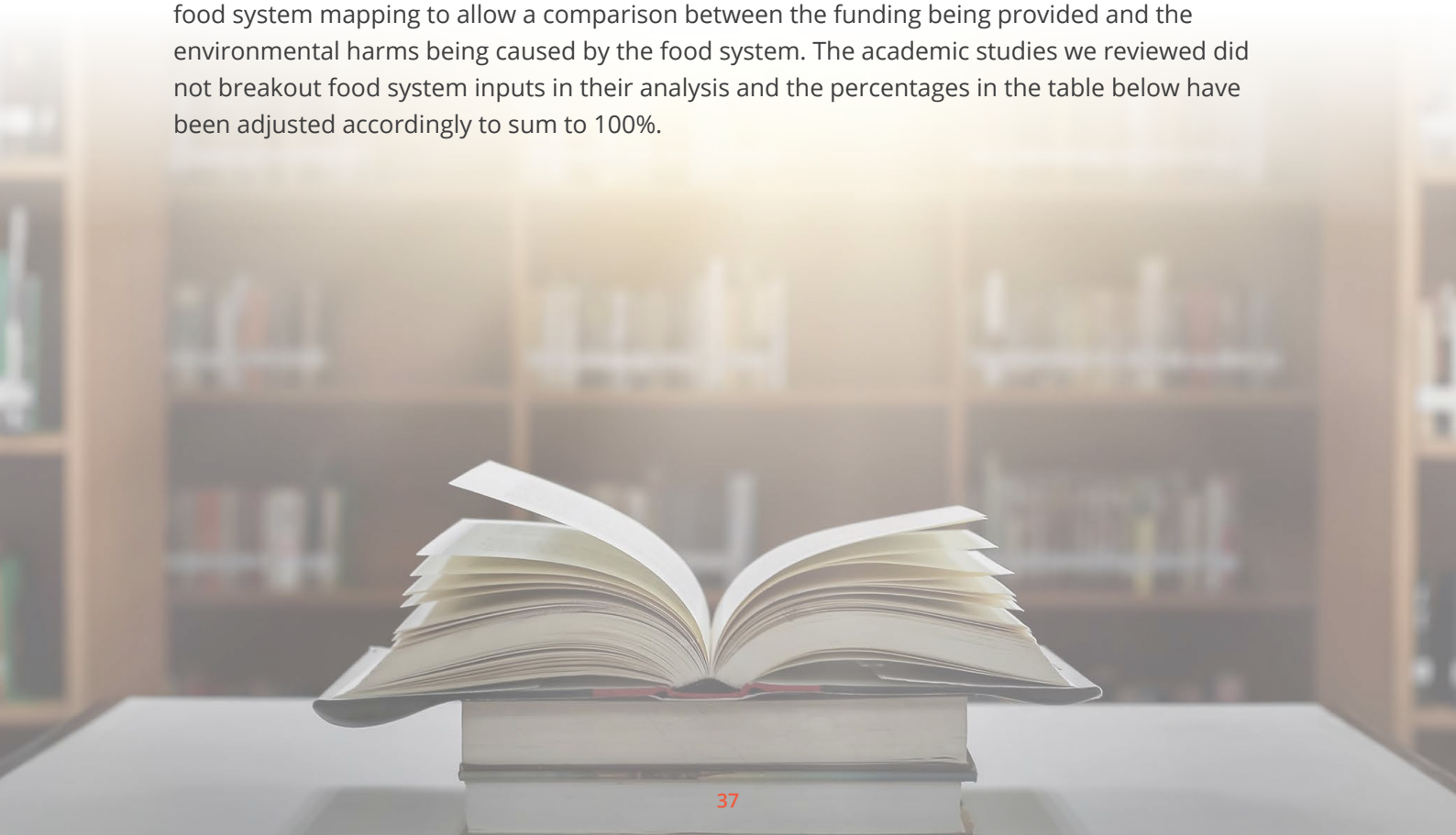
In this section, we present our analysis of the key sustainability metrics reported by c.3,500 companies, combined with financial analysis to identify where harms are occurring on a Node basis, as reported by companies. The companies reporting environmental data provide a variety of disclosures, but **consistent and comparable data are only provided with respect to three categories: GhG emissions, water use, and waste**. The following sections will discuss the key findings from our analysis of companies' GhG emissions, water use and waste, across the different food system Nodes.

We have extrapolated the environmental data disclosed by the 3,500 companies using linear revenue-based intensity factors to estimate the total GhG emissions, waste and water usage at a Node and food system level based on company reporting.

In the context of our database of just over 400,000 companies, 3,500 companies reporting environmental metrics is clearly a small proportion and is a slightly smaller number than the c.4,000 public companies in our database. This highlights the very limited extent of environmental data being disclosed by companies across the food system. This presents a challenge to investors who are seeking to differentiate between individual companies from a sustainability perspective, and also makes it difficult to compare the information reported by companies with the environmental analysis conducted at a systems level. Nevertheless, it still provides us with a significant dataset that allows us to draw some important conclusions.

Comparing Planet Tracker's Node analysis of the food system's environmental and funding footprint with academic studies

Our database provides an alternative view to the majority of analysis which takes a macro level perspective. In Table 1, we have analysed key academic studies of the food system to produce a top-down view of its environmental footprint on a Node basis, in line with our bottom-up food system mapping to allow a comparison between the funding being provided and the environmental harms being caused by the food system. The academic studies we reviewed did not breakout food system inputs in their analysis and the percentages in the table below have been adjusted accordingly to sum to 100%.



Planet Tracker's bottom-up analysis highlights the extent to which companies are still failing to provide comprehensive disclosure of their environmental footprints. This provides a key initial area of engagement for financial institutions. Despite poor company disclosure, it is interesting to note that when aggregated the bottom-up environmental footprint revealed is consistent with the academic top-down view – see Table 1.

Table 1: Heatmap showing the environmental footprint of the global food system compared to its funding Source: Planet Tracker.

	Producers and traders	Manufacturers and distributors	Retailers and food service
Company reported data			
CO_2 (tonnes) per USD 1m of revenue (Scope 1&2)	73%	16%	10%
Water usage (m^3) per USD 1m of revenue	89%	7%	4%
Waste (tonnes) per USD 1m of revenue	62%	24%	14%
Macro level (academic studies)			
GhG	84%	11%	5%
Water Use	82%	17%	1%
Air Pollution	90%	6%	4%
Finance			
Public equity financing	16%	67%	17%
Bank lending	24%	58%	18%

The environmental footprint of the global food system is heaviest at the producer end of the supply chain, but the public equity and bank finance is focused primarily on the manufacturing and distribution Node, as shown in Table 1. On that basis, the obvious conclusion is that in some cases financial institutions will have to exercise indirect influence on the companies further up the supply chain using their funding of the companies in the downstream Nodes to achieve the sustainability improvements required.

The concentrated buying power of the manufacturers and distributors in relation to the food producers suggests that the ability of financial institutions to indirectly influence behaviour among the producers will be strong.

However, it is also worth noting that bank lending is focused on the food producers as well (and to a much greater extent than is the case with equity providers) so there is a strong potential for direct influence on the food producers by banks.

Finally, equities may be proportionately less significant for food producers as a source of funding than banks, but equity investors have invested USD 825 billion in these companies suggesting that equity investors will still have considerable influence.

Key takeaways from our Node analysis of company-reported GhG figures

The current food system is estimated to be responsible for 34% (18 Gt) of global anthropogenic GhG emissions, according to a study by Crippa et al. (2021).[xiii] Deforestation is responsible for a significant proportion of that total,[xiv] with methane emissions from the livestock supply chain and from rice farming accounting for much of the remainder.[xv]

Planet Tracker's factor model estimate of global food system emissions based on company reported figures is c.1.6 Gt of CO_2e each year. This figure represents companies' reported Scope 1 and 2 emissions, which to avoid double counting, excludes Scope 3 emissions, such as those from deforestation and other land use change.

It should be noted that companies are not incentivised to report high GhG emissions, so reported figures may be lower than real emissions. For example, Planet Tracker's research[28] found that companies involved in meat and dairy production appeared to be significantly under-reporting enteric methane emissions that should be included in Scope 1 and 2 emissions.. Other assumptions and limitations of company reporting are discussed in Appendix 5.

As highlighted in the summary section above, the largest GhG footprint occurs among the producers and traders. This is particularly clear when emissions are compared to revenues to derive a 'GhG intensity' measure (CO_2e tonnes per USD 1 million of revenue) for each Node. The GhG intensity of the producers and traders is five times higher than that of the manufacturers and distributors – see Figure 20.

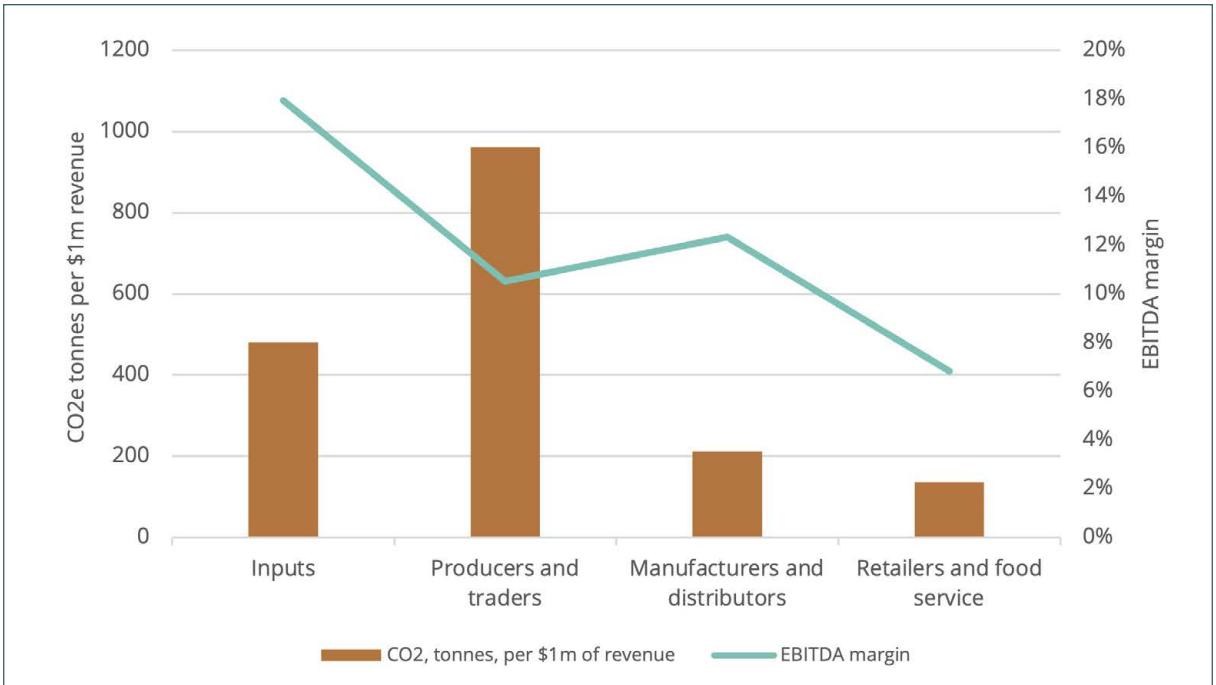


Figure 20: GhG intensity across the global food system supply chain. Source: Planet Tracker.

[28] The methane footprint of financial institutions supporting the meat and dairy industry is discussed in Planet Tracker's 'Hot Money' report.

This reflects the significant emissions from deforestation and other land use change as well as methane emissions from livestock and rice farming and nitrogen emissions from fertiliser[29].

It is interesting to compare the amount of funding provided with the GhG emissions on a Node basis. As Figure 21 shows, the producers and traders have the highest GhG footprint, but the funding is focused further down the supply chain. This clearly shows the critical requirement for downstream companies and their funders to take responsibility for their indirect impacts, in this example Scope 3 emissions. Banks, which are more likely to have financial relationships with producers and traders, may have a better opportunity to directly influence the food systems' GhG emissions footprint.

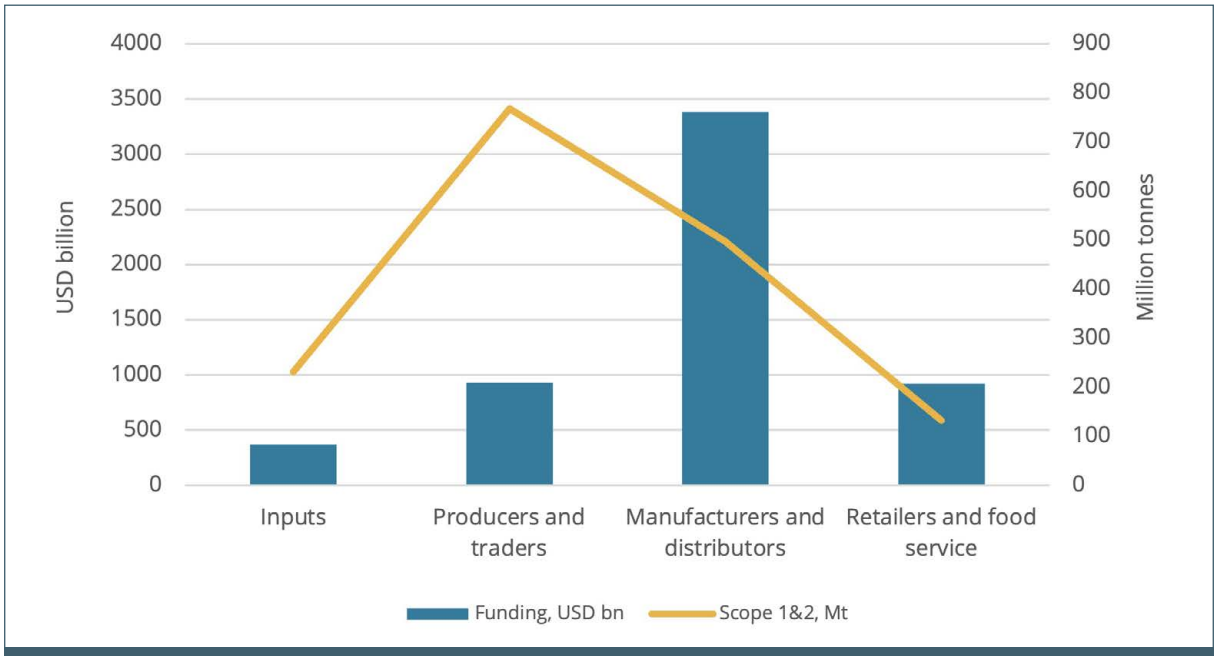


Figure 21: Funding and GhG footprint by Node. Source: Planet Tracker.

Key takeaways from our waste analysis

The FAO estimates that one third of the food produced is wasted or lost.[xvi] The UN estimates that 14% is lost between harvest and retail and 17% is wasted in retail, food service and consumption.[xvii] UNEP estimates that food waste amounts to 931 million tonnes (Mt),[xviii] implying that food loss amounts to 767 Mt and the total loss and waste amounts to 1.7 Gt. Food that fails to make it through the system to the retail end of the supply chain is referred to as 'food loss', whereas food that gets to the retail or food service stage or even through to the consumer but is not eaten is referred to as 'food waste'[30].

[29] Refer to Appendix 5 on page 139 for a more detailed discussion. Although the heavier GhG footprint for producers is as expected our analysis suggests companies are not reporting the full extent of their emissions

[30] These figures include food loss and waste across the whole food system including wild catch fishing and aquaculture.

Based on our analysis of company disclosures we estimate that the companies in our database are responsible for 277 Mt of waste each year. It is important to note that company disclosures don't differentiate between food and non-food items, such as packaging, when quantifying waste. This means it is not possible to conduct more detailed analysis or to easily compare our analysis to external estimates of the losses through the food system.

Given that our database captures around 53% of the food system's overall revenues, we might expect the reported figure to be lower than the overall estimate for the system, but there would still appear to be a material reporting gap, as with GhG emissions reporting. There is a real opportunity for financial institutions to work with companies across the food system to improve reporting on waste, as a first step to tackling the environmental impacts associated with this issue.

Our analysis shows that the total waste reported by companies in the producing and manufacturing Nodes (B though F) amounts to 233 Mt. If all this waste was food, it would be classified as food 'loss'. In contrast, the reported waste by companies in the retail and food service Nodes (G and H) amounts to 37 million tonnes – if this was all food it would be classified as food 'waste' – see Figure 22.

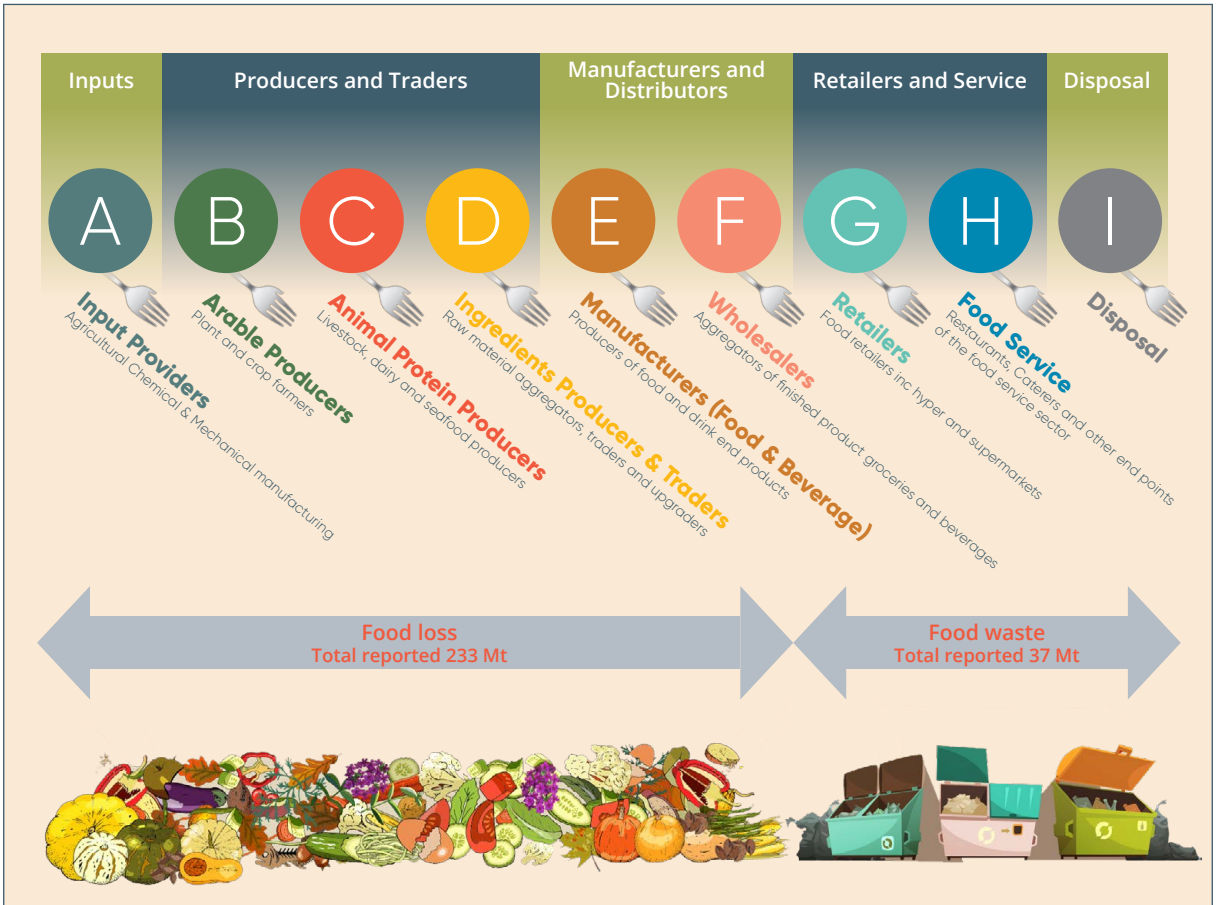


Figure 22: Food loss and waste vs total waste reported. Source: Planet Tracker.

On a Node basis, the greatest waste intensity (tonnes of waste per USD 1 million of revenue) occurs at the producers stage of the supply chain – 134 tonnes (see Figure 23). The food system average is 27.1 tonnes of waste per $1m of revenue.

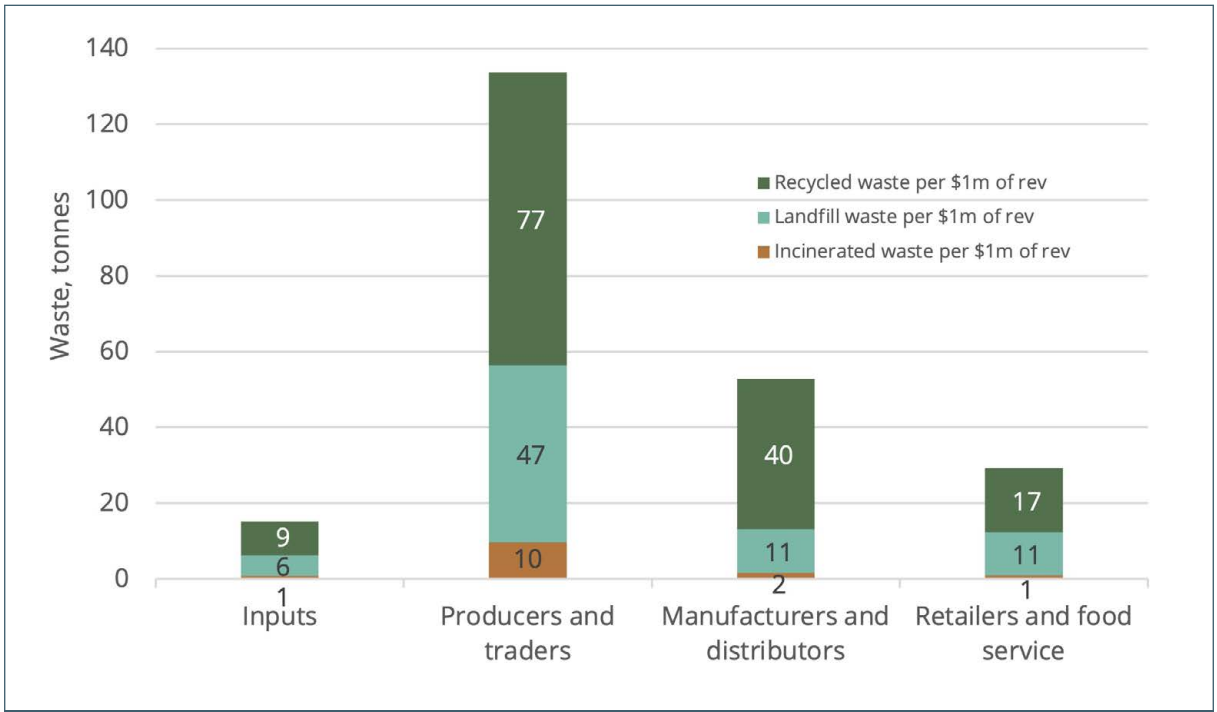


Figure 23: Breakdown of waste by Node per USD 1 million of revenue. Source: Planet Tracker.

Figure 24 shows the breakdown of waste disposal methods for each supply chain stage:

- Whilst manufacturers and distributors have the second highest absolute volumes of waste, these companies also have the highest recycling rate in the food system; 75% of waste, by tonnage, is recycled[31].
- In contrast, the Inputs Node has the lowest rate of recycling in the food system and a landfill rate that is 8 percentage points higher than the food system average.

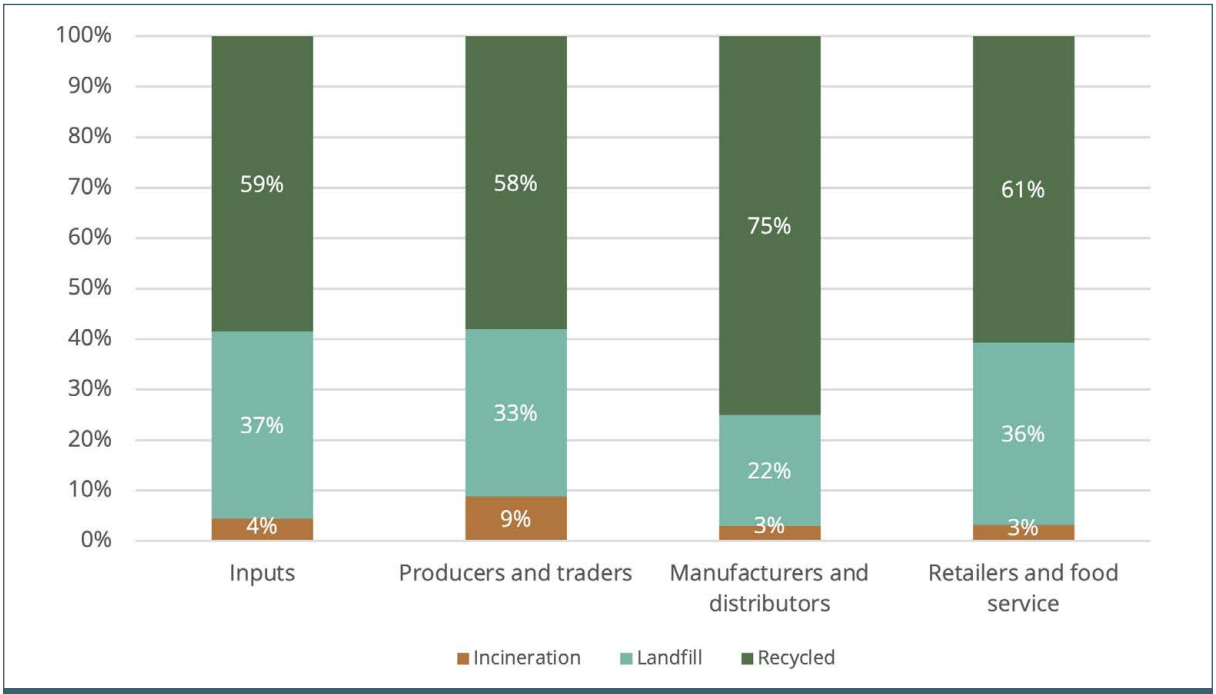


Figure 24: Breakdown of the waste produced by each Node. Source: Planet Tracker.

Analysis based on our database shows that:

- There is no correlation between waste sent to landfill or incineration and EBITDA margin. This implies that the extent of recycling is driven more by management choice than operational efficiencies.
- As one moves down the value chain, generally the amount of waste produced per $1m of revenue decreases and so does the amount of CO_2e produced, per $1m of revenue.
- This suggests that there is potentially a relationship between waste production and CO_2e production i.e., efficient companies control both their waste and their emissions.

[31] As noted earlier, companies do not disclose how much of their waste is food waste and how much is non-food waste such as packaging, so it is not possible to assess the extent to which any of the recycling relates to food nor what techniques are being used if that is the case.

Key takeaways from our water analysis

The OECD estimates that freshwater abstractions globally in 2010[32] totalled 790 billion m^3 [xix] of which 70% is used for agriculture,[xx] implying a figure of 553 billion m^3.

Our estimate of annual water usage by the companies in our database is 141billion m^3 of water each year (based on company reported figures). Although that is the equivalent of 57 million Olympic swimming pools it would still appear that companies are under-reporting their water usage by a factor of two – potentially more since the estimate based on OECD figures only relates to agriculture and does not account for water usage further down the supply chain.

Figure 25 shows the distribution of water usage across our food system map, highlighting that usage at the producer end is much higher than further down the system. This is not surprising when one considers the quantities of water required for food production. In some areas, water stress is set to increase driven by increasingly unpredictable weather patterns caused by climate change and increasing demand from a growing population. Producers in particular are likely to be negatively impacted by these trends, especially those producing particularly water-intensive commodities, or rain-fed crops. Companies further down the supply chain may face more indirect risks, including increased variability in the availability and price of certain commodities.

As noted previously, Banks, who are more likely to fund producers and traders, may have a better opportunity to directly influence the food systems' water emissions footprint. However, downstream companies and their funders will still face indirect risks associated with water stress and a resilient food system will require collaboration across the food system and its funders to tackle this issue.

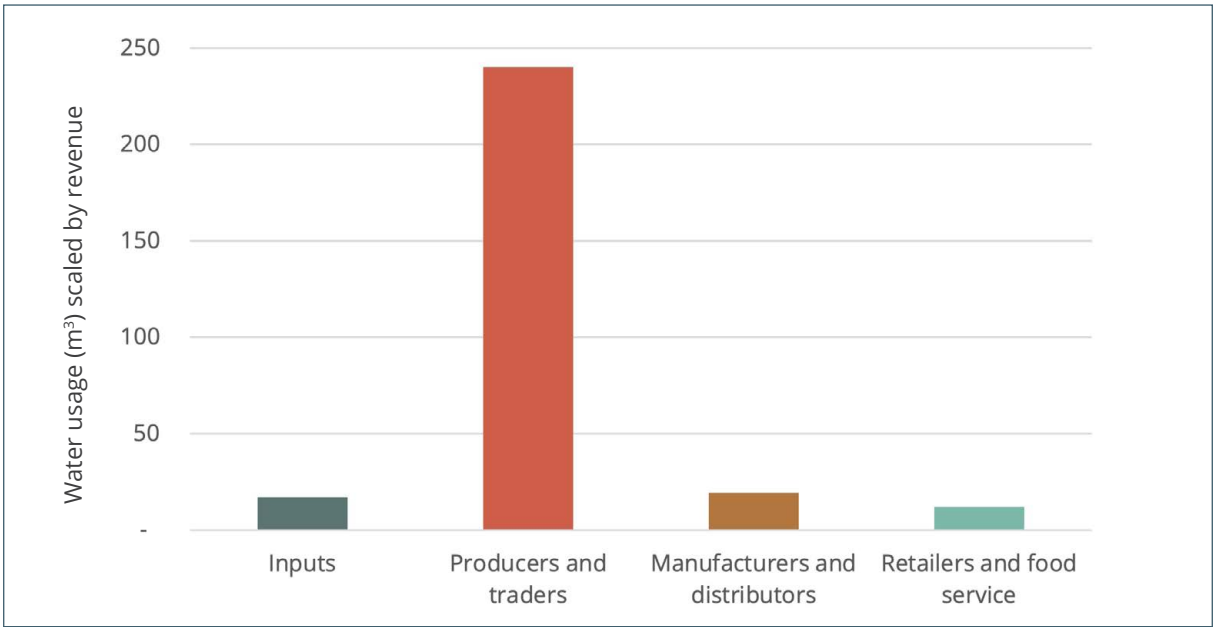


Figure 25: Water usage by Node intensity across the global food system. Source: Planet Tracker.

[32] Some countries provide more recent figures but 2010 gives the widest coverage for a global estimate.

What environmental data is missing

Our dataset is based on the company reported datapoints which are used by financial institutions when evaluating companies and so only covers GhG emissions, Waste, and Water. There is no viable company-reported data on many of the environmental harms caused by the global food system, (e.g. impact on nature, plastic usage, methane emissions, dietary impact, etc.) and so these data are not included in our dataset.

Further, much of the data that is reported by companies is not audited. As a result, company disclosures are often not consistent across time or between peers. Sustainability disclosures are not usually mandatory so many companies choose not to report or only report to a limited extent.

Table 2 provides a high-level summary of the problem and the areas where we believe investors need more consistent information[33].

Table 2: High-level comparison of the sustainability-related data reported widely by companies vs the data financial investors require to properly assess a food systems company's impact in the context of food system transformation.

Key Environmental & Social Harms	Company reporting	Planet tracker recommendation
GhG emissions	Reported	Fully capture scope 3, including agri-methane
Waste	Partially reported	Fully capture scope 3; provide details of waste categories
Water usage	Partially reported	Fully capture scope 3; quantify and explain water usage
Air pollution	Not reported	Report air pollution with sufficient details to enable risk analysis
Human health impact	Not Reported	Food manufacturers, retailers and food service companies should report health-related ingredient data with output volumes
Impact on nature (biodiversity)	Not Reported	Food system companies should adopt the TNFD framework and make use of existing reporting standards (e.g. GRI's Biodiversity reporting standard, GR304)

[33] This is a very high level summary of a complex set of topics so the recommendations should be seen as indicators of the direction of travel. We expect to return to each of these issues in future work.

Summary – the global food system's environmental footprint

We have analysed key academic studies of the food system to produce a top-down view of its environmental footprint on a Node basis in line with our food system map. Although company disclosures are frequently less comprehensive than investors require, it is interesting to note that when reported company figures are aggregated together the bottom-up environmental footprint they reveal is consistent with the academic top-down view – see Table 3.

Table 3: Environmental footprint of the global food system – company reported vs academic studies. Source: Planet Tracker.

	Inputs	Producers and traders	Manufacturers and distributors	Retailers and food service	Disposal
Company reported data					
CO_2 (tonnes) per USD 1m of revenue (Scope 1&2)	27%	54%	12%	8%	
Water usage (m^3) per USD 1m of revenue	6%	83%	7%	4%	
Waste (tonnes) per USD 1m of revenue	7%	58%	23%	13%	
Macro level (academic studies)					
GhG		81%	11%	5%	4%
Water Use		82%	17%	1%	
Air Pollution					
Anthropogenic emissions primary PM2.5		92%	1%	1%	6%
Ammonia (NH_3)		98%	0%	0%	2%
Nitrogen oxides (NOx)		82%	10%	5%	4%
Sulphur dioxide (SO_2)		65%	16%	12%	6%
Non-methane volatile organic compounds		89%	0%	0%	10%

Table 3 provides a more detailed comparison than Table 1 (on page 38) and the percentages have not been adjusted to align with the funding data (not included in this table) so are shown as reported. As discussed previously, company disclosures do not enable us to take a view on the 'Disposal' part of the system, in contrast to the academic studies where estimates are available. The academic studies we reviewed did not breakout food system inputs in their analysis.

FINANCIAL ANALYSIS OF GLOBAL FOOD SYSTEM COMPANIES

This section outlines Planet Tracker's analysis of key financial metrics of the food system Nodes to show how well placed companies in each Node are to invest in the changes needed for the transformation to a sustainable food system. This will provide financial institutions with an indication of where and how they may be able to support companies as they transition.

Planet Tracker's food system universe captures financial data from over 400,000 companies across 160 countries. 99% of these companies are private and so are not required to disclose much financial data beyond revenue (and disclose even less sustainability-related data). However, by combining their relatively thin disclosures with the much more comprehensive data set from the (much larger) public companies we have been able to analysis the financial metrics of each of the food system Nodes in our universe.

System-level financial metrics

Based on our food system database we estimate that:

- The aggregate asset value of the food system is USD 14 trillion, with an equity value of USD 9-11 trillion (similar to the Food and Land Use Coalition's 2019 estimate[xxi] of USD 10 trillion)[34].
- The aggregate food system revenues total USD 15-19 trillion, equivalent to c.20% of global GDP[35].
- The average EBITDA[36] margin of food system companies is 10%.
- The average return on capital employed is 9%.

Our analysis shows concentrations of power and finance across the food system:

- Fewer than 0.001% of companies in our food system universe are quoted but their total market capitalisation amounts to USD 5.5 trillion (roughly half of the food system's equity value).
- 53% of estimated total revenues are generated by less than 0.1% of the companies (those in our database).

The aggregate ASSET VALUE of the food system is USD 14 trillion

[34] We discuss the details of the funding supporting the global food system and our valuation estimates later in this report.

[35] Global GDP was USD 96.1 trillion in 2021 according to the World Bank.

[36] Earnings Before Interest, Tax, Depreciation and Amortization – a measure of profit.

Key takeaways from our financial analysis

The structure of our database allows us to examine the financial characteristics of each Node. Table 4 shows a summary of the financial characteristics of each Node relative to the others.

Table 4: Food system Node rankings (1 = high). Source: Planet Tracker analysis.

Node		Number companies	Revenue	EBITDA	EBITDA margin	Market Cap	Total Debt	ROCE
Input Providers	Node A	7,592	5	5	1	5	5	2
Arable Producers	Node B	122,029	6	6	3	6	6	3
Animal Protein Producers	Node C	60,607	8	7	5	7	7	6
Ingredient Producers & Traders	Node D	53,680	4	4	6	3	4	5
Manufacturers (Food & Beverage)	Node E	79,067	2	1	2	1	1	8
Wholesalers	Node F	112,914	1	2	4	2	2	4
Retailers	Node G	37,759	3	3	8	4	3	1
Food Service	Node H	93,088	7	8	7	8	8	7
Top-ranked node		Node F	Node F	Node E	Node A	Node E	Node E	Node G
Bottom-ranked node		Node G	Node C	Node H	Node G	Node H	Node H	Node E

Our analysis highlights the extent to which revenues are concentrated in the hands of a few companies. On average, in each of the Nodes in our database, the companies with revenues in excess of USD 5 billion (0.3% of all the companies in our database) account for 45% of the revenues in each Node. When we analyse the Nodes separately, we find that this market share is never lower than 30%, and in Node A (input providers) it is 57% and among the food retailers (Node G) it is 71%.

Figure 26 illustrates the relative concentrations of power in each of the Nodes.

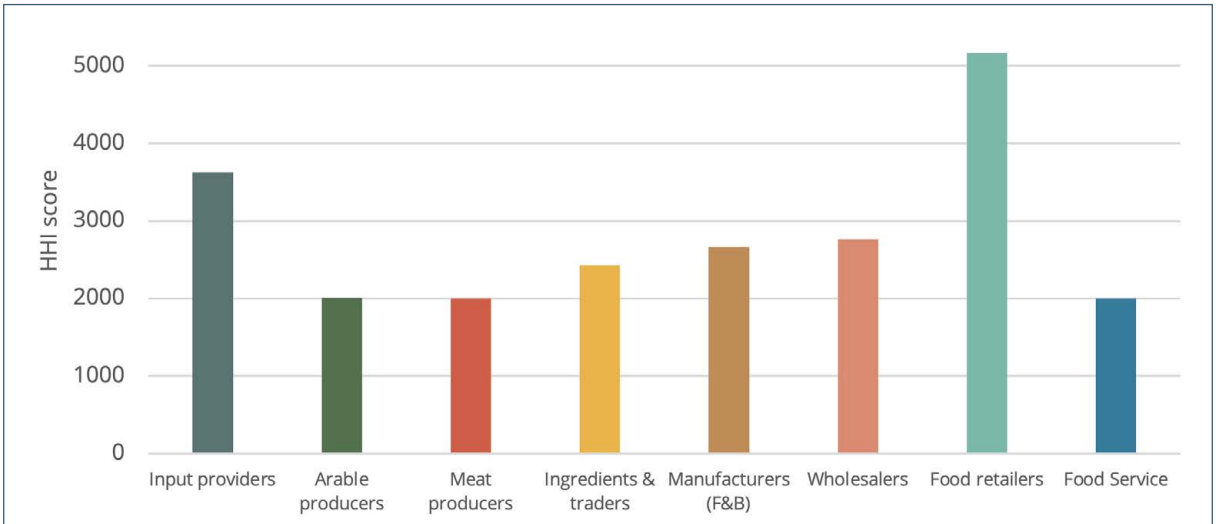


Figure 26: The Herfindahl–Hirschman Index (HHI) is a commonly used measure of market concentration (the extent to which a particular market is dominated by a few large participants). HHI is calculated by squaring the market share of each firm competing in the market and then summing the resulting numbers. High concentration scores can suggest the presence of an oligopoly or even a monopoly. Source: Planet Tracker.

Profit is not distributed equally across the global food system:

- Companies producing food system inputs such as fertiliser, pesticides and agricultural equipment (Node A) have the highest EBITDA margin within the food system.
- Food & beverage manufacturers (Node E) have by far the largest aggregate profit[37] as well as having the second-highest profit margin – see Figure 27.

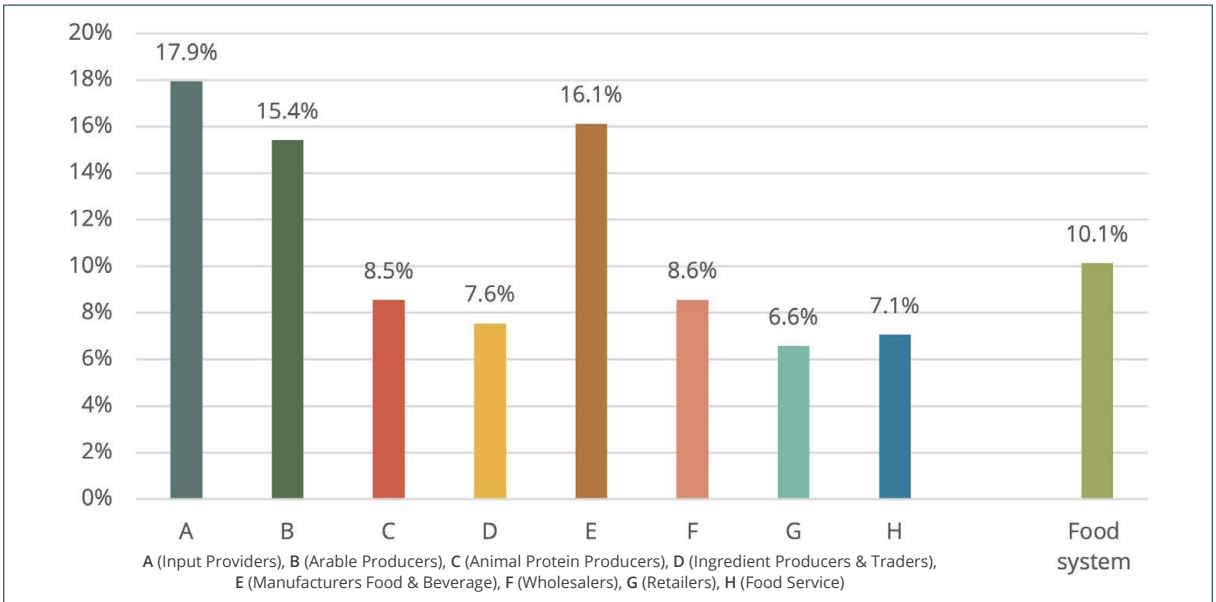


Figure 27: The EBITDA margins of each of the nodes in the food system . Source: Planet Tracker.

However, when profit is compared to the assets required to generate it, a comparison of the Nodes reveals a different picture:

- Food manufacturers (Node E) have the lowest ROCE[38].
- Food retailers (Node G) have the highest average ROCE - 14.2% vs the food system average of 8.6% – see Figure 28.

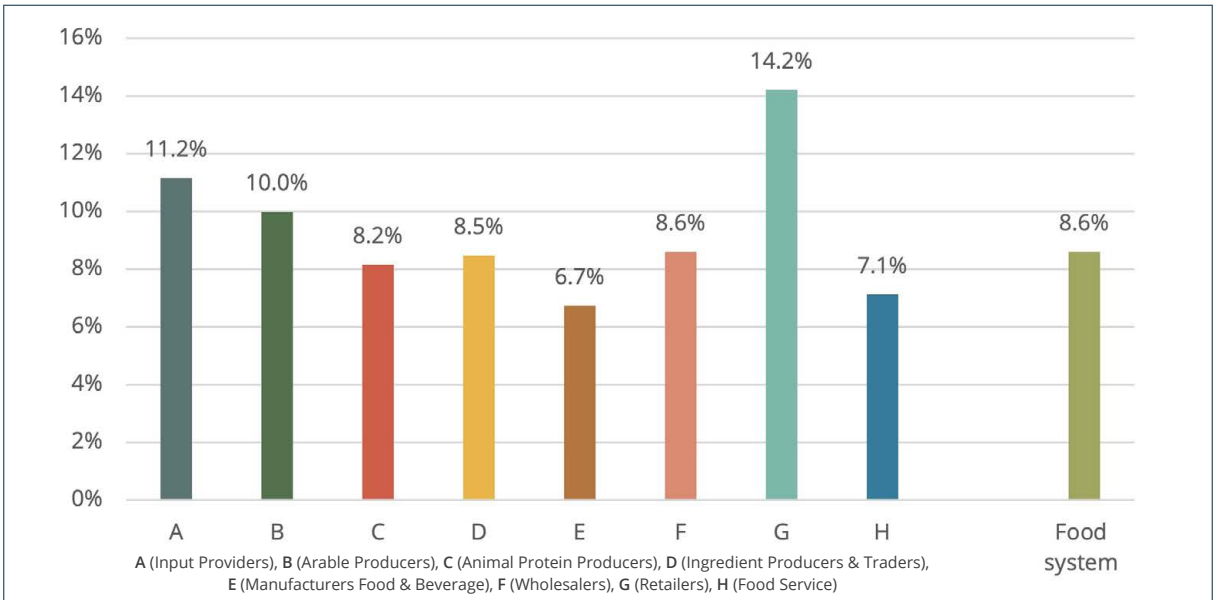


Figure 28: Return on Capital Employed (ROCE) by node. Source: Planet Tracker.

[37] To ensure comparability across our dataset we use Earnings Before Interest, Tax, Depreciation and Amortization (EBITDA) as our measure of profit.

[38] Return On Capital Employed – due to limited reporting by companies in our database we have calculated ROCE as EBITDA divided by net debt plus market cap.

The proportion of funding provided by debt varies across the system with evidence suggesting a barbell pattern (higher debt at early and late Nodes in the system with lower debt levels in the middle):

- Arable and animal protein producers (including dairy and seafood) are some of the most indebted with debt constituting broadly half their capital base. Food Service companies are also heavily indebted.
- The downstream end of the system (from food manufacturers onwards - Nodes E through H) have the largest absolute amount of net debt with nearly 70% of the total food system. However, their leverage ratios are relatively low (with the exception of food service companies) because their debt is supported by their large aggregate profit pools.

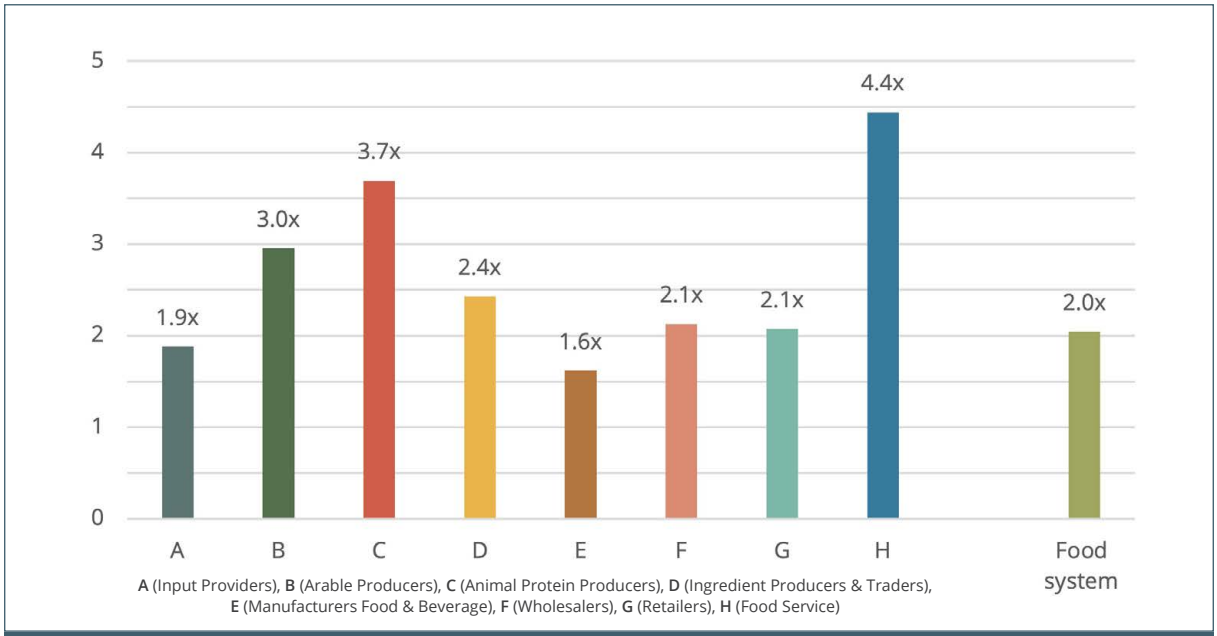


Figure 29: Net debt to EBITDA by node for the food system. Source: Planet Tracker.

In overall terms, our analysis supports the view that revenues and profits are concentrated towards the downstream end of the supply chain. With respect to revenues, 46% of the aggregate revenues in our database are captured by manufacturers and distributers – see Figure 30.

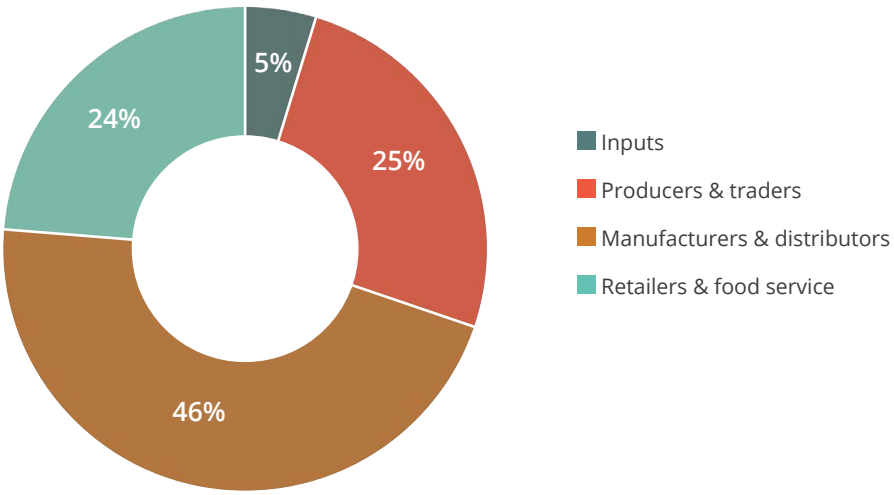


Figure 30: Distribution of revenues across the global food system. Source: Planet Tracker analysis.

This is particularly true in terms of profits, where only 19% are captured by producers and traders compared to 54% of the profits captured by food manufacturers and distributors as shown by Figure 31.*

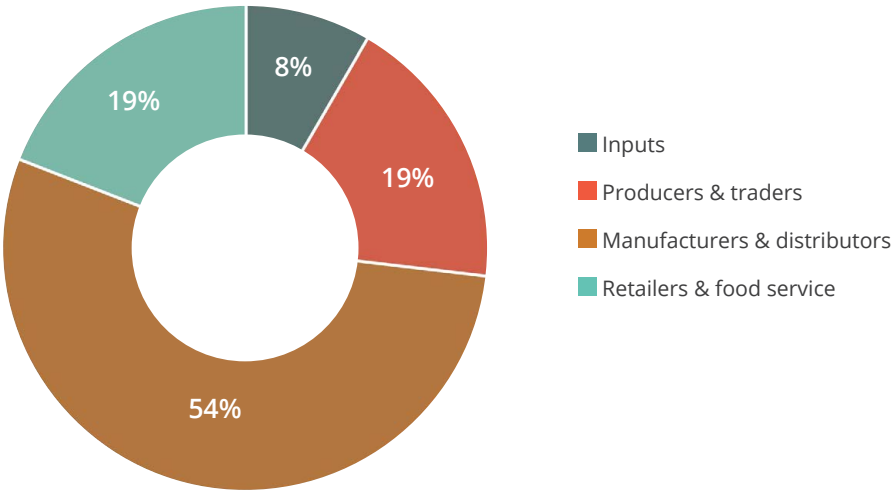


Figure 31 Distribution of profits across the global food system. Source: Planet Tracker analysis.*

Our Node structure does not quite match up to 'farm' vs 'post-farm' but our analysis that 80% of the profits in the system (excluding inputs) relate to non-producing activities (four times the producer's profit share) is consistent with other studies[39].

[39] For example, the World Bank estimates that 'the food system generates 2 to 5 times as much value as farm production itself' https://blogs.worldbank.org/voices/do-costs-global-food-system-outweigh-its-monetary-value

* An earlier version of this report incorrectly stated that 'Only 13% of the aggregate profits in the database are captured by producers compared to 47% of the profits captured by food retailers and food service companies'. This has been corrected.

SUMMARISING THE ENVIRONMENTAL FOOTPRINT AND FUNDING OF THE GLOBAL FOOD SYSTEM

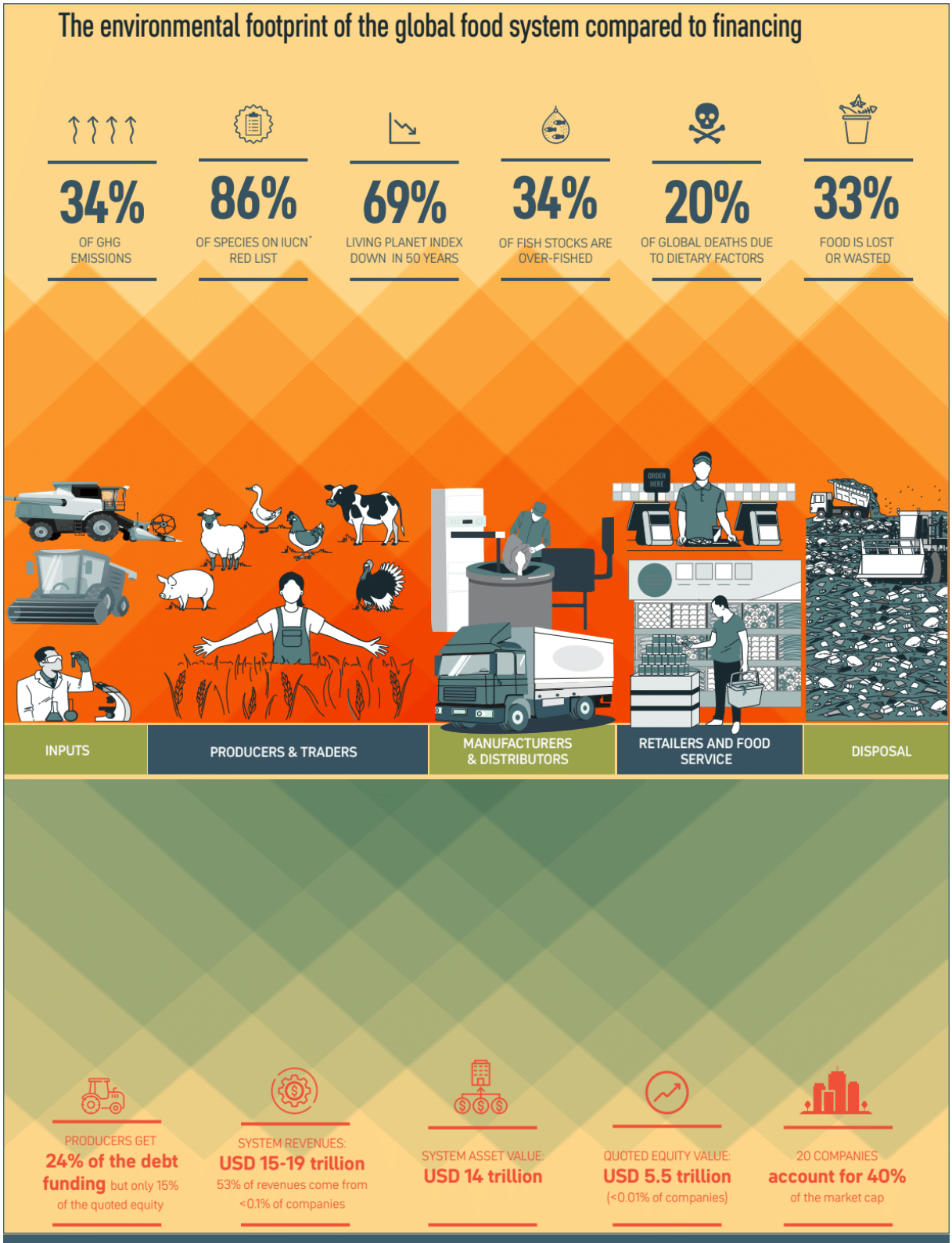


Figure 2: The environmental footprint of the global food system compared to financing. Source: Planet Tracker analysis.

* International Union for Conservation of Nature

GLOBAL TARGETS DEPEND UPON FOOD SYSTEM TRANSFORMATION

None of the global targets, pledges and ambitions that have been agreed in recent years with respect to people, planet and climate will be achieved unless the global food system is transformed, and many require significant action by 2030 including:

- **The UN's 17 Sustainable Development Goals** should be achieved by 2030[40]
- **The Leaders Pledge for Nature** aims for 'nature-positive by 2030'
- **The Kunming-Montreal Global Biodiversity Framework** agreed at COP 15 includes 23 'action-oriented global targets' to be achieved by 2030[xxii]
- **The Glasgow Leaders Declaration on Forests and Land Use** commits to halt and reverse forest loss and land degradation by 2030
- **The Global Methane Pledge** targets a 30% reduction in methane emissions by 2030
- **The Paris agreement** to limiting global temperature rise to 1.5°C by 2050 includes reducing emissions by 45% by 2030[xxiii]
- **World Health Organisation global targets** for improving nutrition by 2025[xxiv]

The financial sector has a crucial role to play

As discussed in this report, Planet Tracker estimates that the value of private finance currently invested in the global food system is USD 8.6 trillion[41] (63% of its estimated USD 14 trillion asset value), with the potential to provide annual funding of around USD 630 billion. This is estimated based on the estimated current level of bank lending to food system companies in our database (c.USD 560 billion per annum) plus an estimated potential USD 70 billion per annum from equity markets.[42]

From the perspective of the financial sector, the food system's heavy carbon footprint means that, without radical changes, financial institutions will not be able to meet their net zero commitments. Similarly, any commitments made with respect to nature will not succeed unless the food system is transformed.

[40] There are 17 SDGs all of which would be helped to a greater or lesser extent by transforming the food system but in particular that transformation will be fundamental to achieving these goals: #2 – Zero hunger; #12 Responsible production and consumption; #13 Climate action; #14 Life below water; #15 Life on land.

[41] Equivalent to 4% of global domestic equities value in 2021 (source WFE) and 2% of credit to non-financials in 2Q22 (source BIS)

[42] Equity finance raised in 2021 was USD 1 trillion (source SIFMA) and the consumer staples sector accounts for c. 7% of the global index so a broad indicator of the potential equity funding available annually would be 7% x USD 1 trillion = USD 70 billion. In practice, the appetite of equity investors to provide funding to particular areas of the economy is dependent on a variety of factors and can change rapidly. This doesn't include funds from private equity / venture capital

From a risk perspective, it is clear that the financial sector is very exposed to the threats posed to the food system by climate change and nature loss, and also to the changes that will be forced on the system as various governments implement the policy changes required to meet the global targets outlined above.

There is a significant financial benefit too. In their 'Growing Better' report[xxv] the Food and Land Use Coalition (FOLU) estimate that there are annual business opportunities worth USD 4.5 trillion associated with the ten critical food system transformations they identify and an economic benefit of USD 5.7 trillion from avoiding hidden costs embedded in current practices. They estimate the annual investment required to achieve these results is USD 300-350 billion – equivalent to 4% of the USD 8.6 trillion of private capital invested in the system or 2% of estimated system revenues[43].

Transforming the global food system will not be easy, and there is remarkably little time left until 2030, but it is clear that the financial sector has a crucial role to play in this process.

In the following sections we discuss how taking a systems approach makes this task more achievable and the four food system transformation themes that financial institutions should focus on when deciding how to allocate their capital and configure their investment policies and processes.

taking a **systems approach** makes this **task** more **achievable**

[43] See 'How much is your food worth?' (Planet Tracker's estimate of global food system revenues is USD 15-19 trillion).

WHAT SHOULD THE FINANCIAL SECTOR DO?

As discussed in the previous sections, financial institutions need to deploy their firepower to support the transformation of the global food system.

To help financial institutions decide where to focus their efforts, what investment and engagement policies to put in place, and what initiatives to support this Roadmap uses a three-four-six structure – see Figure 33.

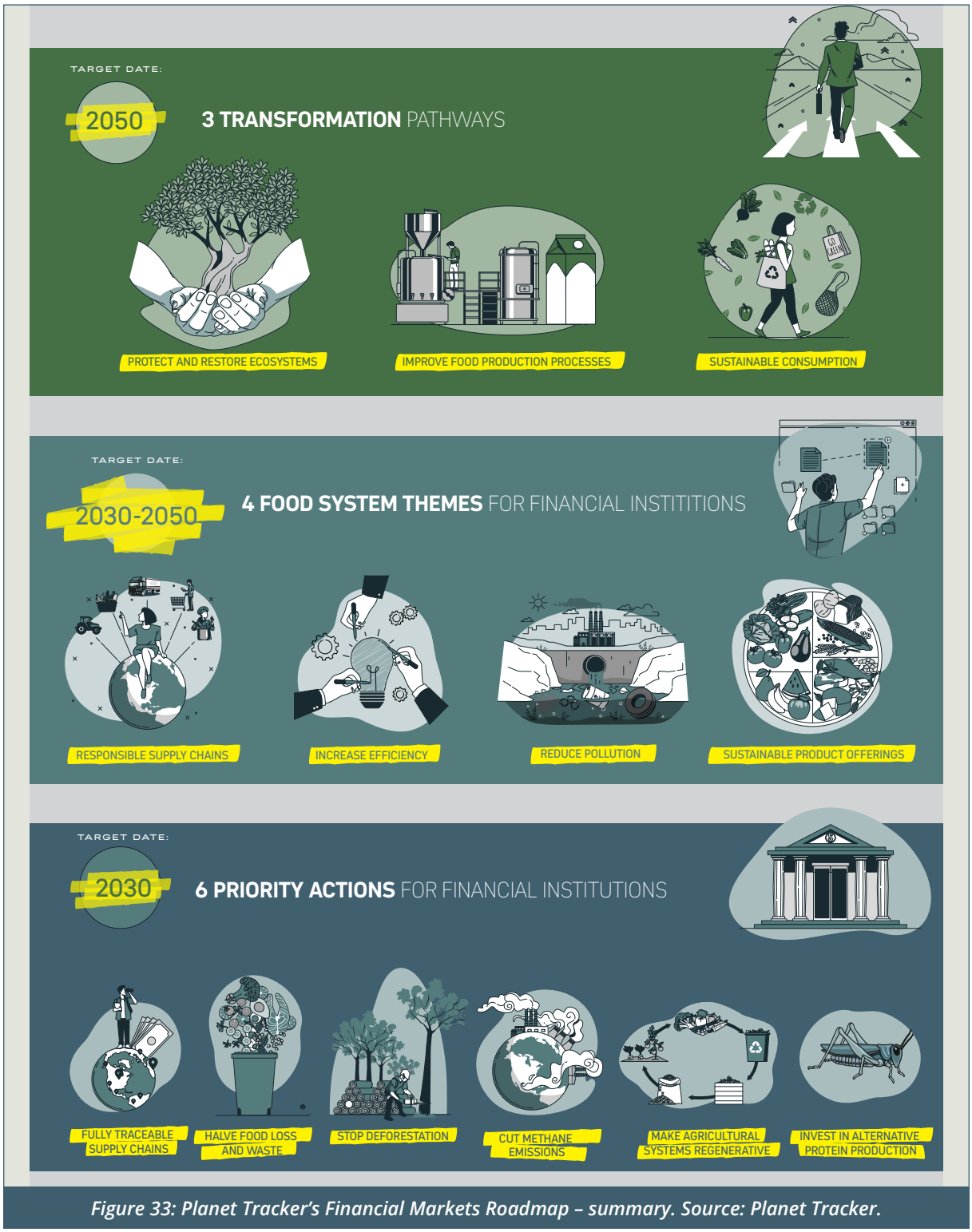


Figure 33: Planet Tracker's Financial Markets Roadmap – summary. Source: Planet Tracker.

The **transformation pathways** are usually targeted at governments and policy makers, and describe the changes required at a systems level. As such, they provide an important context for financial institutions when deciding how best to support the required transformation of the global food system. However, financial institutions need greater detail and actions that can be implemented through their financial relationships with the companies they support.

The **four food system transformation themes** we set out in this report provide financial institutions with the structure they need to develop policies and configure their investment and company engagement processes to ensure they are allocating capital in support of the food system transformation and mitigating the investment risks associated with the changes that will occur.

Finally, the **six priority actions** we have identified provide financial institutions with a list of actions **that financial institutions should take before 2030** if they wish to have an immediate impact to reduce the harms that the global food system is generating and a correspondingly beneficial contribution towards net zero lending or investment portfolios.

There are significant risks for financial institutions that fail to position themselves to take account of the inevitable changes that will impact the global food, but for those that seek to actively support and drive the required changes there are significant investment opportunities.

This Roadmap is designed to be the start of the journey. Planet Tracker's work will continue to build on the four food transformation themes, and we intend to provide more detailed analysis and toolkits in the future to support financial institutions to implement the priority actions. However, the urgency of the linked climate and nature crises requires immediate action, and the financial sector's role in this is crucial.

This **ROADMAP** is the **Start** of the **JOURNEY...**

THREE TRANSFORMATION PATHWAYS

A variety of organisations have proposed frameworks ('transformation pathways') for the changes required to make the global food system sustainable.

The transformation pathways we have identified are based on the extensive work of organisations such as the Food and Land Use Coalition (FOLU), Global Alliance for the Future of Food (GAFF), World Wildlife Fund (WWF), World Bank, World Economic Forum (WEF), and World Resources Institute (WRI) to name but a few, as well as an extensive review of the academic literature[44]. These organisations take different approaches and emphasise different aspects depending on their intended audiences, but the transformation pathways they recommend can be broadly grouped under three headings – see Figure 34.

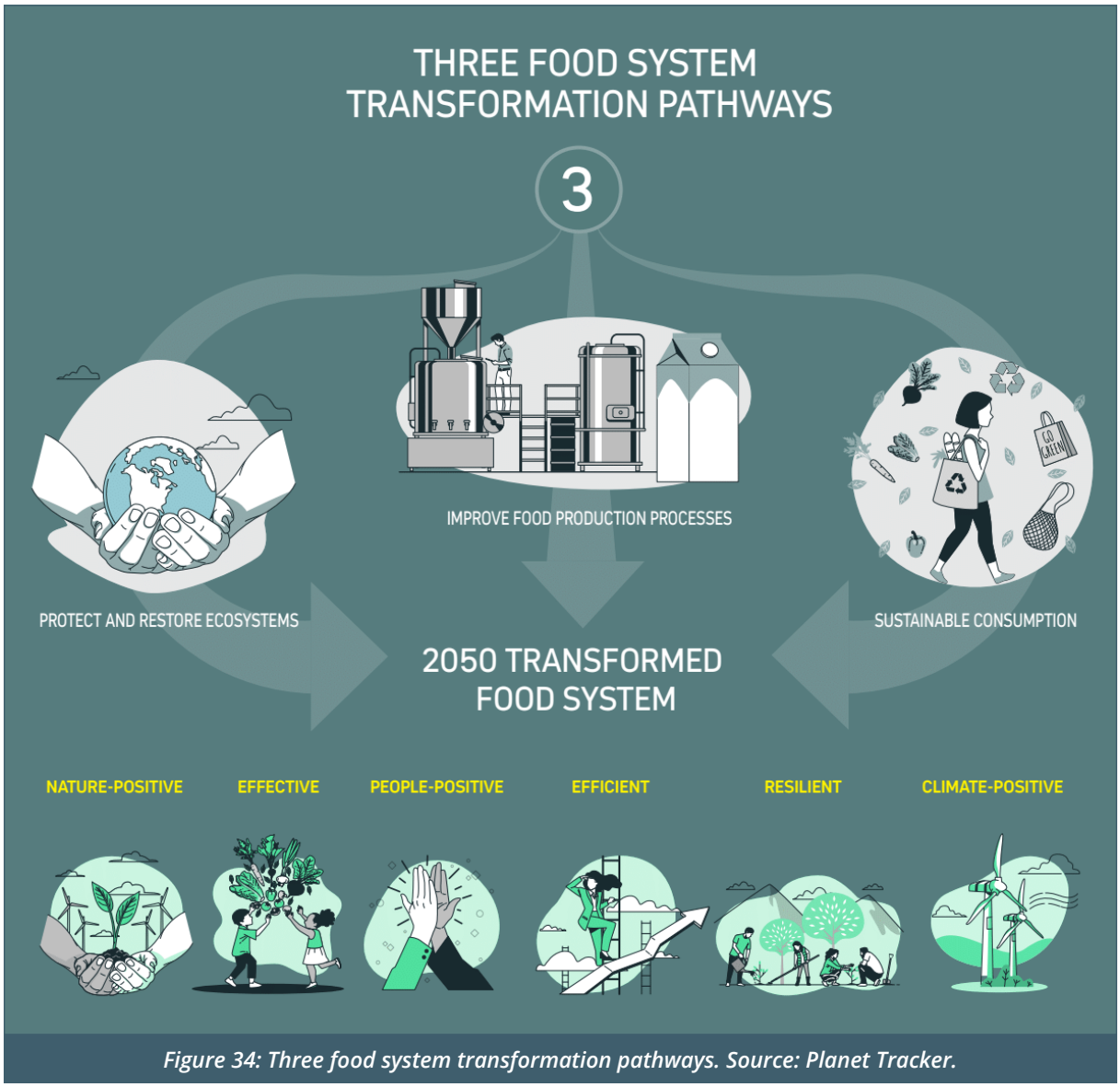


Figure 34: Three food system transformation pathways. Source: Planet Tracker.

[44] For example, the WRI has four 'interconnected pillars' ('Produce-Protect-Reduce-Restore') to address the land gap discussed earlier that align closely with our three transformation pathways. – protect and restore ecosystems, produce more on existing lands, and reduce projected growth in demand for land-intensive goods, particularly by high consumers.

1 Protect and restore ecosystems
2 Improve the food production process
3 Achieve sustainable consumption

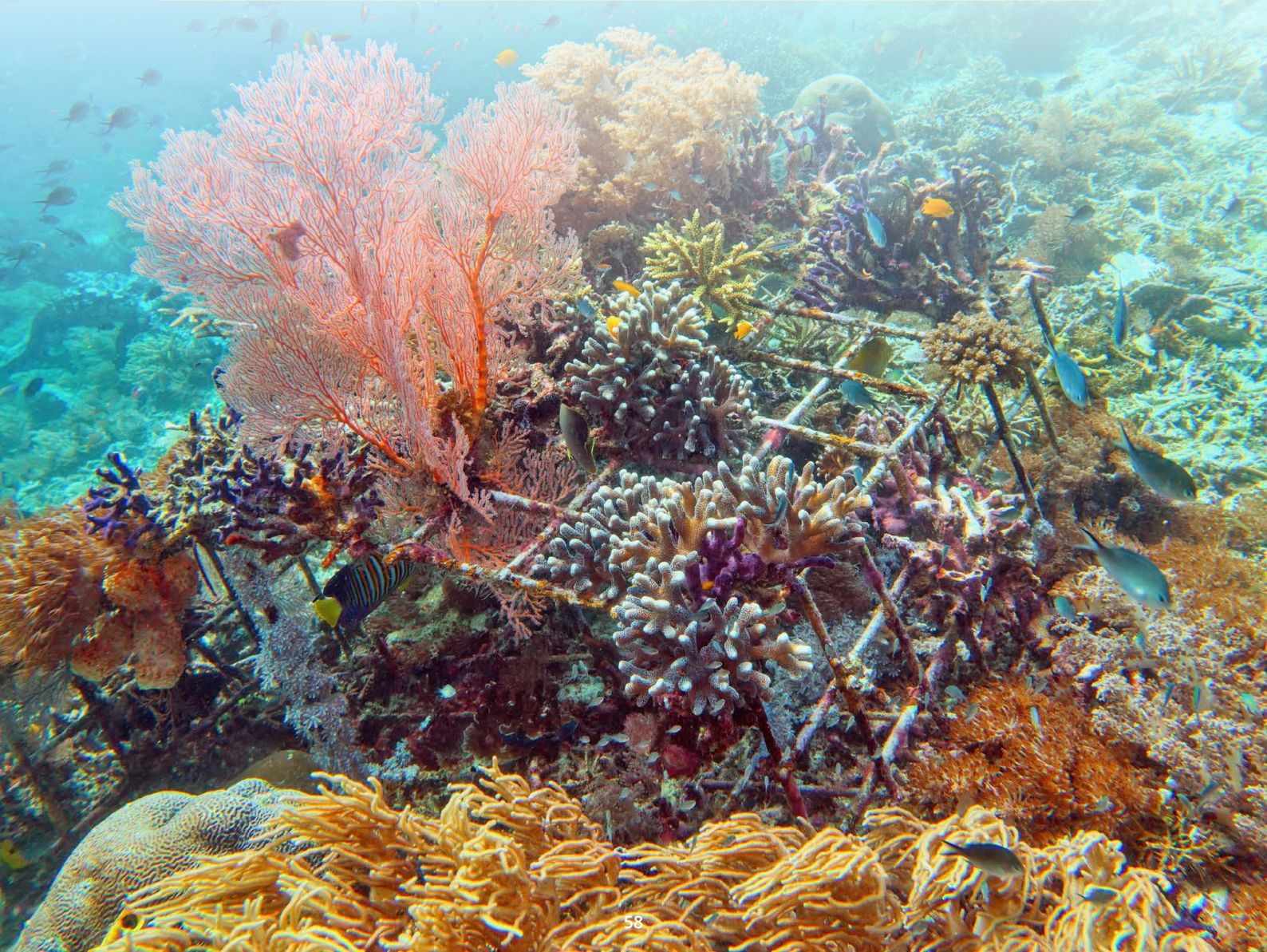
These pathways address the climate, nature and societal harms being caused by the food system in its current form.

Protect and restore ecosystems

As summarized in this report, the food system is having a negative impact on a variety of ecosystems and thus on our climate and the resilience of our food system. Protecting ecosystems from further harm and taking action to restore ecosystems to full health is an essential part of the food system's transformation.

Actions to be taken will include:

- Stopping deforestation
- Habitat restoration and biodiversity enhancement (including marine habitats)
- Controlling land use and sea use change
- Ending overfishing and destructive fishing practices



Improve food production processes

The food system is widely acknowledged to be inefficient as discussed in this report (particularly when its true costs are taken into account):

- Both in agriculture and aquaculture, costly inputs generate pollution such as nitrogen run-off instead of food calories;
- Land use is often suboptimal;
- Crop yields are lower than they could be;
- Crop types are undiversified and so vulnerable to threats such as disease and climate change;
- Soil health is depleted not enhanced by the agricultural methods deployed;
- Conventional aquaculture negatively impacts marine environments rather than enhancing them; and
- A significant proportion of the calories generated by the solar energy captured by plants fails to make it through the food system into food calories and protein for human consumption.

Organisations focused on transforming the food system agree that food production processes need to be changed to address all these problems.

Actions to be taken will include:

- Enhance soil health and CO_2 capture (replacing extractive methods with regenerative ones)
- Increase land use efficiency (including crop yield improvements, and shifting to food sources that use land more efficiently)
- Alternative protein production that does not use agricultural land or wild caught fish
- Reduce chemical and antibiotic inputs
- Reduce water usage
- Reduce pollution (including GhGs such as methane and nitrous oxide, nitrogen run-off, overuse of antibiotics and plastics)
- Reducing food loss from production (both land and oceans-based) to retail

Achieve sustainable consumption

Protecting and restoring ecosystems and improving food production processes will ensure the food system is resilient and able to increase the supply of calories and protein to feed a growing population. However, the consensus among organisations working to create a sustainable food system is that the demand side of the system must be addressed too.

In many parts of the world people lack sufficient food to ensure their health and well-being so addressing demand should not be equated to 'eating less' as a solution. What is required is a change to the system so that the demands made are sustainable and do not push the system beyond planetary boundaries.

Because the demands are generated at the downstream end of the system, one of the key components to ensuring they are appropriate is to have supply chains that are fully traceable, clearly linking consumers through to producers so that all food system participants have full visibility.

Other actions will include:

- Sustainable packaging and transport
- Changing food environments to encourage a shift to sustainable diets with a reduced nature and climate impact
- Shifting food production to focus on providing food that is less processed and that provides improved (diverse) nutrition and reduced fat, salt, and/or sugar
- Reduce waste by food service companies and consumers

Just transition

Although this is not a transformation pathway as such, it is important to note that the concept of 'just transformation' underpins all three transformation pathways.

As summarized in this report, the food system is a vital source of employment and income for many people across the world, particularly in developing economies (see Figure 57 on page 130). Any transformation process must take into account the needs of the people who depend on the food system for their livelihoods and ensure that they are better off as a result of the transformation.

The International Labour Organisation has set out guidelines for a just transition and concludes that 'a just transition … needs to be well managed and contribute to the goals of decent work for all, social inclusion and the eradication of poverty.'

If the transformed food system fails to meet this basic test, then the transformation will not have been completely successful.

FOUR FOOD SYSTEM TRANSFORMATION THEMES FOR FINANCIAL INSTITUTIONS

This section provides financial institutions with a framework for developing a food systems investment strategy.

Financial institutions that wish to tailor their own approach to supporting the transformation of the food system can obviously do so based on the three transformation pathways summarized in the previous section.

However, financial institutions that want a more granular structure on which to base their food system strategy (and the associated investment and engagement policies) should use this framework of four food system transformation themes – see Figure 35.

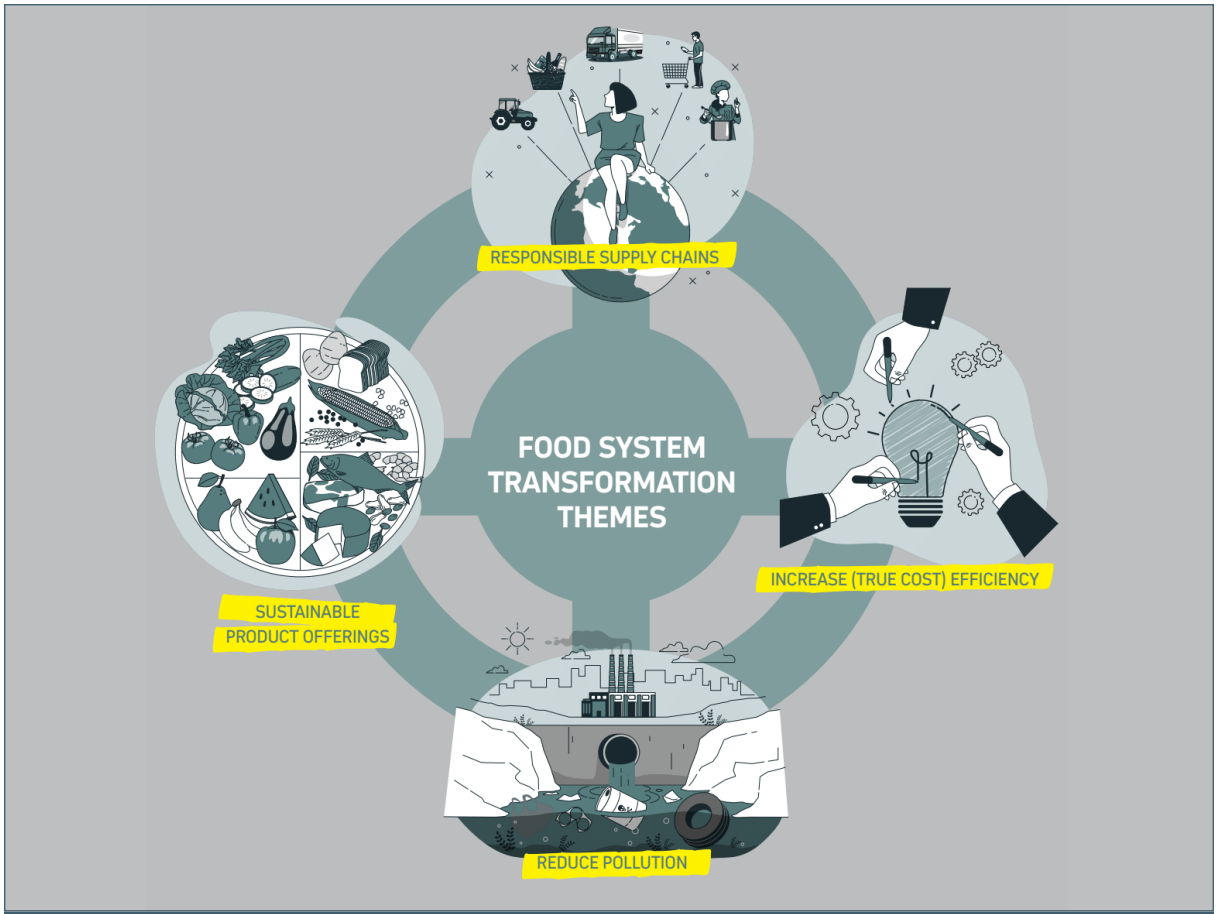


Figure 35: Four financial markets themes for food system transformation. Source: Planet Tracker.

These themes focus on areas where financial institutions are likely to have influence through the companies they fund, providing a more focused framework than the transformation pathways.

We discuss each of these themes in more detail below, including the actions that financial institutions should be urging companies to take to achieve the required transformation of the food system.

Responsible supply chains

As we summarise in this report, many of the harms caused by the food system occur upstream, in food production but the demand that drives these harms is generated further downstream which is where the majority of the funding provided by the financial markets and lending banks is focused.

As a result, mitigating or preventing these harms will require actions to be transmitted up the supply chains involved and information about the effect of these actions will need to be transmitted back to the downstream actors responsible and to their funders. In addition to this, downstream companies will need to work with their peers to support upstream companies across supply chains and to transfer the capital, resources and knowledge required to enable sustainable transformation. Ultimately, the food system's problems are beyond any one company's capacity to solve so a focus on responsible supply chains will be essential.

Financial institutions intending to build investment policies and company engagement processes to address the responsible supply chains theme should use this as their core principle: that **all their portfolio food system companies should take full responsibility for their supply chains and for the businesses and people involved.**

This means that financial institutions should require their portfolio companies to incorporate sustainability and social responsibility into all aspects of supply chain management:

1. identifying, selecting and contracting supply chain partners;
2. managing and developing the relationships in the supply chain; and
3. monitoring and controlling performance of supply chain partners.

Financial institutions intending to build policies and actions based on this theme should use the OECD's 'Guidelines for Multinational Enterprises'[xxvii] as a starting point, supplemented by the OECD-FAO 'Guidance for responsible agricultural supply chains'.[xxviii]

The OECD-FAO guidance has been specifically designed for food system supply chains and covers all aspects, from inputs and food production at one end through to food distribution and retail at the other. It sets out a 5-step framework that Multinational Enterprises should follow to ensure they have responsible food supply chains – see Figure 36.

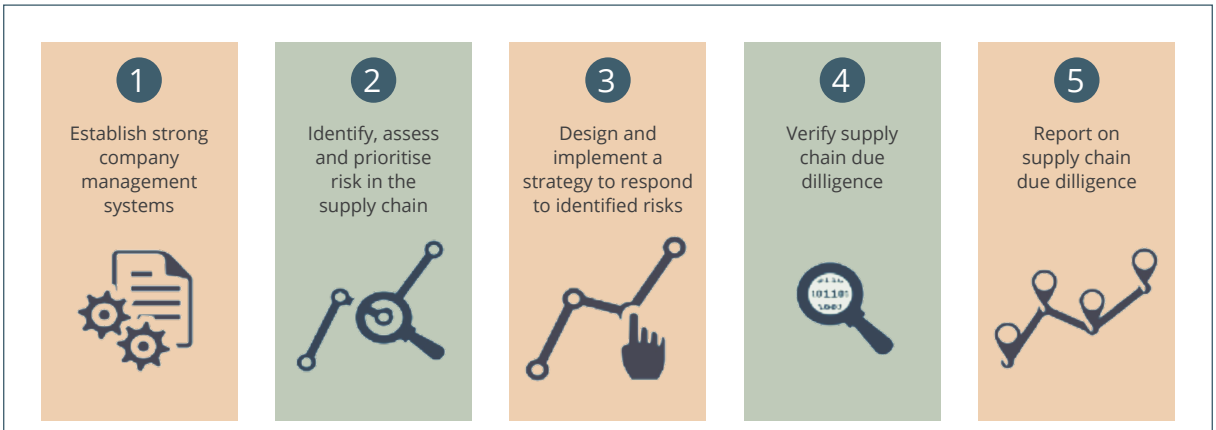


Figure 36: 5-step framework for responsible food system supply chains. Source: OECD-FAO Guidance for responsible agricultural supply chains.

The OECD-FAO Guidance also highlights the risks that arise at different stages of the food system. Financial institutions should use this as a framework for the requirements they impose on portfolio companies with respect to supply chain risk mitigation – see Figure 37.

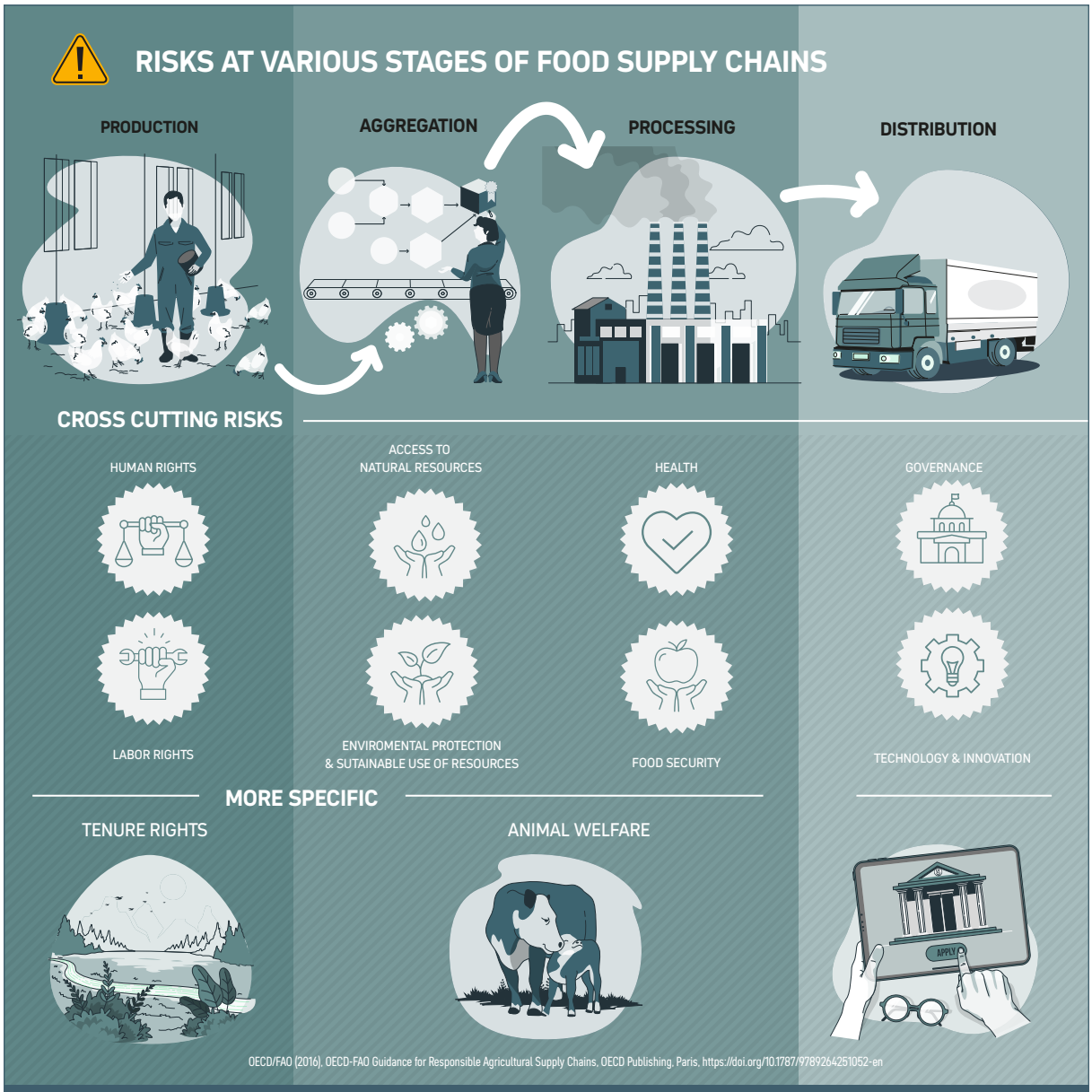


Figure 37: Risks at various stages of food supply chains.
Source: OECD-FAO Guidance for responsible agricultural supply chains.

Supply chain monitoring and transparency is a fundamental requirement for achieving responsible supply chains and so is included as one of the Priority Actions this Roadmap recommends – see discussion later in this report on page 77.

The Kunming-Montreal GBF also has a 2030 target relating to transparent supply chains: 'Requiring transnational companies and financial institutions to monitor, assess, and transparently disclose risks and impacts on biodiversity through their operations, portfolios, supply and value chains',[xxix] so policy pressure can be expected to grow in this area.

Increase food system true cost efficiency

As summarized in this report, the food system is very inefficient, particularly when all its costs are considered. Conceptually, addressing this challenge is simple:

1. Inputs with high economic, environmental and social costs need to be reduced;
2. Protein and calorie production, and nutritional content and diversity must be increased without expanding or depleting the land or sea used; and
3. Loss and waste throughout the food system must be eliminated, including by making the system less linear and more circular by recycling products through the system.

Practically, these are all tough challenges to overcome but financial institutions wishing to construct investment policies and company engagement processes to address these issues should focus on supporting the following changes:

- Limiting the expansion of agricultural land and stopping deforestation;
- Reducing the quantities and costs of external (chemical) inputs;
- Increasing output in terms of the quantity of calories and protein per hectare;
- Increasing output from regenerative agriculture and regenerative aquaculture;
- Improving soil health;
- Improving ocean health;
- Improving water management;
- Reducing transport costs;
- Reducing food loss and waste; and
- Investing in technological advances to enhance food production.

Apart from the food loss and waste component, which needs to be addressed throughout the system, many of these efficiency changes are more applicable to the production stage.

Regenerative agriculture

Many larger food system companies are already investing significant sums in food production processes under the banner of 'regenerative agriculture', so this potentially provides financial institutions with a helpful platform for supporting many of these improvements.

There is no agreed definition of 'regenerative agriculture', but FOLU provides a clear summary of the key elements in its 'Growing Better' report. At its core, regenerative agriculture is a set of practices that maintain high levels of productivity while it:

- regenerates soil;
- reduces (or even eliminate) synthetic fertilisers and pesticides;
- reduces water use and negative impacts on freshwater and oceans; and
- aims to ensure positive environmental effects including increasing biodiversity.

It is supported by related techniques such as sustainable land management and integrated water resource management.

Regenerative aquaculture

Fish and seafood is an important source of meat protein, representing around 30% of global meat consumption in 2019[xxx] and an increase in seafood production will be required as part of the solution to feed a growing global population. However, 90% of global fish stocks are fully fished or overfished already, i.e., at or above their Maximum Sustainable Yield, so increasing wild catch fishing is unlikely to be possible. Aquaculture will therefore need to fill the gap.

However, Planet Tracker's research suggests that aquaculture is already meeting natural barriers to further expansion due to the concentration of fish species being farmed, the land and ocean resources required to produce feed for the farmed fish, and the industrialised nature of the aquaculture processes being employed. We estimate the total annual demand for seafood could be 267.5 Mt by 2050 compared to 157.4 Mt in 2020 but the supply might only reach 217.4 Mt, a 50 Mt shortfall. Technological developments with respect to aquaculture may help but we estimate they might only reduce the shortfall by up to 5 Mt, accounting for 10% of the gap.

Expanding the range of species farmed, particularly into bivalves and seaweed, would allow the aquaculture industry to become more regenerative and less extractive. Combined with a shift from meat-based to plant-based proteins, we believe aquaculture could meet the expected increase in demand if the required investment capital is provided to fund these developments.

Agri-tech and food-tech

Enhanced technology has significant potential to increase the output of the food system while reducing the inputs required, including the land itself, through the use of such technologies as alternative protein production.

Key risks to beware of

Financial institutions focusing on the theme of increased food system efficiency will need to beware of two key risks:

Greenwashing

Terms such as 'regenerative agriculture' and 'food-tech' are inherently vague, so it will be important to ensure that policies and investment practices are sufficiently granular, and that associated due diligence is sufficiently thorough. This will help to ensure that the financial institution is not put at risk of allocating funds to projects and businesses that are promising much but delivering little, or even worse, further increasing the harms caused by the food system.

Industrial / extractive food production practices

The 'green revolution' that occurred after the Second World War enabled farmers around the world to increase their crop yields dramatically, and was accompanied by a series of innovations, particularly with respect to livestock farming, that appeared to increase the efficiency of the system. However, in reality these innovations, ignored factors such as increased pollution and increased soil depletion on the basis that they were treated as 'externalities'.

This approach has resulted in a food production system that is extractive, depleting soil reserves and the broader natural capital base on which its very existence depends. A prime example of this is wild catch fishing. In addition to this, it has encouraged an industrial approach to the production of animal protein, treating the animal as a unit of production rather than part of the natural system, and pursuing growth while ignoring the seriously harmful consequences in terms of the overuse of antibiotics, the challenges of manure management, and significant failures within the production process to protect animal and human welfare.

A holistic approach is required

To avoid these risks, financial institutions investing in the theme of increased food systems efficiency need to ensure they are taking a holistic ('true cost') approach. This will ensure that their investment policies and company engagement processes focus on improving the system as a whole, including the social / human welfare aspects, not just a specific component.

Reduce food system pollution

As summarized in this report, the food system is the source of a significant proportion of the pollution poisoning the ecosystems on which humanity depends for its survival.

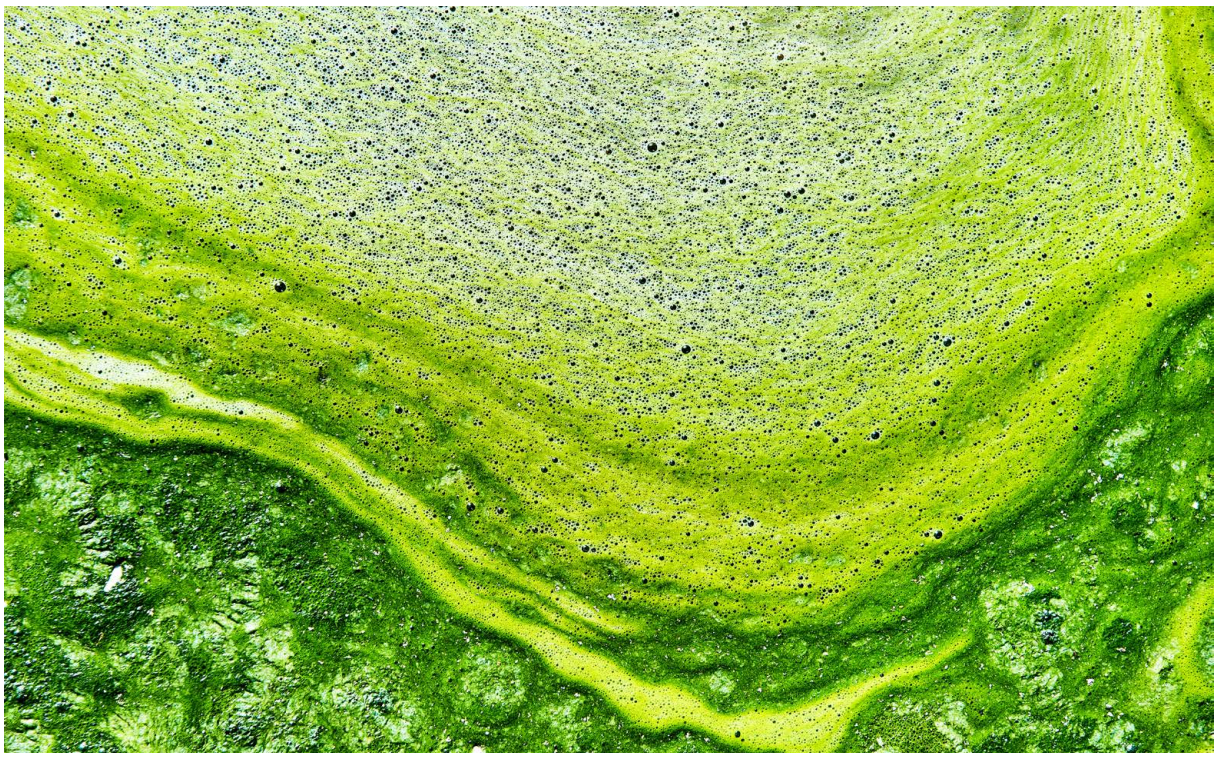
In particularly, the food system is a significant source of:

- Anthropogenic GhG emissions (including gases with very high climate heating effects such as methane and nitrous oxide);
- Nitrogen and phosphorous run-off;
- Pesticide leakage;
- Particulate air pollution;
- Antimicrobial resistance through excess use of antibiotics; and
- Plastic pollution.

The benefits of cutting pollution are obvious and in many cases the actions required have the potential to be self-funding over time because the pollution represents an unnecessary drain on the resources of the businesses concerned.

As a result, there is a strong link between this theme and the theme of increased true cost efficiency and financial institutions can support actions that address both at the same time.

As always, financial institutions that wish to focus on the theme of reducing food system pollution need to ensure that they are taking a holistic, systems-based approach so that they can avoid the potential negative consequences of actions that appear positive when considered in isolation[45].



[45] Food losses vs plastic packaging is one example of a potential conflict – the argument being that plastic packaging reduces food losses in the system. The issue is complex but there is a significant risk that promoters of plastic packaging use food loss as an excuse without the evidence to support their defence of plastic (and without weighing the total systems costs of plastic pollution against the total systems costs of food loss).

Sustainable product offerings

One of the three transformation pathways is Sustainable Consumption which might suggest that the focus should be on consumers – an area of the food system that is hard for financial institutions to influence. However, the issue is much more fundamental than just consumer behaviour – the food system will struggle to be sustainable unless the demand for food products is configured so that it does not push the system beyond its planetary boundaries.

The demand faced by food producers comes from the food manufacturers, retailers and food service companies further down the food supply chain. As such, it is these food system actors who have the power to reshape the food environments to influence the demands being made to ensure they are sustainable. These companies also have a significant role in shaping the demand from consumers, in terms of their choice of product, and the quality and quantity they require.

The sustainable product offerings theme brings together the linked issues of the demands being made on food producers and the desires being stimulated among food consumers to focus on the businesses that are responsible: the food manufacturers, retailers and food service companies.

This downstream part of the food system is where the majority of financial capital is focused and so this theme is an essential component for any financial institution wishing to support the transformation of the food system through their investment policies and company engagement processes.

Within this theme there are a number of topics that financial institutions should concentrate on including:

- Sustainable 'food product architecture' - redesigning products to

  – ensure the underlying raw materials can be produced with a reduced nature and climate impact; and

  – improve their nutritional content, and taste, and to reduce chemical additives and levels of fat, salt and sugar;
- Reconfiguring 'food choice architecture'[46] to encourage consumers to choose food products that are better for them and the planet;
- Reducing waste by food service companies and consumers;
- Developing methods for recycling unconsumed food and other food system waste products so that the system becomes more circular;
- Sustainable packaging and transport; and
- Supply chain traceability.

As with many aspects of the food system's required transformation, companies will struggle to achieve sustainable product offerings without having clear visibility of, and control over, their supply chains. Consequently, there is a strong link between this theme and the theme of responsible supply chains, particularly for businesses that wish to profit by offering traceable products to their customers.

[46] Food choice architecture encompasses all the aspects of a food product that will influence a consumer's behaviour when choosing that product. It is the food version of choice architecture (Nudge, Thaler and Sunstein, 2008).

CROSS CUTTING THEMES FOR FINANCIAL INSTITUTIONS

There are three cross-cutting themes that financial institutions should incorporate into their approach to supporting the transformation of the food system:

1 Just transition

This has already been mentioned as a requirement for the transformation of the food system to be regarded as successful – see page 65, but it is worth re-emphasising as something that financial institutions should incorporate into all the work they do with respect to the food system.

2 Company lobbying

When making investment decisions and in the context of corporate engagement, it is essential that financial institutions assess the lobbying being undertaken by food system companies as well as their relationship with industry associations and other groups to ensure that there is no conflict with the financial institution's food system strategy.

In many cases this will require company-specific research, but InfluenceMap has a database and research programme assessing corporate lobbying that provides an excellent starting point.

3 Engagement with governments

Changing the legal and policy framework for the food system is a prerequisite for successfully transforming it. This will require action by each country individually as well as collective international action. In addition to this, currently, 86% of the USD 611 billion of public finance that is spent on agricultural production, subsidies etc, every year has potentially destructive impacts on climate, biodiversity, health, and food systems resilience.[xxxi]

Financial institutions should engage directly with governments and other regulators where possible, and indirectly via the companies they fund, to support changes to subsidies and regulatory frameworks that will facilitate the food system's transformation.

SUMMARISING THE ACTIONS THAT SUPPORT THE FOUR FOOD SYSTEM TRANSFORMATION THEMES FOR FINANCIAL INSTITUTIONS FRAMEWORK

Table 5 summarises the actions that will support the four food system themes that financial institutions should focus on to support the transformation of the global food system. This list is obviously not exclusive but provides a helpful starting point for financial institutions wanting to develop their investment policies and company engagement processes within the four themes framework.

Table 5: Summary of actions that support the four financial markets food system themes. Priority Actions highlighted. ▶ indicates the action has a corresponding FLAG target from the Science Based Targets initiative's FLAG guidance

Responsible supply chains	All portfolio food system companies should to take full responsibility for their supply chains and for the businesses and people involved. • identifying, selecting and contracting supply chain partners; • managing and developing the relationships in the supply chain; • monitoring and controlling performance of supply chain partners; and • **Implementing full supply chain traceability.**
Increase food system efficiency	• **Limit the expansion of agricultural land and stop deforestation;** ▶ • Reduce the quantities and costs of external (chemical) inputs • Increase output in terms of the quantity of calories and protein per hectare; • Increase output from aquaculture; • Improve soil health; • Improve water management; • **Reduce transport costs and energy consumption;** • **Reduce food loss and waste;** • **Invest in technological advances to enhance food production; and** • **Implement full supply chain traceability.**
Reduce food system pollution	Reduce: • **Anthropogenic GhG emissions (including gases with very high climate heating effects such as methane and nitrous oxide);** ▶ • Nitrogen and phosphorous run-off; • Pesticide leakage; • Particulate air pollution; • Antimicrobial resistance through excess use of antibiotics; • Plastic pollution; and • **Implement full supply chain traceability.**
Sustainable product offerings	• Sustainable 'food product architecture' - redesigning products to – Reduce their nature and climate impact; and – improve their nutritional content, and taste, and to reduce levels of fat, salt and sugar; • Reconfiguring 'food choice architecture' to encourage consumers to choose food products that are better for them and the planet • **Reducing waste by food service companies and consumers;** • Developing methods for recycling unconsumed food and other food system waste products so that the system becomes more circular; • Sustainable packaging and transport. • Sustainable packaging and transport; and • **Implement full supply chain traceability.**

SIX PRIORITY ACTIONS THE FINANCE SECTOR SHOULD TAKE

Based on the three transformation pathways and the four food system transformation themes we have identified a number of priority actions that financial institutions should take by 2030 to ensure the required transformation of the global food system.

Financial institutions that prefer to chart their own course using the four themes framework may identify actions that fit their specific circumstances better – see Table 5 on page 70). However, financial institutions looking to take immediate action can be confident that these priority actions will a) address the harms being caused by the global food system, and b) integrate well into any future food systems strategy that they might develop based on the four themes framework.

These actions have been selected from the wider range of possibilities based on:

- the size of the potential benefit;
- the immediacy of their beneficial impact (particularly in terms of reducing GhG emissions to assist financial institutions with their net zero plans);
- the extent to which they lie within the power of financial institutions to have an effect; and
- the extent to which they align with existing initiatives that financial institutions can leverage.

The six priority actions are:

1. Fully traceable supply chains
2. Halve food loss and waste
3. Stop deforestation
4. Cut methane emissions by 45%
5. Make agriculture/aquaculture systems regenerative
6. Invest in alternative proteins

Financial institutions should aim to achieve these priority actions before 2030.

2030

The following sections describe the priority actions in detail. Each section:

- Summarises why the action is a priority;
- Summarises the benefits of mitigation;
- Explains what financial institutions should do to support this priority action and what they should require from the companies they fund;
- Highlights the key risks of inaction; and
- Suggests areas to investigate for investment opportunities.

It is worth noting that the priority actions do not combine to form a strategy. They are a mixture of actions that focus on addressing a specific problem with the system (e.g., traceable supply chains) and those that address the problems caused by underlying drivers (e.g. deforestation) rather than the drivers themselves.

Financial institutions wanting to take a strategic approach should use the four themes framework as their starting point - these priority actions will then fit into that.

To ensure there is a just transition, the human dimension of food system transformation must be a key component of each priority action. For financial institutions, this means integrating their work on food systems with wider commitments to uphold human rights and labour standards through:

1. **anticipating and addressing the social risks** of food system transformation (for example, in terms of jobs and communities);
2. **identifying and enabling the social opportunities** of food system transformation (such as potential for strengthening respect for gender equality and Indigenous Peoples' rights); and
3. **supporting meaningful participation by affected stakeholders** in the process of change.

Given the systemic nature of the transformation required, engagement with policy makers will also be vitally important in relation to each of the priority actions set out below.

PRIORITY ACTION #1
require fully traceable supply chains before 2030

Theme 1 Responsible supply chains and **Theme 4 Sustainable product offerings**

This Priority Action links to all the other Priority Actions since fully traceable supply chains will increase the effectiveness of all of these other actions.

Why is this a priority?

The food system has opaque and complex supply chains. This can make it impossible for buyers downstream to accurately know the provenance of the ingredients / inputs they are sourcing and to have an understanding of the environmental harms that may be occurring further up their supply chains[47].

Companies are already expected to provide information about the GhG emissions that are occurring in their supply chains ("Scope 3") and this is likely to become a stricter regulatory requirement in the future[48].

Legal frameworks are being tightened by a variety of countries.

- Both the UK and France have introduced laws that make companies responsible for human rights abuses that occur in their supply chains, and the French law also extends to environmental abuses.
- Germany will introduce a new law in 2023 covering environmental abuse. The UK Environment bill also places due diligence requirements on companies to establish a system to identify, assess and mitigate the risk of illegally produced forest commodities entering their supply chains.
- The EU Commission has proposed a Directive on Corporate Sustainability Due Diligence which would require companies to mitigate and prevent human rights abuses and environmental harms from their supply chains and could take effect in 2024.[xxxiii]
- In Japan, the Diet passed a new law to introduce traceability in the fisheries sector, effective from December 2022.[xxxiv]
- In the US, the Food and Drug Administration (FDA) is proposing new regulations that would require participants in the food supply chain to maintain end-to-end electronic records. Companies would be required to make these available upon request within 24 hours during a food-borne outbreak or food recall investigation. The regulation, if enacted, would apply to food categories deemed to be higher risk from a human health perspective[49] which are estimated account for 20% to 30% of food consumption in the US.
- The EU is likely to adopt a Regulation[xxxv] requiring EU importers to confirm that cattle, cocoa, coffee, oil palm, rubber, soya, wood and derived products are deforestation-free. This will require visibility of the supply chain through to the original producer (including geolocating the land used for production)[50].

[47] Many countries have food safety rules requiring rudimentary traceability systems, often referred to as "one-up, one-back". They are designed to record who supplied the food ("one-back") and who it was subsequently supplied to ("one-up"), to facilitate public health related product recalls. As such, they do not provide the necessary, end-to-end visibility of a food supply chain.

[48] For example, the EU and some EU member countries are introducing supply chain 'due diligence' rules which will require importers of specific products to ensure they can trace the origins and environmental impacts of those products.

[49] Fruits, vegetables, soft cheeses, peanut butter and other nut butters, most fish and seafood, and eggs sold in their shells.

[50] See Planet Tracker's blog EU Regulation to cause log jam in commodity flows for more details

All of these rules (particularly the EU's) have the potential to have a global impact on suppliers as well as the target buyer groups. Businesses need fully traceable supply chains in order to address the climate, nature and people-related harms caused by the global food systems, and to prepare for the raft of due diligence legislation currently in the pipeline in major economies, including in response to the Kunming-Montreal GBF supply chain target referred to earlier[51].

Mitigation potential

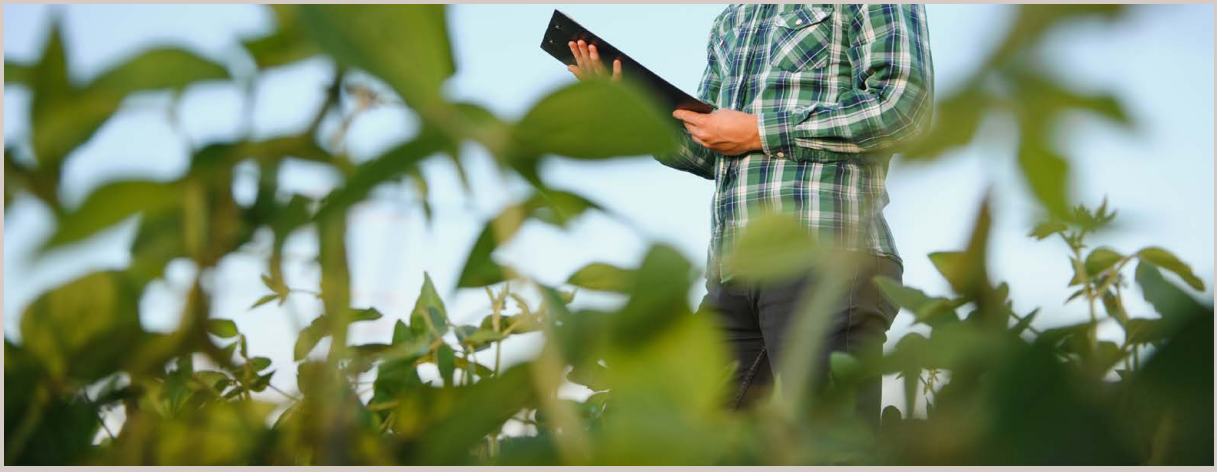
Unlike the other Priority Actions discussed in this report, it is not possible to quantify the benefits of traceability in terms of GhG emissions eliminated. But, without fully traceable supply chains all the other necessary changes will be much harder to achieve and very difficult to monitor and assess.

In addition to these 'compliance' drivers, a fully traceable supply chain will be more resilient and will enable waste and fraud to be reduced. Planet Tracker's research shows that there are potentially significant upsides for companies that implement effective traceability regimes[52]. This provides a strong incentive for the financial institutions funding the food system to press their investee companies to implement fully traceable supply chains.

As a stepping stone towards a fully traceable supply chains, financial institutions should encourage companies to use certification systems to mitigate climate, nature and people risks. Such systems can also incentivise suppliers to improve their practices and enable the shift of food supply chains towards transparency and traceability of goods through the value chain.

However, it is important to note that a) certification systems only apply to a small number of commodities, and b) the certification rate is often low (i.e. getting access to certified supplies is not always easy).

Figure 38 shows that certification rates across eight soft commodities associated with environmental and social harms are low. Soybeans stands out as having a particularly low share of certified production, demonstrating why certification is not a substitute for traceability[53].



[51] Requiring transnational companies and financial institutions to monitor, assess, and transparently disclose risks and impacts on biodiversity through their operations, portfolios, supply and value chains by 2030.

[52] Planet Tracker's research shows that implementing traceability systems often improves profitability so more than offsetting the investment required (for example see How to Trace USD600 billion – where investing USD 21 billion could lead to annual profits increasing by USD 46 billion).

[53] See Increased soy certification would decrease deforestation risk for further discussion on this topic.

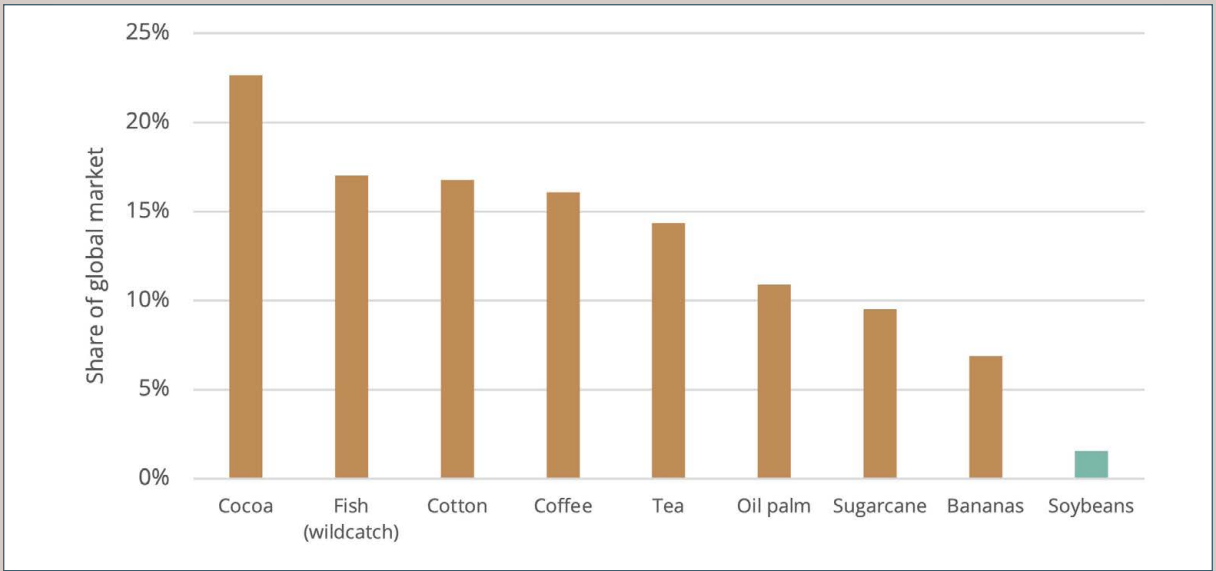


Figure 38: Certification rates for selected soft commodities. Source: soft commodities: FiBL-ITC-SSI survey 2021, wildcatch fish: Marine Stewardship Council, Planet Tracker analysis.[xxxvi, xxxvii]

How should financial institutions support this?

What should they do themselves?

Investors and banks funding companies towards the downstream end of the food supply chain (manufacturers, wholesalers, retailers, and food service companies) should assess the extent to which their portfolio companies in these Nodes have fully traceable supply chains.

We recommend the following questions should be included in pre-funding due diligence questionnaires and when meeting company managements:

1. What traceability systems are currently in place at the company?
2. What is their scope, precision, breadth, and depth?
3. How interoperable are the company's traceability systems with those of suppliers and clients? (for example, in the context of seafood, do they use GDST[54] standards?)
4. What prevents the company from implementing robust traceability solutions on 100% of its products?
5. How much would the required investment cost and what would be the financial benefits to become 100% traceable?
6. How can investors and lenders support the transition towards being 100% traceable?

Companies that lack traceable supply chains are more risky than their better informed peers – portfolio weightings and lending decisions should price in this risk.

[54] Global Dialogue on Seafood Traceability.

What should they require of their investments?

Sovereign bond investors should engage with governments to encourage the requirement for end-to-end food supply chain traceability particularly in relation to products that carry a high risk of environmental and/or social harms (for example deforestation, child labour, etc). The 'due diligence' requirements relating to deforestation-risk commodities being introduced by the EU is a good example.[xxxviii]

Investors and banks should:

- Press the companies they fund to implement traceability systems in their supply chains.
- Encourage companies they fund to collaborate with peers and suppliers to agree what standardised environmental and social data are to be collected and reported and to ensure collective actions are taken to mitigate specific harms.

What are the risks for financial institutions that continue to fund business as usual?

In the short term, the key risk is a partial or complete loss of the investment if a business funded by the investor or bank is found to be responsible for environmental and/or social harms that have occurred in its supply chain.

The investment risk is likely to be increased where it is clear that it was possible to have a traceable supply chain (for example, because peers have this), but the business decided against implementation.

There is also the potential for reputational damage to the investor or bank if it appears that they have funded the company in question without asking sufficiently probing questions to protect their investment.

Are there investment opportunities that should be considered?

There is a growing market for traceability software solutions and potential investment opportunities relating to providers of supporting technology (IoT, sensors, monitoring, remote sensing systems, etc).

Sustainability Linked Bonds (SLBs) also provide a potential way to capture the benefits of traceable supply chains. For example, Thai Union issued an SLB where '100% monitoring of their tuna fleet' was a KPI. Buying these bonds, if they are structured correctly and with ambition, is a way to support companies seeking to improve their business practices and may also provide an investment opportunity.

At its most simple, funding businesses that are about to implement traceability systems in their supply chains has the potential to provide an investment opportunity given the improvements in profitability and resilience that can result.

PRIORITY ACTION #2
halve food loss and waste before 2030

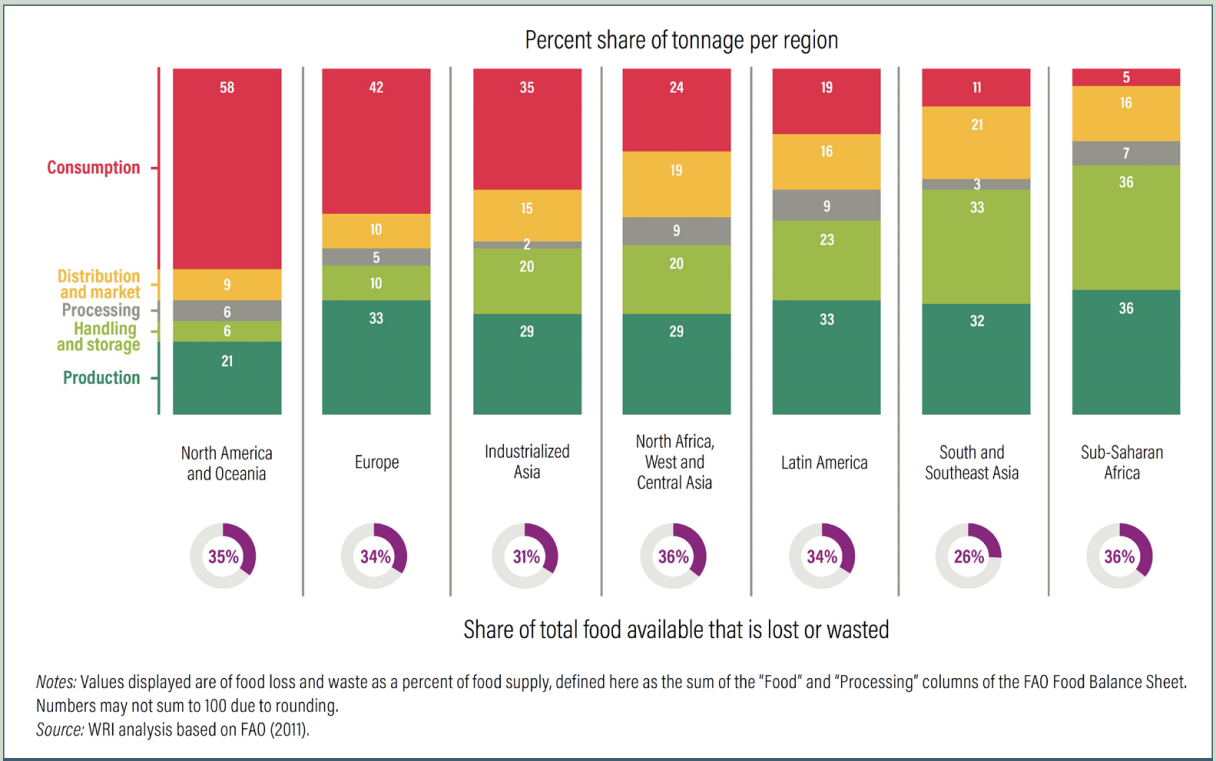
Theme 2 Increase food system efficiency and **Theme 4 Sustainable product offerings**

This Priority Action links to Priority Action #3 (stop deforestation) and Priority Action #4 (cut methane emissions) since reducing food loss and waste will reduce the level of demand in the system that drives deforestation and industrial meat production.

Why is this a priority?

As discussed earlier, the FAO estimates that approximately one third of the food produced globally (c.1 billion tonnes) is never consumed. It is either lost in the initial production process or further down the supply chain, or wasted by the retailer or end user, and an estimated 8% of global GhG emissions are associated with food loss and waste.[xxxix]

The distribution of loss and waste across the food system varies with the level of economic development – see Figure 39.



Notes: Values displayed are of food loss and waste as a percent of food supply, defined here as the sum of the "Food" and "Processing" columns of the FAO Food Balance Sheet. Numbers may not sum to 100 due to rounding.
Source: WRI analysis based on FAO (2011).

Figure 39: Distribution of Food Loss and Waste by Region and Stage in the Food Supply Chain, 2007. Source: WRI analysis based on FAO data.[xl]

In developed economies the largest amount of loss and waste is in the consumption stage, while in developing economies the largest contributors are in the food production, handling and storage. This points to different priorities for addressing waste and loss, depending on the economic context.

The UN estimates that globally 14% of food is lost between harvest and retail and 17% is wasted in retail, food service and consumption.[xli] Our analysis of company reported data implies that companies are only reporting a third of the actual waste from production through manufacturing and only 5% of the total food waste at the food retail and food service stage meaning approximately 731 Mt of food loss and 698 Mt of food waste are not being reported[55]. This hinders the identification of the companies which are contributing to the harms.

The UN's Sustainable Development Goal 12.3 aims to halve food waste and reduce food loss by 2030 and the Kunming-Montreal GBF has adopted the same target. In the context of a growing global population the need to avoid loss and waste is obvious if we are to feed all these people without breaching planetary boundaries.

Mitigation potential

Despite the economic and environmental harm of food loss and waste, there is surprisingly little regulation globally to achieve a significant reduction in waste, although there are signs that this is beginning to change. A small number of developed countries have launched campaigns or introduced legal rules focused particularly on food waste, and some developing countries are working to improve agricultural practices and food supply chains to reduce food loss.

Roe et al.[xlii] estimates that food system emissions could be reduced by 0.9 Gt CO_2e annually, through measures such as improved storage and transport systems, increased public awareness, and changing consumer behaviours. This equates to nearly 2% of estimated annual anthropogenic GhG emissions[56]. Roe et al.'s estimate assumes that food waste is reduced, towards being halved by 2050 and does not assume any contribution from avoided land conversion.

In additional to reducing the GhG emissions from the food system, reducing food loss and waste will make the food system more efficient which in turn will contribute to:

- Reducing the impact on biodiversity by reducing the demand for converting land to agriculture and for wild-caught fish;
- Improving food security;
- Reducing malnutrition and improving health;
- Reducing the demand for water consumption;
- Reducing pressure on waste management systems; and
- Improving profitability throughout the food system.

FOLU, in their 2019 'Growing Better' report[xliii] identify economic savings worth USD 455 billion and business opportunities worth USD 30 billion relating to reducing food loss and waste.

[55] Total estimated food loss: 767 Mt vs 233 MT reported; total estimated food waste: 931 Mt vs 37 Mt reported.

[56] Using the estimated 2015 total anthropogenic footprint of 52 Gt CO_2e – see Appendix 3: Varied estimates for the food system's GhG footprint.

How should financial Institutions support this?

What should they do themselves?

Financial institutions should:

- Establish a clear investment due diligence approach that gathers data on food loss and waste from prospective investee companies and establishes clear criteria for including that information in the investment decision.
- Engage proactively with companies at the upstream end of the supply chain (through to the food manufacturers) to encourage them to address food loss and waste in their own operations and in those of their suppliers.
- Engage proactively with food retailers and food service companies to encourage them to take steps to reduce food waste through their own operations and in the hands of consumers.
- Engage proactively with food retail and food service companies to ensure that (in addition to reducing the absolute amount of food waste) they maximise the usage of food waste through such means as composting, using waste as a source of bioenergy, etc.
- Reduce their holdings of, or loans to, food system companies that do not have a clear focus on reducing food loss and waste and shift their capital to those that do.
- Establish clear portfolio assessment, monitoring and reporting processes so that they can evaluate the extent to which their capital is being deployed in support of reducing food loss and waste and be held to account for their actions.

Since consumers are responsible for some of the food waste, financial institutions should also ensure that their own food operations (staff restaurant etc) are focused on reducing waste and that their own staff are educated about the issue.

What should they require of their investments?

The 2021 UNEP Food Waste Index report identifies a lack of high-quality data on waste at a national level as a factor that holds back progress on reducing food loss and waste. This also extends to corporate reporting making it an aspect of the problem that financial institutions should pay particular attention to.

Sovereign bond investors should engage with governments to encourage them to introduce policies and laws that aim to tackle food loss and waste as well as removing incentives that may encourage the opposite behaviour.

Financial institutions should encourage their investee companies to:

- Significantly improve the extent to which they report food loss and waste.
- Establish clear assessment, monitoring and reporting processes focused on food loss and waste, both in their own operations and those of their suppliers so that they can evaluate the extent to which they are reducing food loss and waste.

What are the risks for financial institutions that continue to fund business as usual?

Businesses that are more efficient are generally more likely to be better investments. However, given the current scale and widespread nature of food loss and waste in the system, it is unlikely that investors or banks will lose money or risk reputational damage in the near term as a result of funding businesses that are responsible for (and failing to tackle) food loss and waste.

However, over time, as more companies begin to focus on the issue the fiduciary and investment risks of continuing to fund wasteful business practices will grow.

Are there investment opportunities that should be considered?

The scale and value of food waste is attracting significant investment. Private investment to reduce food loss and waste within food supply chains grew 30% in the USA to USD 4.8 billion in 2021 according to ReFed,[xlv] with investments targeting waste reduction through innovations in:

- Food protection;
- Expanding the use of imperfect produce;
- Cold chain management and storage systems;
- Alternative sales channels; and
- Recycling and bringing waste food back into the supply chain as an input (e.g.as biogas, compost or animal feed).

The World Bank is focused on addressing the issue of food loss and waste[xlvi] and between March 2019 and October 2020 issued the equivalent of USD 2.7 billion in over 35 sustainable development bonds with a focus on tackling these challenges. Countries have followed suit – the Climate Bonds Initiative reported that the cumulative total of GSS+[57] sovereign bond issuance stood at USD 3.3 trillion at the end of the first half of 2022, highlighting the scale of potential investment opportunities.[xlvii]

[57] GSS+: green, social, sustainability, sustainability-linked, and transition labelled debt instruments.

PRIORITY ACTION #3
stop deforestation before 2030

Theme 2 Increase food system efficiency and **Theme 4 Sustainable product offerings**

This Priority Action links to Priority Action #4 (cut methane emissions) since both methane emissions and deforestation are driven by industrial beef production

Why is this a priority?

Emissions from land use change (principally deforestation) are responsible for 32% of the GhGs produced by the food system, c.5.7 Gt CO_2e (see Figure 54 in Appendix 1). As a proportion of humanity's total GhG footprint, deforestation accounts for c. one tenth, so stopping it would be a significant step towards a 'net zero' outcome[58].

From a climate perspective, standing forests are much better at capturing carbon, including in the soil, than newly planted forests so stopping deforestation is much more effective than reforestation).[xlviii]

In addition, deforestation is responsible for a significant amount of biodiversity loss and has significant negative impacts on society where the deforestation is occurring[59].

Without addressing deforestation, it will be impossible to achieve the climate, nature, and society goals discussed earlier. As a result, the Science Based Targets initiative includes a requirement for companies using its FLAG[60] guidance to commit to 'no deforestation' by 2025.[xlix]

Currently, the food system companies most responsible for deforestation are not doing enough. The 2023 Forest500 report[l] showed that:

- 31% (117 of 350 companies) have no deforestation commitment at all.
- 38% of 350 companies surveyed only have a deforestation commitment for some of the forest-risk commodities in their supply chains.
- Only 28% (99 of the 350 companies) have a deforestation commitment for all the commodities they are exposed to.
- For the companies that have made commitments, many fail to provide evidence as to how they implement their commitments, particularly for soy and beef.

[58] 'Deforestation' is used here to indicate all forms of destructive land use change including the conversion of peatland and mangroves, as well as the deforestation of tropical and non-tropical forests.

[59] ncluding negative health effects from the smoke / particulate emissions from the fires that are often associated with deforestation, and the frequent association of illegal logging and mining activities with deforestation which in turn are linked to increases in other illegal activities such as gun and drug running. Finally, deforestation is often associated with the abuse of land rights, particularly those of Indigenous Peoples and the diseases and forced migration that may follow.

[60] FLAG: Forest, Land And Agriculture.

Mitigation potential

Protecting forests and other ecosystems is one of the most effective mitigations to reducing GhG from the food system. In Roe et al.'s 2021 paper 'Land-based measures to mitigate climate change: Potential and feasibility by country'[li] reducing deforestation, and conversion of peatland and mangroves for agricultural production is estimated to offer up to 3.9 Gt CO_2e annually of cost effective GhG mitigation[61], with a maximum potential of 6.0 Gt CO_2e.

Conservation International's 2022 report 'Exponential Roadmap for Climate Solutions'[lii] estimates that achieving 'no deforestation supply chains' would reduce annual GhG emissions by 1.1 Gt CO_2e by 2030. This would equate to a reduction of just over 2% of humanity's annual GhG footprint[62].

This is particularly relevant given the enthusiasm among some investors to support Direct Air Carbon Capture (DACC) technologies, since trees provide the original form of DACC and the capital cost of leaving a tree standing is essentially zero compared to the very high costs, and current low efficiency of DACC technologies.

In addition to reducing GhG emissions, ending deforestation also reduces the loss of habitat and biodiversity that is linked to food production and is likely to have significant societal benefits for the people living in areas subject to deforestation[63]. So, financial institutions looking beyond a narrow climate-based 'net zero' commitment will be able to achieve multiple sustainability targets with one set of actions targeting deforestation.

A further benefit of stopping deforestation from a portfolio protection perspective is that this avoids other potential related threats, including regional climate change and zoonotic diseases[64], which can impact investments well beyond the global food system.

Ending deforestation is a very cost-effective mitigating action. For the countries concerned, the main costs are associated with monitoring and enforcement[65]. For companies, the main costs will be the premium paid to purchase deforestation and conversion free goods[66] and/or the supply chain investments required to ensure a deforestation-free supply chain, including putting traceability systems in place[67].

FOLU, in their 2019 'Growing Better' report[liii] identify economic savings worth USD 895 billion and business opportunities worth USD 65 billion relating to protecting and restoring nature, including stopping deforestation.

[61] Roe et al assumes $100/T CO2 price for their cost-benefit analysis.

[62] Using the estimated 2015 total anthropogenic footprint of 52 Gt CO_2e – see appendix.

[63] Refer to Appendix 1 for a more detailed discussion of deforestation in the context of the environmental harms of the food system.

[64] In 'Destroying Brazil's Aircon' we use Brazil as a case study to illustrate the material threats to its economy that come from regional climate change driven by continued deforestation, including the severe impacts of changing precipitation patterns, droughts, and the increased frequency and severity of extreme heat days which threaten lives, particularly in deprived areas.

[65] The opportunity cost of not cutting down the trees (for example, logging revenues foregone) will be massively outweighed by the benefits, particularly when the avoided costs associated with regional climate change are taken into account – see Destroying Brazil's Aircon for a detailed discussion.

[66] The costs of procuring DCF goods will likely reduce over time as these goods become the norm and regulatory changes (such as the EU's deforestation due diligence regulation) will render these costs unavoidable in some situations.

[67] As noted earlier, Planet Tracker's research shows that implementing traceability systems often improves profitability so more than offsetting the investment required (for examples see How to Trace USD600 billion and Lifting the Rug).

How should financial institutions support this?

What should they do themselves?

Financial institutions should implement the following policies[68] to address deforestation risk in their investment/lending portfolios:

- Publicly commit to ensuring zero gross deforestation of all natural forest ecosystems (legal and illegal) in their investment/lending portfolios.
- Reinforce the commitment by publishing regular, timely action plans and progress updates.
- Specifically target deforestation-linked emissions in their 'net zero' plans.
- Actively engage with and support initiatives such IFACC[68A], to move funding away from deforestation linked activities.
- Make the financing of companies operating in agriculture production contingent on comprehensive zero deforestation policies that include time-bound requirements for monitoring and transparency.

What should they require of their investments?

- Require portfolio companies to proactively report on deforestation-linked CO_2 emissions in their supply chains.
- Require upstream companies (producers and traders) to disclose the location of their production facilities and volumes produced as a condition of funding.
- Require portfolio companies to purchase only products that are certified as deforestation-free.

What are the risks for financial institutions that continue to fund business as usual?

Net zero

Financial institutions will find it increasingly difficult to convince clients and regulators that they have credible net zero plans if they fail to address deforestation. That in turn could lead to increased regulatory scrutiny and clients taking their custom elsewhere, potentially driven by their own net zero commitments.

Investment

As more companies move to be deforestation-free there will be a growing risk that those that are left are riskier investments. This is based on the reasonable assumption that a failure to address deforestation when many peers have done so is an indicator of poor management and/or a lack of investment in management systems. It is also likely that the actions of other investors will make share prices in these companies more volatile and the actions of banks and credit rating agencies could lead to higher borrowing costs or even liquidity squeezes. Finally, these companies could find their revenues threatened as customers seek to ensure deforestation-free supply chains, a trend that will be accelerated if supply chain due diligence regulations become more widespread and demanding.

Reputation

Deforestation is likely to become a growing concern among individuals and companies, increasing the reputational risks for financial institutions providing funding to companies linked to deforestation. This risk will be particularly acute for financial institutions that are not monitoring their exposure to deforestation risks since they will be unaware of the potential for a reputational portfolio shock.

[68] 'Global Canopy's Deforestation-Free Finance initiative includes a Finance Sector roadmap that recommends the key steps needed for financial institutions to eliminate commodity-driven deforestation, conversion, and associated human rights abuses from their portfolio within four years of beginning the process.'

[68A] Innovative Finance for the Amazon, Cerrado and Chaco (IFACC)

Are there investment opportunities that should be considered?

There are multiple investment opportunities associated with ending deforestation including:

- Providers of deforestation-monitoring equipment and satellite data providers.
- Supply-chain traceability software providers.
- Alternative protein providers[69]. For example, since beef farming is one of the drivers of deforestation, reducing demand for beef is likely to reduce deforestation and conversely, action against deforestation is likely to raise the cost of beef and reduce demand for it. Financial institutions can potentially benefit from this by investing in beef alternatives, through funding companies producing plant-based meat alternatives and those using precision fermentation techniques to produce beef without using cattle. Similar arguments could be made for companies developing alternatives to other commodities associated with deforestation such as palm oil and cocoa, and alternatives to fish that reduce the aquaculture demand for soy.

An important caveat: deforestation is a symptom

It is important for financial institutions to remember that deforestation is a symptom of other problems in the food system, principally demand for unsustainable commodities such as industrial beef, and supply-side problems such as food loss and waste and inefficient land use.

Efforts to eliminate deforestation are more likely to be successful when placed in this wider context as part of a food systems transformation strategy.

[69] Investing in alternative protein production has significant potential to mitigate food system harms and so is included as a separate Priority Action.

PRIORITY ACTION #4
cut agri-methane emissions by 45% before 2030

Theme 3 Reduce food system pollution and **Theme 4 Sustainable product offerings**

This Priority Action links to Priority Action #3 (stop deforestation) since both deforestation and methane emissions are primarily driven by industrial beef production.

Cutting methane is the headline because it is measurable and the objective of international targets, but the main way to achieve this is by cutting industrial meat production. This will have significant co-benefits in terms of reducing other food system pollutants such as nitrogen.

Why is this a priority?

The agriculture sector accounted for 48% of non-CO_2 GhG emissions in 2015, far more than the energy sector which 'only' contributed 29% (see Figure 40), and meat production is responsible for approximately half this total.[liv]

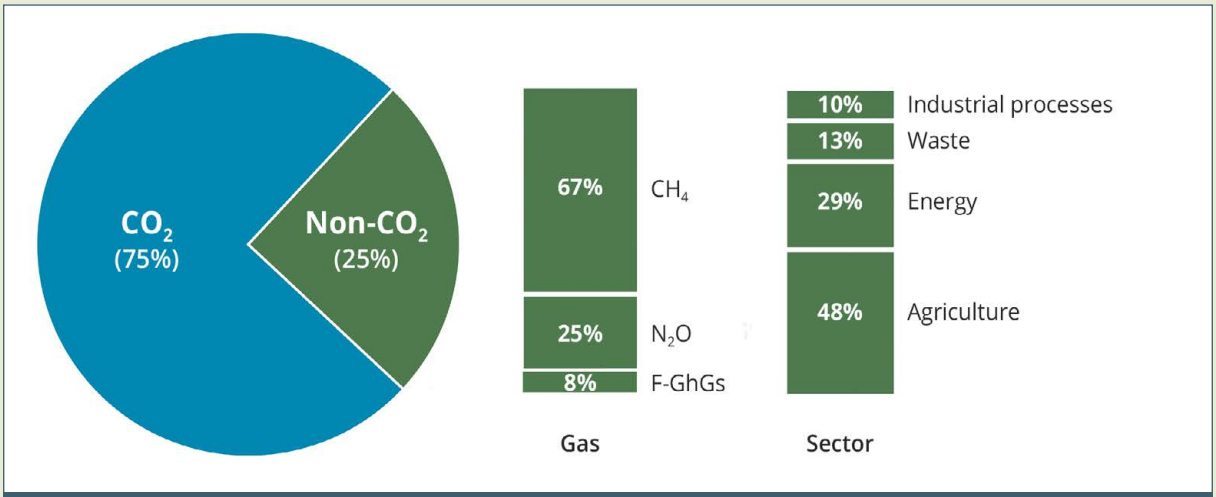


Figure 40: Global Non-CO_2 Emission by Gas and Sector in 2015.
Source: Global Non-CO_2 Greenhouse Gas Emission Projections & Mitigation, 2015-2050, EPA).
CH4: methane; N_20: nitrous oxide; F-GhGs: fluorinated greenhouse gases.

Methane constitutes 91% of the gases emitted by livestock with a Global Warming Potential (GWP_{20}[70]) 80 times that of CO_2. The other 9% is nitrous oxide, with a GWP_{20} factor of 273.[lv]

Methane from meat production is increasing rapidly, driven by the continued growth in the industrial meat sector, creating a significant threat to humanity's efforts to limit climate heating.

The IPCC's sixth report noted that enteric fermentation accounts for about 90% of the methane emissions from livestock. They estimate that emissions from livestock (enteric fermentation and manure) have increase by 25% when comparing the 10 years from 1990-1999 with the decade from 2008-2017,[lvi] driven mainly by the increase in livestock population.

The total cattle population increased by 18% over the same period,[lvii] and livestock production systems shifted from grazing and mixed systems toward intensive specialized livestock production systems that typically have manure management systems with high methane emissions.

Figure 60 (in Appendix 1, page 126) shows the dramatic rise in meat production since 1961. The US Environmental Protection Agency (EPA) forecasts that the global livestock population of dairy cows and cattle will increase by 12% from 2015 to 2030 and that emissions from the sector will increase by 10%, to 6.4 Gt CO_2e.[lviii]

From a funding perspective the challenge of agri-methane is exacerbated by very poor company disclosure that increases the risks for the investors and banks providing finance to different parts of the global food systems. Planet Tracker's analysis of the disclosures provided by 15 meat and dairy producers showed that three fail to provide any GhG data and six only report some of their overall GhG emissions (mainly Scope 1 & 2). None of the companies examined disclosed their methane emissions.[lix]

The Science Based Target initiative's FLAG guidance includes a requirement for companies to set targets that include methane and other non-CO_2 emissions (including Scope 3), Their FLAG sector pathway includes 'improve agriculture' and 'shift diets' as two of their seven priority mitigation pathways.[lx]

[70] GWP is a measure of how much energy the emissions of 1 ton of a gas will absorb over a given period of time, relative to the emissions of 1 ton of carbon dioxide (CO2). The larger the GWP, the more that a given gas heats the Earth compared to CO2 over that time period. The time period usually used for GWPs (particularly for comparing countries) is 100 years, however we believe the alternative (higher) 20-year measure is more relevant in the context of 2050 targets.

Mitigation potential

Reducing GhG emissions from a growing livestock herd is challenging.

There are several potential ways to reduce agri-methane emissions including:

- Shifting production away from high methane industrial meat and dairy towards alternative sources of protein;
- Increasing feed conversion rates[71] which can reduce the emissions related to enteric fermentation;
- Increasing the use of anaerobic digesters to convert methane produced by manure into biogas to use a source of energy (a substitute for fossil gas).

The Global Methane Pledge was launched at COP 26 in November 2021. The 130 countries that have signed the pledge agree to take 'voluntary actions to contribute to a collective effort to reduce global methane emissions at least 30 percent from 2020 levels by 2030'.[lxi]

Analysis published in the 2021 UNEP Global Methane Assessment[lxii] showed that currently available abatement methods could reduce anthropogenic methane emissions by 45% by 2030.

Shifting production away from intensive animal protein

Diverting resources away from high GhG emitting animal meat and dairy production processes so that production volumes fall offers the greatest potential for reducing GhG emissions from livestock.

Roe et al.[lxiii] estimate that a shift to more sustainable diets has the potential to reduce annual food GhG emissions by 0.8 Gt CO_2e, equivalent to c.2% of annual GhG emissions[72]. Other studies cited by the IPCC have estimated even larger benefits as illustrated by Figure 41[73].

[71] Feed conversion rate i.e. how effectively feed is converted into animal. Feed Conversion Ratio (FCR) is the conventional measure of livestock production efficiency: the weight of feed intake divided by weight gained by the animal.

[72] Using the estimated 2015 total anthropogenic footprint of 52 Gt CO2e – see appendix.

[73] The saving estimated by Roe et al is on a 'cost-effective' basis whereas the IPCC figures are just 'technically possible' (and therefore larger because costs have not been considered).

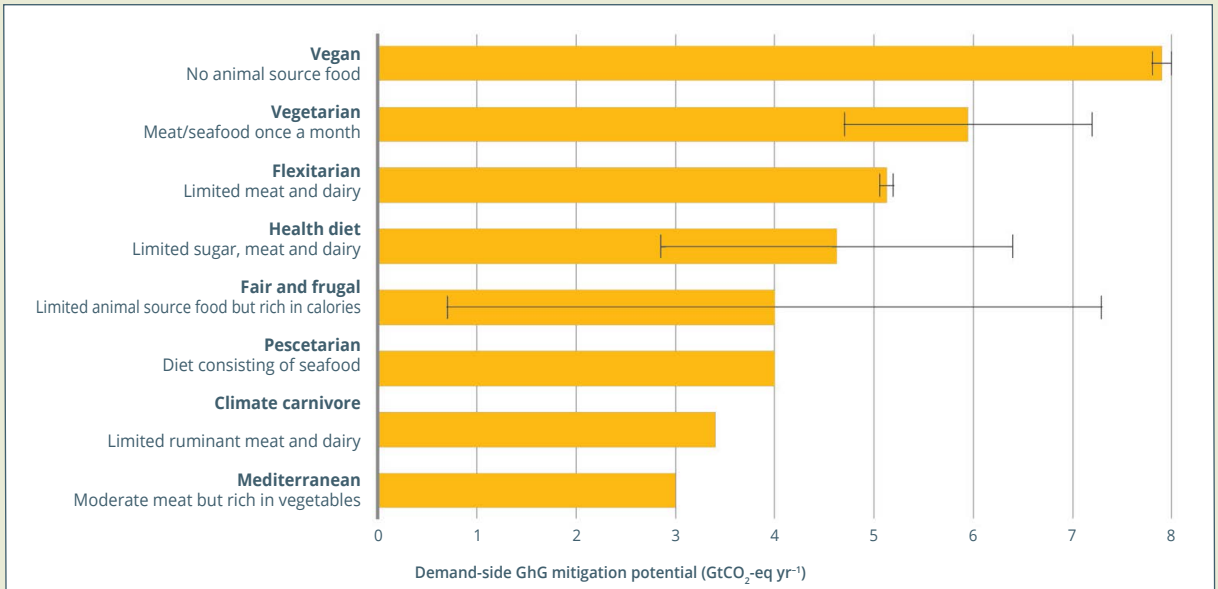


Figure 41: Potential GhG mitigation from various diets. Source: IPCC, Chapter 5.

The 2019 EAT-Lancet report[lxv] illustrated how by shifting to healthier diets it would be possible to feed 10 billion people in 2050 without breaching planetary boundaries (meeting climate, nature, and people goals).

Research on consumers in the US has shown that consumers of all generations see environmental benefits as a reason to eat more plant-based foods and has led to more customers trying alternative proteins. At the same time, studies in US grocery stores have shown that sales of plant-based foods can be increased by presenting these meals alongside meat, rather than in a separate area. For more information on these studies, see the Alternative Proteins section on page 103.

This highlights some of the areas that financial institutions can engage with food manufacturers, retailers and food service companies to reduce demand for industrial animal proteins.

Financial institutions have an important role to play in driving this change through the investments they make or the businesses they lend to. It is clear that consumers are already moving away from meat-based diets towards alternatives (at least in some regions), leading to a significant growth in investment opportunities in businesses established to exploit this trend as well as incumbents that are seeking to adapt.

Co-benefits of shifting diets away from intensive meat

Reducing a key driver of deforestation

In addition to lower GhG emissions (particularly methane), shifting production away from industrial meat will significantly reduce pressure on nature as agricultural land can be used more efficiently – see Figure 42.

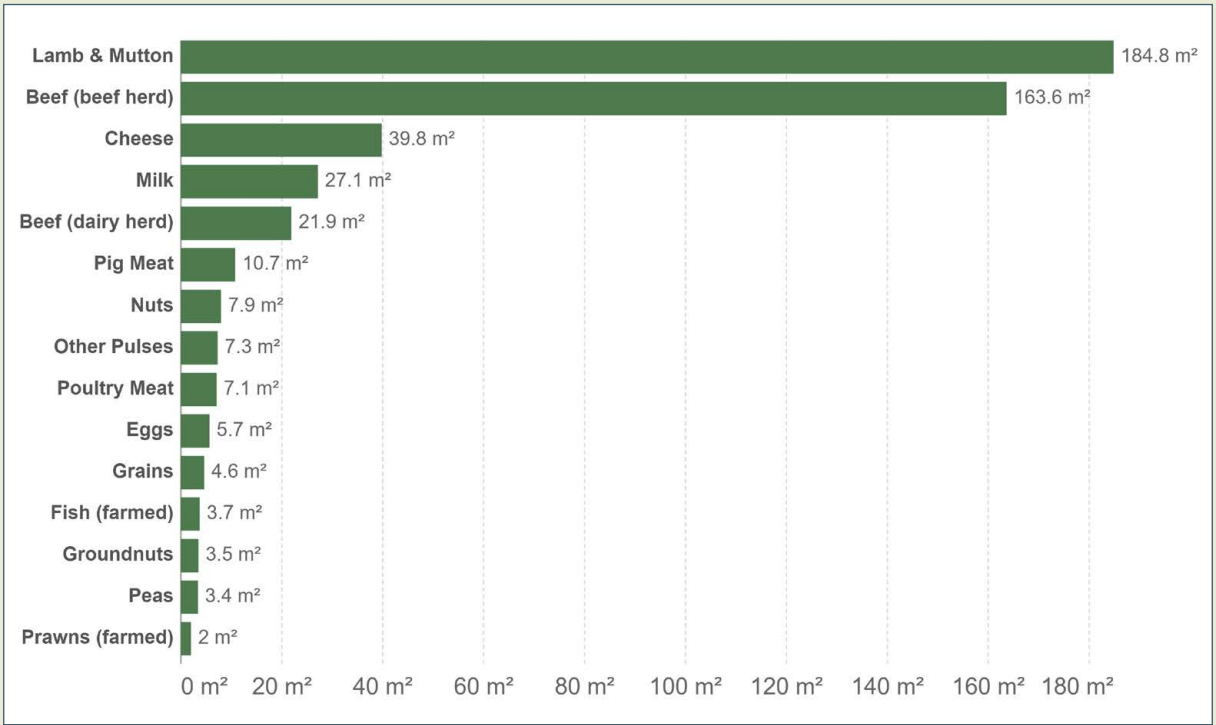


Figure 42: Land use per 100 grams of protein. Source: Our World In Data based on Poore et al, 2018.[lxvi]

This means that reducing the volume of industrial animal proteins produced will also help relieve the demand for grazing land. In turn this could reduce deforestation: beef production is directly responsible for 41% of tropical deforestation globally; while soy, which is mainly used as animal feed, is responsible for 18% of global tropical deforestation – see Figure 43.

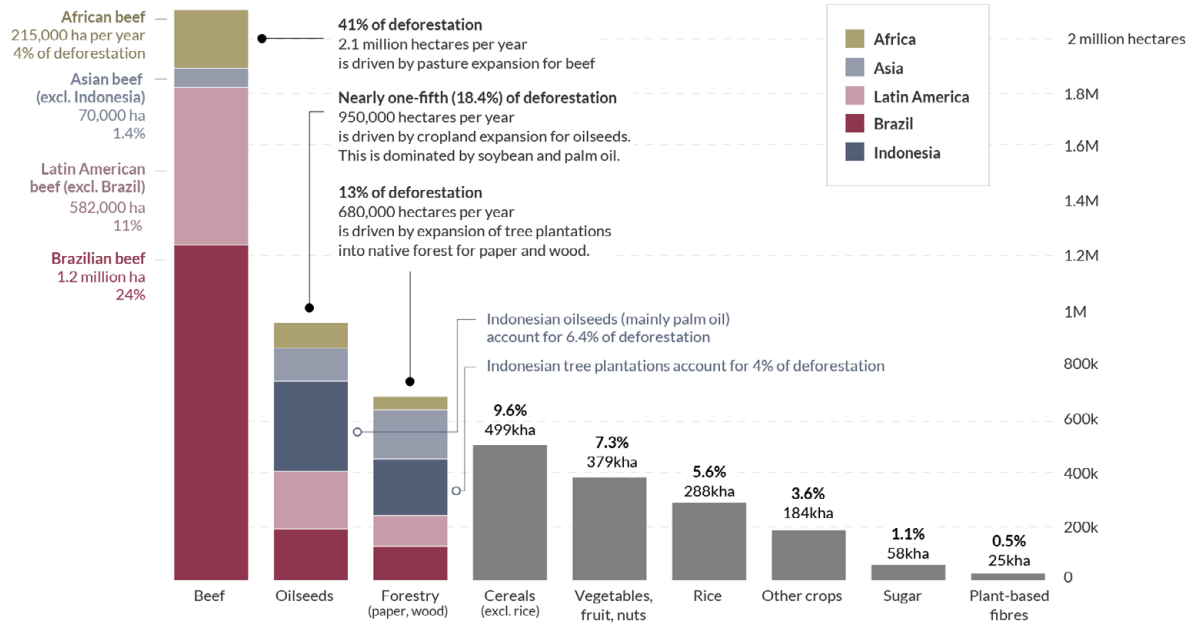


Figure 43: Drivers of tropical deforestation. Source: Our World in Data analysis.[lxvii]

Reducing pollution

Shifting diets away from animal-based proteins will contribute to human health[74] as a result of reducing pollution from industrial food production processes. Food production is responsible for significant levels of **particulate pollution**[75] which has serious health consequences (even causing death) if concentration levels exceed healthy limits. One study estimated that food production is responsible for over half the deaths in the USA associated with particulate pollution.[lxviii]

Nitrogen emissions from the livestock sector are estimated to amount to 65 Mt per year. This alone is enough to overshoot the nitrogen planetary boundary (57 Mt)[lxix] by 14%[76] and is a key source of harmful eutrophication, poisoning freshwater and coastal areas and so creating a negative feedback loop with respect to aquaculture, impairing our ability to increase food production via that route.

Food production is also responsible for 9% of total sulphur dioxide emissions and 19% of the total emissions of other volatile organic compounds.[lxx] Sulphur dioxide pollution causes respiratory diseases and contributes to acid rain which has a negative impact on biodiversity and crop yields.

Cutting industrial meat production will have a beneficial impact on all of these types of pollution and this in turn will benefit human health, biodiversity and the food production process itself.

[74] The UNEP Global Climate Assessment notes that their proposed 45% reduction would prevent 255 000 premature deaths, 775 000 asthma-related hospital visits, and 73 billion hours of lost labour from extreme heat.

[75] PM2.5 – particles with a diameter of <2.5 µm.

[76] Nitrogen pollution takes the form of nitrous oxide, ammonia (72% of total pollution), and nitrogen oxides (13%).

Increase feed conversion efficiency

There are two broad approaches that aim to reduce the methane emissions from producing meat and milk without requiring a drop in production.

The first is the use of natural or synthetic feed supplements that reduce methane from enteric fermentation. A wide variety of feed supplements are currently under investigation (including seaweed and essential oils), with a wide range of claims regarding their efficacy[77]. Effectively administering supplements to the livestock, particularly pasture-fed cattle, can be challenging and this may reduce the benefits in practice.

The second approach is to increase the 'efficiency' of protein production i.e. ensuring that more animal protein is produced per tonne of methane generated. This could be done through selective breeding or the application of techniques such as gene editing.

Both approaches (particularly the second) fail to address any of the other environmental and social harms arising from the industrial meat protein production approach, nor do they address the animal welfare concerns associated with these processes. They might even exacerbate these issues and also potentially require techniques with their own negative impacts, such as increased antibiotic application which in turn would increase the risk of antimicrobial resistance.

With respect to supplements, there is a risk that they simply raise the cost of production for producers and fail to reduce methane to the extent claimed, but if efficacy can be demonstrated (on an ongoing basis) supplements could have a part to play in reducing the agri-methane footprint of the food system.

However, the risk with both approaches is that producers will likely seek to increase production further if they can present the narrative that their approach has a 'lower methane intensity', while actually leading to an increased methane (and pollution) footprint overall.

As a result of these risks, we believe financial institutions should be sceptical and cautious with respect to supporting technological solutions to a problem that fundamentally relates to production volumes.

[77] Many of the claims for dramatic reductions are based on in vitro tests rather than in an agricultural setting so must be regarded with scepticism.

Biogas

Generating biogas from manure in anaerobic digesters will mitigate agri-methane emissions from manure and also generate revenue for farms by generating heat and electricity from captured methane gases.

The mitigation potential arises from converting methane into CO_2 by burning it. As such it is obviously not a complete solution to the problem, however given methane's GWP_{20} factor of 80 it is clearly better than simply emitting the methane into the atmosphere (assuming methane leaks can be minimised). Encouraging adoption may also be easier given the energy cost savings that can result for producers.

Economic benefits

FOLU, in their 2019 'Growing Better' report[lxxi] identify economic savings worth USD 240 billion and business opportunities worth USD 25 billion relating to 'diversifying protein supply' away from industrial meat to other categories including 'lab-grown' protein, insect and plant-based foods. They also identify USD 1.28 trillion of economic benefits and business opportunities worth USD 2 trillion from a shift towards 'healthy diets', covering similar trends such as the shift away from meat and including opportunities relating to the reduction of HFSS (high fat, salt, and sugar) and ultra-processed foods.

How should financial institutions support this?

What should they do themselves?

Sovereign bond investors should:

- Engage with governments that are already signatories to the Global Methane Pledge (which aims to reduce methane emissions by at least 30% by 2030 compared to 2020 levels) to urge them to explicitly include reducing animal protein production as a methane reduction strategy[78].
- Engage with signatories to the pledge to encourage, detailed, separate sector-based targets and milestones to ensure the 2030 goals are achieved.
- Set deadlines for investments in sovereign instruments of the three largest emitters of methane which did not commit to the Global Methane Pledge (China, Russia and India[79]) to sign the pledge or at least set targets that will put their methane emissions on a path consistent with the pledge.

Banks and investors in equities and corporate bonds should:

- Allocate their capital away from industrial animal protein production towards alternative protein producers.
- Engage with food system companies further down the supply chain to encourage them to shift their production portfolios away from industrial animal protein production and to engage with their customers to encourage a shift in demand and consumption in the same direction.
- Restrict new financing to producers which have not committed to reducing methane emissions from their production of animal proteins and link financing to quantitative production-related methane emissions reduction targets.
- Ensure new financing polices are in alignment with The Global Methane Pledge.
- Assess the aggregate methane footprint of their portfolios and report annually.

[78] The Global Methane Pledge currently only refers to 'seeking abatement of agricultural emissions through technology innovation as well as incentives and partnerships with farmers.'

[79] The USA ranks as #3 behind China and India and ahead of Russia, but the USA has signed the pledge.

What should they require of their investments?

- Require investee food systems companies to provide comprehensive data regarding production in terms of volumes and locations[80].
- Require portfolio companies (particularly meat and dairy producers) to consistently and comprehensively report their methane emissions separately from other GhGs, including Scope 3.
- Engage with investees directly involved in animal protein production to ensure producers are aligned with the Global Methane Pledge and have clear, science-based, quantified and time-framed plans to improve their production processes (including manure management) to reduce the absolute quantity of methane produced. Progress against these plans should be audited and reported against annually.
- Engage with investees in downstream Nodes (ingredient producers and traders, food manufacturers, retail, and food service) to set targets for their animal protein supply chains to quantify Scope 3 emissions by 2025 and align with the Global Methane Pledge by setting targets to reduce emissions by 2030.

Given the very heavy methane footprint of the industrial meat producers investors should consider divesting their holdings in these companies unless their engagement efforts provide a clear indication of money being spent to move towards more sustainable alternatives. Similarly, lenders should divert funds or at least charge a premium to compensate for the significant risk that industrial meat production assets will become stranded as government policies and consumer preferences shift.

What are the risks for financial institutions that continue to fund business as usual?

As noted above, there is a significant risk of stranded assets with respect to industrial animal protein producers and the methane footprint of industrial meat production means that exposure to the companies concerned is incompatible with a net zero portfolio in the medium term and will be a significant impediment to achieving a portfolio aligned to a 50% global reduction in CO_2 by 2030[82,83].

Policy shifts with respect to agri-methane will rebalance winners and losers within portfolios. For example, New Zealand is debating introducing a tax on GhG emissions from farm animals and carbon tax regimes (including Carbon Border Adjustment Mechanisms) could be extended in the future to cover high emitting food production. Reforms to agricultural policy and subsidies are likely in the future across multiple countries as policy makers look to methane reduction as a quick way to meet climate targets.

Reputation risk for an investor in, or funder of, businesses that are responsible for impact on climate is ever-present. The negative news associated with meat packing companies in the USA during the Covid-19 pandemic is a reminder that methane is only one of the challenges associated with industrial animal protein production – the social dimension is equally important from an investment risk perspective.

[80] This information is extremely valuable for basic investment analysis and risk assessment even without taking into account the sustainability reporting benefit.

[81] For example, see Emissions Impossible: how big meat and dairy are heating up the planet published by the Changing Markets Foundation and Institute for Agricultural and Trade Policy (2022).

[82] The requirement set out by the IPCC and incorporated into net zero commitments by GFANZ (Glasgow Financial Alliance for Net Zero) membership organisations.

[83] The methane footprint of financial institutions supporting the meat and dairy industry is discussed in Planet Tracker's Hot Money report.

Are there investment opportunities that should be considered?

Alternatives to industrial animal protein production offer exciting investment potential and the market for plant-based foods, and 'lab-grown' meat and meat alternatives is forecast to grow rapidly.

A Bloomberg Intelligence report from August 2021[lxxii] forecasts that the plant-based foods market could grow from USD 29.4 billion in 2020 to USD 162 billion in 2030. EY Food and Agriculture practice estimates that the alternative protein market size will grow to between USD 77 billion and USD 153 billion by 2030 – see Figure 44.

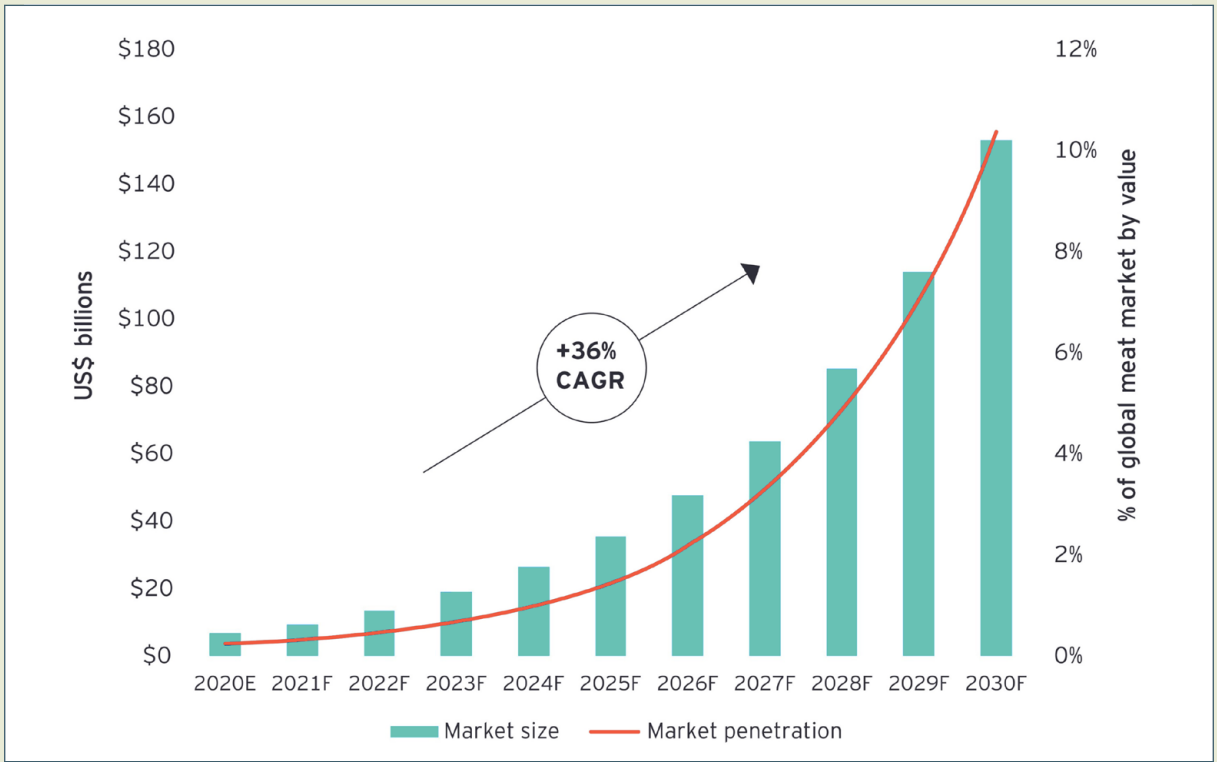


Figure 44: Global alternative protein market size ($b) and market penetration 2021 to 2030. Source: EY Parthenon Analysis.[lxxiii]

This will provide opportunities for direct investment in early-stage businesses focused on these areas, but also in well established, larger, businesses that successfully pivot towards this new growth area.

PRIORITY ACTION #5
make agriculture/aquaculture[84] systems regenerative before 2030

Theme 2 Increase food system efficiency and **Theme 3 Reduce food system pollution**

This Priority Action links to Priority Action #4 (cut agri-methane emissions) since both high agri-methane emissions and impacts such as soil depletion are driven by industrial (extractive) food production practices, particularly those supporting the industrial beef sector.

Why is this a priority?

The global food system contributes 34% of anthropogenic GhG emissions, with the agricultural production Nodes responsible for 39% of this footprint (c.7 Gt CO_2e). In addition, agriculture has a large negative impact on nature, causing biodiversity loss on land and in water, and drawing heavily on fresh water resources.

Unsustainable farming practice has degraded more than 500 million hectares of agricultural land[lxxiv] to the extent it that has now been abandoned. More than half of current farmland is considered to be degraded to some extent and is therefore underperforming as both an economic and environmental asset.

The additional demands on agriculture and aquaculture to feed a population that is expected to grow by over 20% to 9.7 billion by 2050[lxxv] will further increase the impact the food system has on climate and nature.

As a result, transforming agricultural systems from extractive to regenerative is clearly essential if we are to meet our climate and nature goals by 2030 and 2050.

Government policies are beginning to shift in response. The Kunming-Montreal GBF includes a 2030 target relating to regenerative agriculture that requires countries to ***'Ensure that areas under agriculture, aquaculture, fisheries and forestry are managed sustainably****, in particular through the sustainable use of biodiversity, including* ***through a substantial increase of the application of biodiversity friendly practices****, such as sustainable intensification, agroecological*85 *and other innovative approaches contributing to the resilience and long-term efficiency and productivity of these production systems and to food security, conserving and restoring biodiversity and maintaining nature's contributions to people, including ecosystem functions and services.'* lxxvi

[84] 'Agriculture' in this context includes aquaculture and other systems such as regenerative livestock grazing'

[85] 'Agroecology' is the broadest term, defined by the FAO as 'a transdisciplinary field that includes the ecological, socio-cultural, technological, economic and political dimensions of food systems, from production to consumption.' ... 'It seeks to optimize the interactions between plants, animals, humans and the environment while also addressing the need for socially equitable food systems within which people can exercise choice over what they eat and how and where it is produced.' 'Regenerative agriculture' can be regarded as s subset of agroecology. (https://www.fao.org/agroecology/overview/en/)

The Breakthrough Agenda, launched at COP 26 in Glasgow by leaders of 45 countries collectively representing over 70% of global GDP included a breakthrough goal for agriculture '**to make climate-resilient, sustainable agriculture the most attractive and widely adopted option for farmers everywhere by 2030**.' [lxxvii]

Large food companies are also beginning to invest money and time in regenerative agriculture. For example, in November 2022, the Sustainable Markets Initiative launched an Agribusiness Task Force (ATF), bringing together some of the world's largest food companies[86] to 'accelerate regenerative agriculture into becoming the predominant agricultural system in the world.' [lxxviii]

Investors are also beginning to focus on regenerative agriculture. In a 2019 report, the Croatan Institute identified 70 investment funds in the USA alone with combined assets of USD 47.5 billion that included one or more criteria related to some facet of regenerative agriculture in their investment criteria.[lxxix]

Greenwashing risk (defining 'regenerative')

There is no agreed definition of 'regenerative agriculture' so terminology is a challenge in this context and this creates a significant risk of greenwashing by companies which financial institutions focusing on this Priority Action will need to beware of in their pre-funding due diligence processes.

We use 'regenerative' to mean the opposite to the current common practice of 'extractive' agriculture which depletes the soil and the wider natural environment over time and requires synthetic chemical inputs to compensate for this depletion and maintain yields.

FOLU provides a clear summary of the key elements in its 'Growing Better' report:[lxxx] regenerative agriculture is a set of practices that maintain high levels of productivity while it:

- regenerates soil;
- reduces (or even eliminate) synthetic fertilisers and pesticides;
- reduces water use and negative impacts on freshwater and oceans; and
- aims to ensure positive environmental effects including increasing biodiversity.

It is supported by related techniques such as sustainable land management and integrated water resource management[87].

[86] ATF members: Mars Inc., PepsiCo, Mondelez, Olam, Yara International, Bayer, McCain Foods, Waitrose & Partners, and McDonald's. Other food companies such as Danone, Nestle and Unilever have announced significant investments (USD billions) in regenerative agriculture.

[87] The 2022 Breakthrough Agenda report has a similar definition of 'sustainable agriculture'

Mitigation potential

Regenerative agricultural methods offer the potential to help reduce the heavy burden of food production on nature and climate by adopting practices that:

- Protect and enhance soil health;
- Reduce the use of synthetic external inputs;
- Conserve water;
- Sequester carbon;
- Protect and enhance biodiversity.

GhG emissions

Roe et al.[lxxxi] estimate that adopting sustainable agriculture practices has the potential to reduce the GhG footprint of agricultural production by 0.6 Gt CO_2e annually by changing fertilizer application and management practices and the subsequent reduction in emissions linked to the production of synthetic fertilizer. Practices include split fertilization, 100% crop residue incorporation, nitrification inhibitors, and reducing nitrogen fertilizer applications by 20%. In addition to saving GhG emissions, reducing the amount of fertilizer will help reduce the impact on nature from eutrophication caused by nitrogen pollution.

In addition to the emission saving from reduced fertilizer use, the GhG footprint of agriculture can be reduced further by using agriculture as part of a nature-based solution to the climate challenge and storing more carbon in agricultural landscapes. Roe et al. estimate potential sequestration benefits of 2.5 Gt CO_2e annually are achievable, through agroforestry, biochar, and soil organic carbon practices which can increase the sequestered carbon in agricultural crop and grasslands. This would be equivalent to nearly 5% of 2015 anthropogenic GhG emissions[88].

Given the potential input costs savings that such methods can achieve, regenerative agriculture has the potential to be a very cost-effective nature-based climate solution that can be deployed at scale.

Benefits for nature

Regenerative agricultural approaches benefit from the synergies of biodiversity, both of natural habitat and on-farm agrobiodiversity through techniques such as crop rotation, multi-cropping, agroforestry and the integration of animals and crops. As well as increasing soil health and biodiversity, these methods enable the use of chemical inputs to be reduced.

[88] Using the 2015 total anthropogenic footprint of 52 Gt CO_2e – see Appendix 3.

Reduced pollution

Reducing synthetic inputs will reduce direct costs and also reduces pollution since many inputs (particularly nitrogen) fail to be absorbed and leak into the wider environment.

As noted earlier (Priority Action #4):

- Nitrogen emissions from the livestock sector are estimated to amount to 65 Mt per year, exceeding the nitrogen planetary boundary (57 Mt)[lxxxii] by 14%[89]. Nitrogen pollution is also a key source of harmful eutrophication, poisoning freshwater and coastal areas and so creating a negative feedback loop with respect to aquaculture, impairing our ability to increase food production via that route.
- 9% of total sulphur dioxide emissions and 19% of the total emissions of other volatile organic compounds.[lxxxiii] Sulphur dioxide pollution causes respiratory diseases and contributes to acid rain which has a negative impact on biodiversity and crop yields.

Reduced water use

Food production accounts for 86% of total human water consumption and 92% of the available 'blue water' (from lakes, rivers and aquifers) is used for irrigation,[lxxxiv] impacting water flows downstream and depleting aquifers. This heavy consumption of water means that the food system is likely to be in conflict with other users of water, including renewable energy sources such as hydropower. This challenge is increased by the fact that water is hard to transport so that shortages in one location cannot easily be compensated for by excess water in another.

The food system's heavy reliance on water is also a key source of climate vulnerability. While climate change may not reduce the overall quantity of rainfall globally, it is likely to make rainfall patterns much more unpredictable, leading to droughts and floods in particular locations. This harmful effect can be magnified by deforestation, which reduces the ability of the land to retain water and impacts local rainfall patterns[90].

Regenerative agricultural techniques include water management techniques which are designed to reduce the consumption of water, in particular reducing water loss through evaporation from the soil and 'drop-per-crop' targeted irrigation techniques that use water more efficiently.

Healthy soil is a key requirement for increasing water retention and avoiding losses through run-off and evaporation, so water management techniques are only really effective when used in conjunction with techniques for maintaining and improving soil health.

Resilience

In comparison to extractive or industrial agriculture, regenerative agriculture methods provide more resilience against increasingly frequent weather extremes resulting from climate change and other related issues such as increasing pests, disease and weeds.

[89] Nitrogen pollution takes the form of nitrous oxide, ammonia (72% of total pollution), and nitrogen oxides (13%).

[90] See Planet Tracker's reports No Rain on the Plain and Destroying Brazil's Aircon for discussion on the impact of deforestation on Brazil's climate and water availability.

Location specific

The specific techniques deployed under the banner of regenerative agriculture will vary depending on location. Therefore, financial institutions wishing to focus on this Priority Action should ensure that the company they are funding has the expertise and information to successfully deploy the right techniques that are likely to succeed in the locations targeted. A 'one size fits all' approach will fail and might well do more harm than good.

How should financial Institutions support this?

What should they do themselves?

Equity investors may find their holdings of companies at the producer end of the food system form a smaller part of their portfolios than companies in the manufacturing and distribution Nodes[91]. This means their focus will need to be on indirectly influencing producers via their customers further down the supply chain.

Conversely, banks are more likely to have direct relationships with companies involved in agricultural production and so should aim to directly influence their behaviour.

Financial institutions should:

- Reduce their holdings of, or loans to, agricultural production companies that do not have a clear focus on applying regenerative agricultural techniques and shift their capital to those that do.
- Engage proactively with investee companies to encourage them to adopt regenerative techniques in their own operations or with respect to their suppliers.
- Establish effective monitoring systems so that any cases of environmental harms resulting from extractive agricultural practices will be identified quickly.
- Disinvest from any companies that appear to be deliberately taking an extractive approach to food production (i.e. where there is clear evidence of environmental and/or social harms).
- Establish clear portfolio assessment, monitoring and reporting processes so that they can evaluate the extent to which their capital is being deployed in support of regenerative agriculture and be held to account for their actions.
- Establish strong due diligence processes to ensure that they can distinguish greenwashing from genuine regenerative agricultural practices.

[91] As discussed earlier in this report – see Table 4 on page 48.

What should they require of their investments?

Sovereign bond investors should engage with governments to ensure agricultural policies and subsidies support regenerative agriculture/aquaculture practices and that policies and subsidies incentivising extractive agriculture/aquaculture practices are abandoned rapidly.

Companies that are funded or are seeking funding should be required to:

- Disclose information about their current agricultural practices (or those of their suppliers) with sufficient granularity to enable a portfolio view of the extent to which regenerative agriculture is being funded (or not).
- Disclose financial information and timelines for regenerative agriculture investment plans (including their supply chains where relevant) and the expected mitigations that will result with respect to climate, nature and people. Companies that are downstream from the food producers and traders should be required to set out their plans for collaborating with peers and with suppliers to encourage the adoption of regenerative agricultural practices.

What are the risks for financial institutions that continue to fund business as usual?

Financial institutions that directly fund companies engaged in extractive agricultural practices or those that rely on such companies in their supply chain are at risk of financial loss since these companies are depleting the natural capital base on which their business success depends. This will either result in a collapse of the business or a sudden requirement for high levels of investment to correct the accumulated problems. As a wider range of financial institutions become aware of these risks, it will become more difficult for existing funders to cut their exposure by passing the investment position to another financial institution[92].

Policy changes such as increased control over water use and the implementation of carbon taxes could threaten the profitability of businesses that are not already pursuing regenerative agricultural practices, or using suppliers that are.

Businesses that are not focusing on regenerative agriculture (directly or in their supply chains) are less likely to be resilient in the face of climate-related risks such as droughts, floods and/or Extreme Heat Days.

Financial institutions that profess to taking a 'sustainable finance' approach will be at risk of reputational damage or even regulatory action if they are subsequently found to be funding businesses employing extractive agricultural practices (or those that support such an approach in their supply chains).

Even financial institutions that adopt a 'greenhushing' approach[93] may suffer reputational damage if they are found to be supporting companies responsible for particularly egregious extractive agricultural practices.

[92] The extreme version of this approach is referred to as 'greater fool' theory i.e. buying a risky investment will be profitable provided one can find a 'greater fool' to buy it at a higher price before the risks become so widely known that no new 'greater fools' are available

[93] Greenhushing is when businesses underreport their sustainability practices to their customers and stakeholders – one reason for doing this is to avoid regulatory attention and/or the costs of being held to account by customers.

Are there investment opportunities that should be considered?

There are numerous investment opportunities associated with regenerative agriculture and aquaculture, from direct investment in farms switching to this approach, through to suppliers of the agricultural inputs and equipment required for different regenerative techniques. This includes new varieties of seeds, more effective fertilizer, precision application farming technology, no till equipment, flexible equipment that is suitable for diversification in crops, recirculating aquaculture systems, etc. Further down the supply chain, manufacturers, retailers and food service companies will be able to charge a premium for their goods because of the regenerative practices underpinning them.

Regenerative agricultural techniques are generally associated with an increase in carbon sequestration in soils. As carbon markets develop and the need to nature-based climate solutions becomes ever clearer, it is likely that food producers using regenerative techniques will be able to supplement their income by selling carbon credits and monetising other forms of ecosystem services.

PRIORITY ACTION #6
invest in alternative proteins

Theme 2 Increase food system efficiency, **Theme 3 Reduce food system pollution** and **Theme 4 Sustainable product offerings**

This Priority Action links to Priority Action #3 (stop deforestation) and Priority Action #4 (cut agri-methane emissions) since both high agri-methane emissions and impacts such as deforestation are driven by industrial (extractive) food production practices, particularly those supporting the industrial beef sector.

Defining alternative proteins

In the context of this Roadmap we define 'alternative proteins' as all types of protein production that do not involve traditional livestock techniques. This includes plant-based meat substitutes as well as proteins from other non-livestock sources such as insects, algae, fungi, worms, and animal proteins grown in the laboratory (also known as "clean meat").

Why is this a priority?

The industrial meat production sector is a source of significant environmental and social harms, as discussed in Priority action #4 – cut agri-methane emissions by 45% by 2030 (starting on page 85)[94].

Figure 60 (in Appendix 1, page 115) shows the dramatic rise in meat production since 1961. The US Environmental Protection Agency (EPA) forecasts that the global livestock population of dairy cows and cattle will increase by 12% from 2015 to 2030 and that emissions from the sector will increase by 10%, to 6.4 Gt CO_2e[lxxxv] unless action is taken to reduce demand for industrial meat and dairy.

The benefits of moving away from industrial meat and dairy with respect to deforestation, particulate pollution and methane emissions are discussed in detail under the heading 'Co-benefits of shifting diets away from intensive meat' (Priority Action #4, page 85).

[94] This is not a new insight. In 2006 the FAO published 'Livestock's Long Shadow' which concluded that 'The livestock sector is responsible for a significant share of environmental damage.' (https://www.fao.org/3/a0701e/a0701e.pdf)

The other harms arising from the industrial meat sector include:

- **Manure pollution:** Intensive farming produces more manure than is required for fertilising crops. Manure runoff and leaching can pollute surface and ground water, leading to eutrophication which destroys marine habitats. Overapplication of manure can spread diseases, hormones and other pharmaceutically active compounds (see antimicrobial resistance below) as well as emitting GhGs such as methane (as discussed above).[lxxxvi]
- **Antimicrobial resistance (AMR):** The expansion of intensive farming has led to a significant increase in antimicrobial use - an estimated 73% of all antimicrobials sold globally are used in animals used for food.[lxxxvii,lxxxviii] The UN recognises the inappropriate use of microbials in animals as a leading cause of AMR in humans, and in 2019 around 1.27 million deaths worldwide were attributed to AMR.[lxxxix]
- **Health:** While meat represents an important source of dietary protein and micronutrients for a large proportion of the world's population, excessive consumption of meat is often associated with a range of negative health impacts. These include: excess weight; obesity; an increased risk of chronic diseases such as type 2 diabetes and cardiovascular disease; and an increased risk of certain types of cancer (from red meat consumption in particular).[xc]
- **Poor working conditions:** The working conditions of livestock farmers are even more challenging than those of crop farmers with a range of potential negative physical and mental health impacts. Physical health risks include, exposure to particulate matter from ammonia, manure, dust and dander which can harm respiratory health. Farm workers face increased risk of bacterial infection and AMR (as discussed above), as well as physical dangers from operating farm machinery and handling animals. Forced labour and human trafficking are also an issue in livestock farming and fisheries,[xci] especially among migrant works who lack the training and language skills making them particularly vulnerable. In terms of mental health, livestock farming has been highlighted as particularly stressful, largely due to long working days and the above health impacts.[xcii] Studies have shown that slaughterhouse workers suffer from higher rates of mental health issues, particularly depression and anxiety.[xciii]

Producing animal protein is also a very inefficient way to utilise land requiring 77% of the agricultural land to produce 37% of our protein and 18% of our calories.[xciv] However, livestock have an important part to play in farming livelihoods around the globe and systems such as regenerative grazing can be important tools for enhancing biodiversity and soil health (making the land more productive) , highlighting the strong link to Priority Action #5 – make agricultural systems regenerative.

Mitigation potential

Shifting to **sustainable diets** has significant potential for reducing the GhG and environmental footprint of the food system, as well as contributing to human health and nutrition, and to the resilience of the food system itself. The IPCC's Special Report on Climate Change and Land sixth report ascribes 'high confidence' to the 'significant potential mitigation' arising from the adoption of healthy diets[95]. The EAT-Lancet Commission has also provided a detailed study setting out how a shift to healthier diets across the world could result in a food system with a significantly lower footprint from a climate and nature perspective.[xcv]

However, rather than attempting to tackle an issue as broad as changing eating patterns across the globe, we believe **financial institutions should focus on the narrower issue of diversifying protein supplies**.

The benefits of diversifying the sources of protein supply for human consumption are not often broken out in the studies recommending a dietary shift but there is a clear consensus that we cannot continue to rely solely on our current food production processes if we are to solve the problems currently caused by the food system.

The IPCC's sixth report states that 'Novel protein sources may have considerable potential for sustainably delivering protein for food and feed alike' and 'could lead to significant reduction in land use for pastures and crop-based animal feeds'.[xcvi]

BCG's July 2022 report (The-Untapped Climate Opportunity in Alternative Proteins) found that "from a macroeconomic perspective, investment in plant-based proteins has the highest CO_2e savings per dollar of invested capital of any sector".[xcvii]

In the same report they noted 'If the total market for animal-based products, which is responsible for 15% of global greenhouse gas (GHG) emissions, were to shift to alternatives, it would eliminate 11% of currently projected emissions in 2030.'

Figure 45 illustrates the extent to which GhG emissions relating to the production of animal proteins from livestock (particularly beef) far exceeds the GhG emissions from other food products.

[95] The IPCC does not define a healthy diet in precise detail but the consensus is that it consists of a balance of food types, weighted towards plant-based foods and away from animal proteins, fats and sugars.

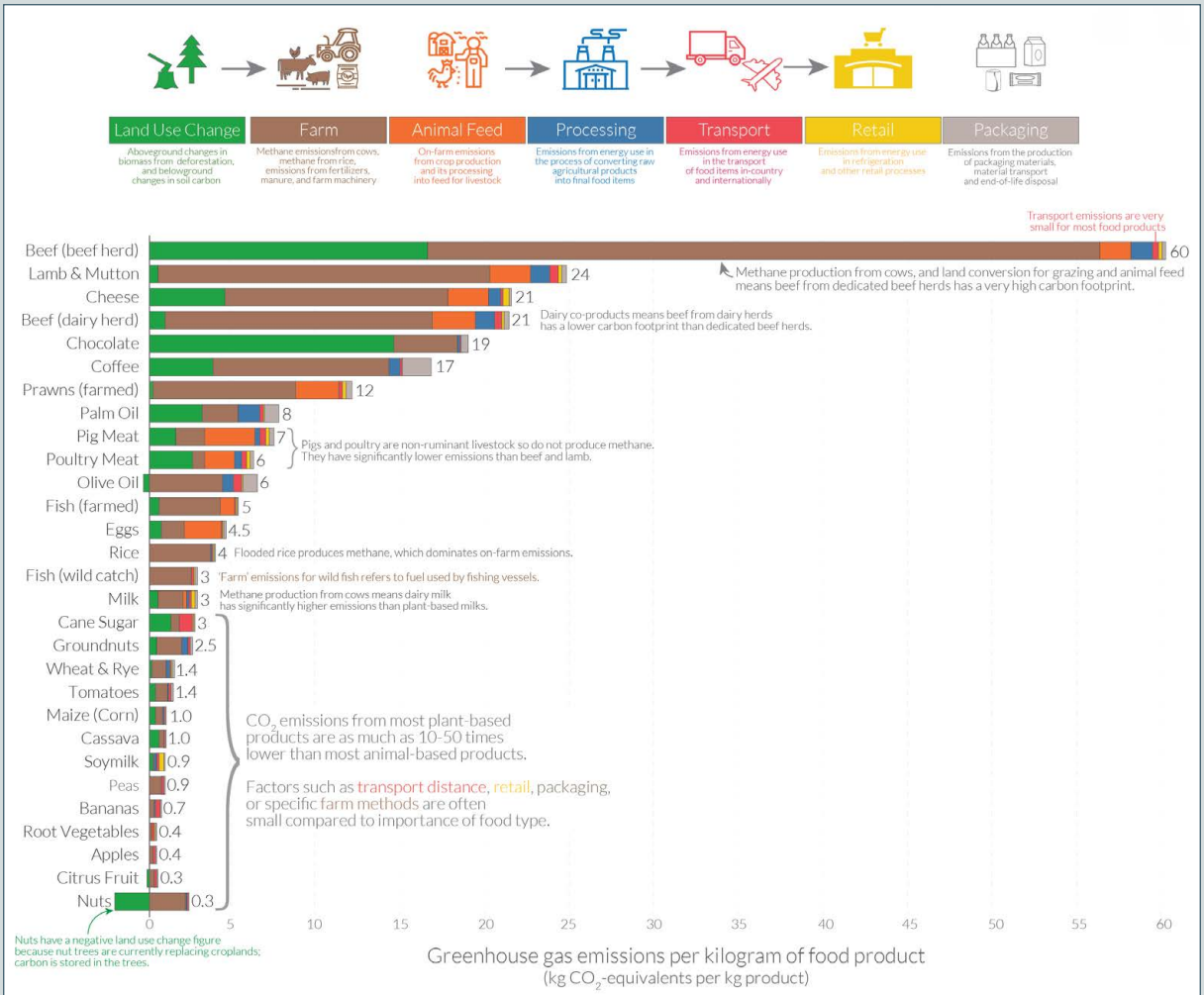


Figure 45: Food: greenhouse gas emissions across the supply chain (GhG emissions per kg of food product). Source: Joseph Poore and Thomas Nemecek (2018), Our World In Data analysis.

It is clear from Figure 45 that shifting diets away from beef would significantly reduce the food system's GhG footprint, however, finding alternatives ways to produce beef (and other animal) protein that avoided the drivers underpinning the GhG emissions would provide an additional solution.

FOLU's 'Growing Better' report[xcviii] estimates that the business opportunities relating to diversifying protein sources amount to USD 240 billion by 2030 and the hidden cost reductions by 2030 would be similar (totalling USD 240 billion with USD 130 billion coming from reduced public health costs), while the investment required would only amount to USD 15-25 billion.

How should financial institutions support this?

Financial institutions have an important role to play in driving this change through the investments they make or the businesses they lend to. The market shift to 'clean meat' has not yet begun (products are not available on a commercial scale) and it will require significant capital to develop to the extent required to achieve the changes that are needed.[xcix] The total of private investments into alternative proteins globally over the last decade to 2022 is just over USD 14 billion,[c] compared with renewable energy which drew more than USD 2.4 trillion in investment over a similar period.[ci]

However, it is clear that consumers are already moving away from meat-based diets towards plant-based alternatives (at least in some regions), leading to a significant growth in investment opportunities in businesses established to exploit this trend as well as incumbents that are seeking to adapt.

The food environment (the products offered, and how they are packaged, displayed, advertised and priced) has a strong influence on consumer behaviour and so financial institutions should assess the extent to which the food manufacturers, retailers, and food service companies they support are seeking to reduce the demand for industrial animal proteins.

Financial institutions also have an important role in terms of influencing government policy and legislation to ensure the regulatory environment is supportive of the development and sale of alternative proteins, and that their investee companies are not engaging in lobbying designed to block progress.

What should they do themselves?

- Engage with governments to ensure regulatory frameworks encourage the development of alternative proteins.
- Allocate their capital away from industrial animal protein production towards alternative protein producers.
- Engage with food system companies further down the supply chain to encourage them to shift their production portfolios away from industrial animal protein production and to engage with their customers to encourage a shift in demand and consumption in the same direction.

What should they require of their investments?

- Require investee food systems companies to provide comprehensive data regarding production of traditional and alternative protein types in terms of volumes and locations[96].
- Engage with investees directly involved in animal protein production to encourage them to shift their production to alternative protein sources.
- Engage with investees in downstream Nodes (ingredient producers and traders, food manufacturers, retail, and food service) to set time-framed targets for shifting their product portfolios away from industrial meat and dairy towards alternatives.
- Require investees in downstream Nodes (ingredient producers and traders, food manufacturers, retail, and food service) to report on their lobbying activities and disclose the steps they are taking to create food environments that support the development and sale of products based on alternative proteins.

[96] This information is extremely valuable for basic investment analysis and risk assessment even without taking into account the sustainability reporting benefit.

Are there investment opportunities that should be considered?

The market for alternative protein is changing rapidly and most direct investment opportunities are currently at too early a stage of business development for many financial institutions to include in their investment or lending portfolios. However, indirect opportunities will arise through funding larger companies that are investing in R&D and/or add-on acquisitions in this space.

As noted earlier, FOLU estimates that the business opportunities relating to diversifying protein sources amount to USD 240 billion by 2030. A Bloomberg Intelligence report from August 2021[cii] forecasts that the plant-based foods market could grow from USD 29.4 billion in 2020 to USD 162 billion in 2030. EY Food and Agriculture practice estimates that the size of the alternative protein market will be between USD 77 billion and USD 153 billion by 2030 – see Figure 44 on page 95.

As should be expected with such and early-stage market, the range of forecasts for its development is very wide. Figure 46 provides a useful summary of some of the more recent forecasts.

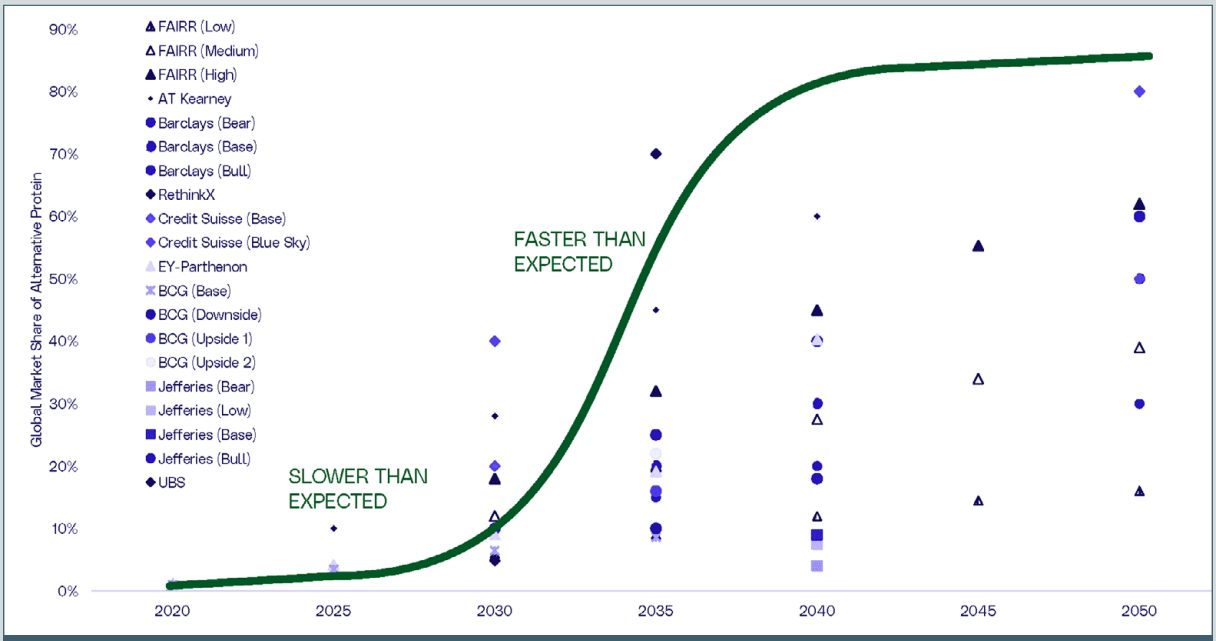


Figure 46: Synthesis Capital alternative protein adoption forecast ('S-curve'). Source: Synthesis Capital.[ciii]

The Good Food Institute provides a wealth of information regarding the alternative protein market.[97]

Risks to consider

Aside from the obvious investment risks associated with funding an emerging industry, financial institutions face risks with respect to the shift away from industrial meat, in particular, stranded asset risk in the industrial beef sector – not just from alternatives to meat itself but also from the development of alternatives to meat and dairy by-products such as lab-grown leather or leather substitutes and the production of dairy components such as casein which is extensively used as a food ingredient.[98]

[97] GFI is a non-profit think-tank made up of an international network of organizations 'advancing alternative proteins as an essential solution needed to meet the world's climate, global health, food security, and biodiversity goals'.

[98] Casein is also extensively used in the production of paper coatings, glues, paints, plastics, and man-made fibres highlighting the extent to which demand from non-food industries will also influence the shift to alternative proteins.

ILLUSTRATING THE BENEFITS OF THE SIX PRIORITY ACTIONS

Calculating a quantified estimate of the benefits of transforming the global food system is extremely difficult. The FLAG[99] Guidance published by the Science Based Targets initiative includes estimated benefits of 12 Gt CO_2e[100] from a range of transformative food system actions.

Using a similar basis (but a much more simplistic approach) we estimate that the six Priority Actions we recommend could reduce food systems emissions by approximately 10 Gt CO2e, nearly 60% of the food system's current footprint, and reduce humanity's overall GhG footprint by a fifth – see Figure 47 and Figure 48.

We are not able to estimate a GhG benefit from Priority Action #1 – fully traceable supply chains – but we can estimate an economic benefit.

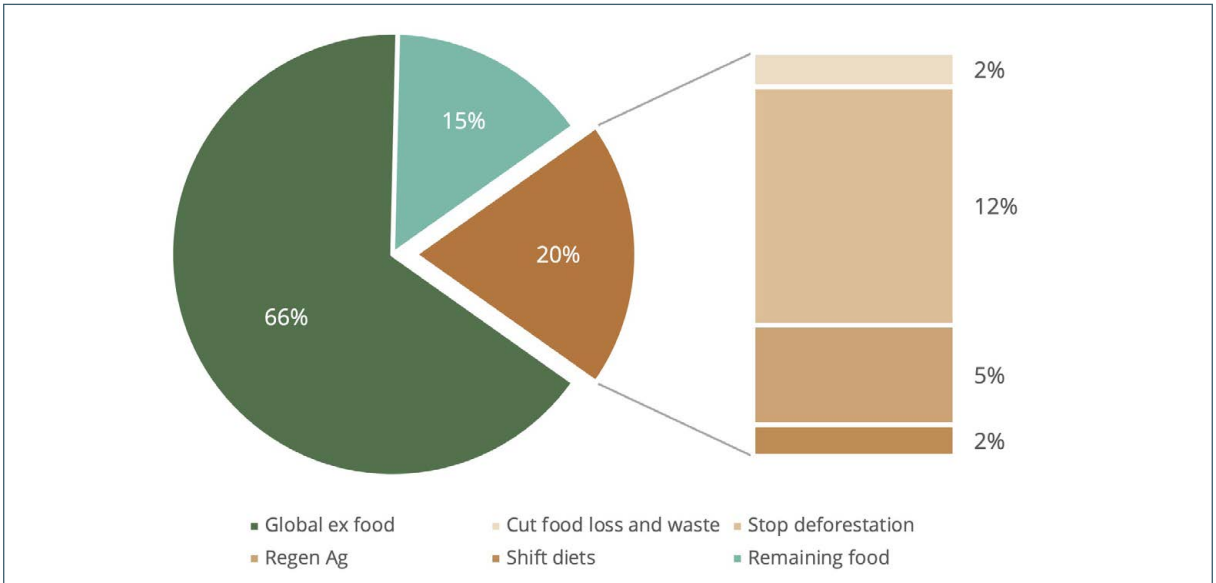


Figure 47: Illustration of the potential benefits of Planet Tracker's five Priority Actions. Source: Planet Tracker. Carbon sequestration in soil is used to illustrate the potential of a shift to regenerative agriculture. 'Shift diets' approximately captures the benefits of cutting methane and shifting to alternative protein sources.

the **6 PRIORITY ACTIONS** could **reduce** food systems **emissions** by nearly **60%** of the CURRENT FOOD SYSTEM'S **footprint**

[99] Forests, Land, And Agriculture

[100] Carbon dioxide equivalent – a measure that enables comparison between different greenhouse gases and aggregation of emissions figures

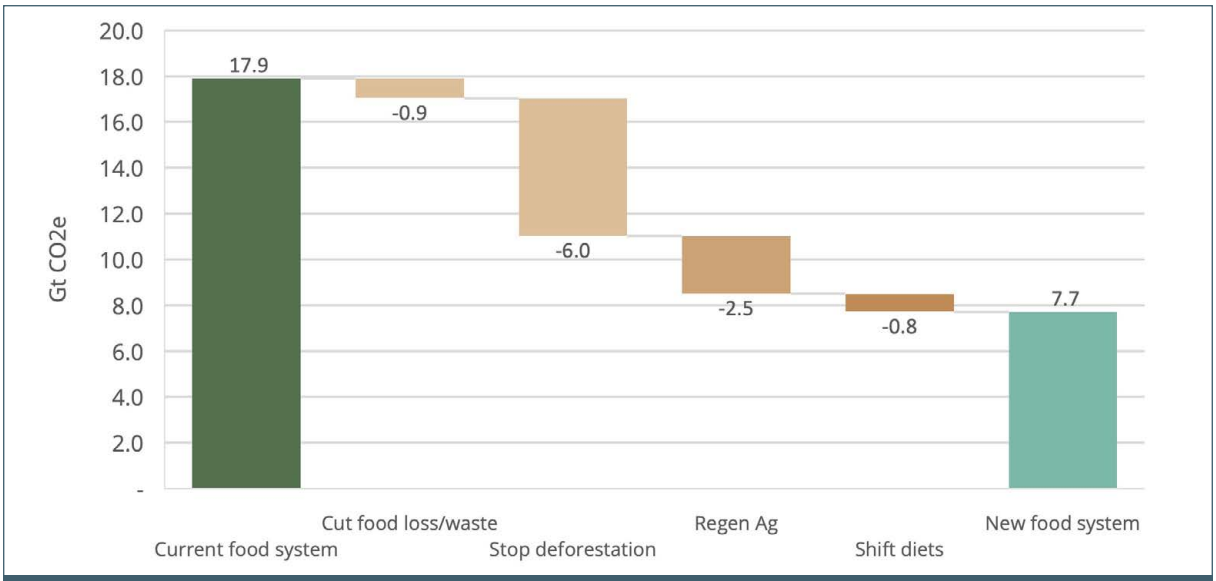


Figure 48: Illustration of the GhG reductions associated with Planet Tracker's six Priority Actions. Source: Planet Tracker analysis based on Roe et al.). Carbon sequestration in soil is used to illustrate the potential of a shift to regenerative agriculture. 'Shift diets' approximately captures the benefits of cutting methane and shifting to alternative protein sources.

The value of the economic benefits is potentially huge. FOLU's Growing Better report includes estimates for the benefit of a variety of actions to transform the global food system. Their framework does not precisely match ours but Figure 49 illustrates the trillion dollar scale of the benefits associated with the six priority actions we recommend (five are based on FOLU's analysis and one – supply chain traceability – is based on Planet Tracker's estimate).

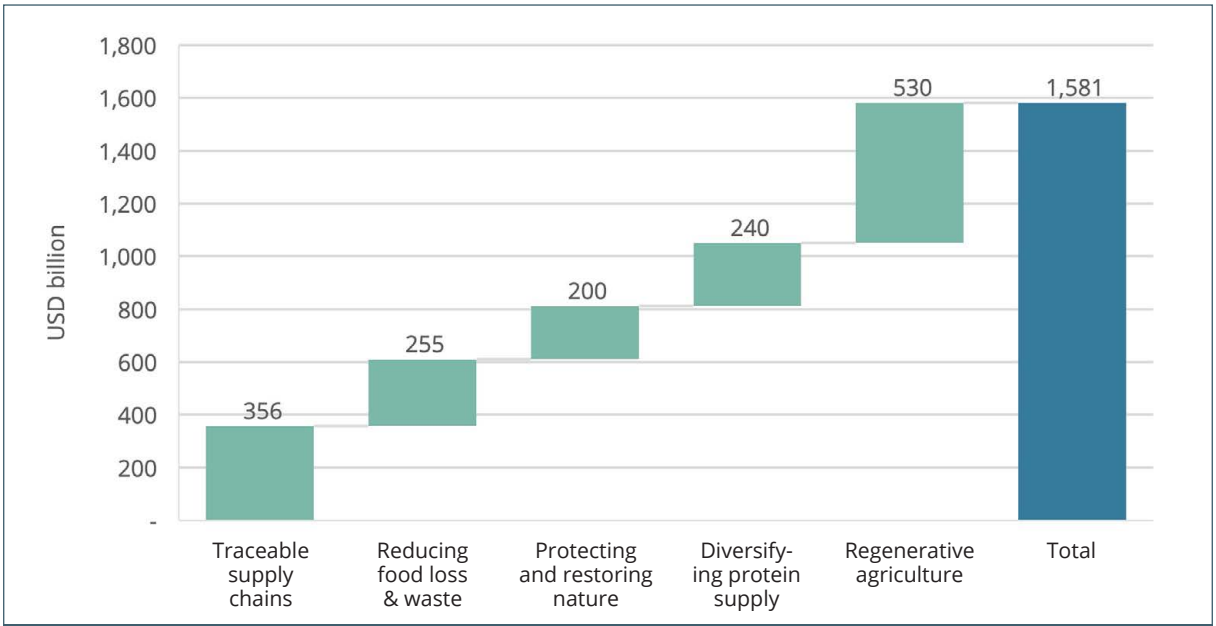


Figure 49: Illustration of the scale of economic benefits associated with Planet Tracker's six Priority Actions. Source: Planet Tracker analysis based on FOLU estimates.NB Diversifying Protein Supply also captures the benefits associated with reducing methane emissions

DOWNSIDE RISKS OF BUSINESS AS USUAL

A 2022 report by Race to Zero[civ] highlights that if food system transition risks are unmitigated, individual firms at the centre of the global food supply system could lose up to 26% of their value, with a sector average hit of over 7% compared to a BAU scenario.

Their analysis covered 40 of the largest and most influential food and agriculture companies collectively worth USD 2.2 trillion and employing nearly 8 million people, selected from the 2021 WBA Food and Agriculture Benchmark's list of 350 influential food and agriculture companies.

The loss across the food companies selected would equate to USD 152 billion. The Race to Zero report concludes that all of this loss is avoidable if the company and sector-specific mitigating actions[101] they recommend are taken.

40 of the **LARGEST** and most **INFLUENTIAL**
food & agriculture companies collectively
worth **USD2.2 trillion** and **EMPLOYING**
nearly **8 million people**

[101] These mitigating actions relate to the specific companies covered in the Race to Zero report and their position in the supply chain but are consistent with our framework

THIS ROADMAP EXCLUDES PUBLIC FINANCE / SUBSIDIES

Why public finance is excluded from this Roadmap

Public finance is very important for the global food system. Currently, USD 611 billion of public finance is spent on agricultural production, subsidies etc., every year. This is up from USD 252 billion in 2011. 86% of the USD 611 billion has potentially destructive impacts on climate, biodiversity, health, and food systems resilience.[cv]

The purpose of this Roadmap is to focus on the role to be played by private finance, so we have not addressed the changes required to ensure that public finance supports and incentivises the necessary transformation of the global food system.

There are multiple ways that public finance influences company behaviour, from subsidies for land use or crop production to land ownership and governance, so the financial analysis included in this report will have been influenced by public finance.

However, companies don't generally report the impact of subsidies and other forms of state support. If they did it would be extremely useful to aid analysis of the harms or benefits that the public subsidies are financing.

What does public funding for the food system look like currently?

Aside from the USD 611 billion of public finance spent on agricultural production, subsidies etc, every year, the global food system also receives public climate finance.

However, the climate finance received falls woefully short of what is required. Food systems currently receive only 3% of public climate finance, despite accounting for one-third of all global emissions. This amounted to USD 9.3 billion on average between 2016-2020 and pales in comparison to the USD 210 billion received by the energy and transport sectors – see Figure 50.

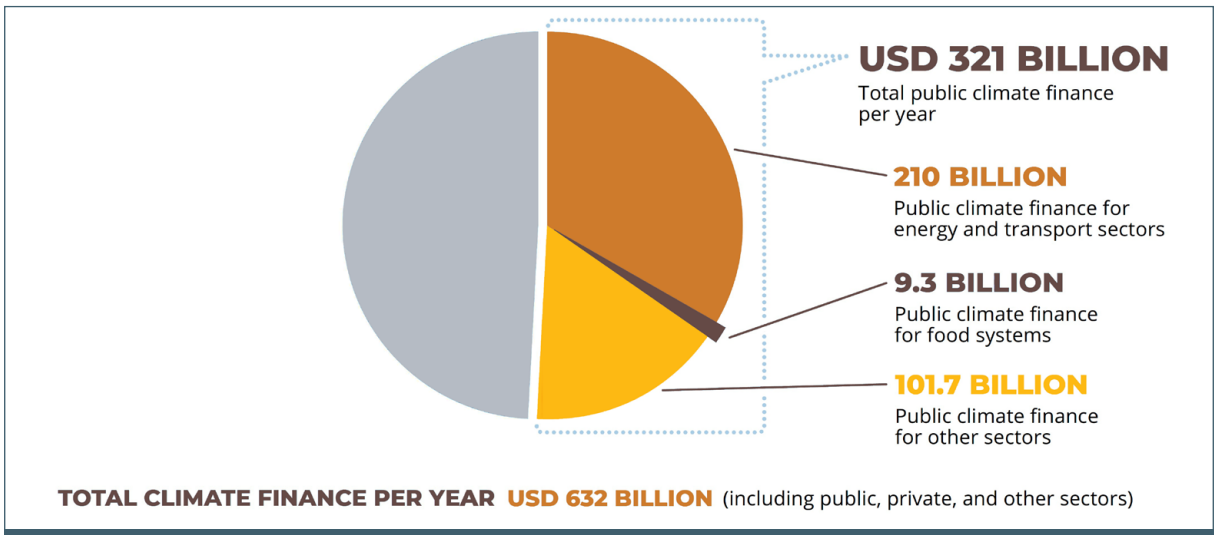


Figure 50: Food system received 3% of total public climate finance on average per year 2016-20. Source: Untapped Opportunities: Climate Financing for Food Systems Transformation, by Global Alliance for the Future of Food.[cvii]

WHAT ACTIONS SHOULD BE TAKEN BY PUBLIC FINANCE

Food system climate funding should increase

Public climate finance provided to food systems has quadrupled in the past 5 years, increasing from USD 1.7 billion per year by 2016 to USD 9.3 billion per year by 2020.[cviii] Whilst this is a positive trend, as we have shown earlier it remains a small amount versus the potentially damaging funding coming from subsidies.

Transforming funding for agricultural production so that it positively changes the way that the food system impacts planetary boundaries will not be easy. Government departments and associated civil society structures are often siloed, separating finance from environment and food production, and any changes will face strong resistance from those who will lose as a consequence.

Examples of specific actions could include linking public finance to regenerative agriculture practices, crop rotation, pesticide and synthetic fertilizer reduction.

Food system financing should focus on wider harms

The food system has a number of significant harms including, but not limited to climate change. Funding should be widened to consider the other planetary boundaries the food system impacts; biodiversity loss, land conversion and nitrogen and phosphorus loading. We are starting to see this happen, but progress needs to be accelerated. Governments could take advantage of favourable interest rates being offered by the markets for sustainability-linked bonds to raise funding to support a shift in public finances towards sustainable food production. This could be achieved either by linking the bond to the purpose for the funding or linking the bond coupon to related sustainability performance indicator[102].

[102] For example, a Deforestation-Linked Sovereign Bond

Public finance should leverage and utilize private finance

There are limits to the extent of public finance that can be provided to the food system, so private finance from the financial markets will also be required. We estimate that the current level of bank lending to food system companies in our database is c.USD 560 billion per annum. In addition, we estimate that the equity markets could provide around USD 70 billion per annum[103]. Combined, these two sources are equivalent to the USD 611 billion per annum of public finance. If additional public finance can be used to encourage additional private investment (financial markets and bank lending) the effect of public finance will be multiplied.

The Kunming-Montreal GBF includes a target to mobilise 'at least USD 200 billion per year from public and private sources for biodiversity-related funding' by 2030'.[cix] Not all of this funding will relate to the food system, but it is likely that a significant amount will, given the food system's current negative impact on biodiversity. In the context of the combined public and private funding flows we've identified (over USD 1.2 trillion), this would represent a significant increase.

Subsidies must be reformed

As noted earlier, 86% of the USD 611 billion of state support for the food system has potentially destructive impacts on climate, biodiversity, health, and food systems resilience.[cx] Clearly if this flow of funds continues to support harmful practices it will negate the positive impact of private financial flows.

The Kunming-Montreal GBF includes an ambitious 2030 target to 'phase out or reforming subsidies that harm biodiversity by at least USD 500 billion per year, while scaling up positive incentives for biodiversity conservation and sustainable use'.[cxi]

[103] The USD 5.5 trillion listed equity valuation referred to earlier in this report does not indicate how much equity finance is available on an annual basis, but equity finance raised in 2021 was USD 1 trillion (source SIFMA) and the consumer staples sector accounts for c. 7% of the global index so a broad indicator of the potential equity funding available annually would be 7% x USD 1 trillion = USD 70 billion. In practice, the appetite of equity investors to provide funding to particular areas of the economy is dependent on a variety of factors and can change rapidly.

APPENDIX 1
The global food system's harmful footprint

The global food system has a very heavy carbon footprint, a strongly negative impact on nature, and is failing to achieve what should be regarded as its core aim: to provide the growing population of the world in a just and equitable way with sufficient nutrition to ensure their health and wellbeing while remaining within planetary boundaries.

Planetary boundaries

The global food system is a key driver behind the breaching of a number of the Stockholm Resilience Centre's 'planetary boundaries', highlighting the extent to which a transformation of the food system is critical to the future health of humanity – see Figure 51.

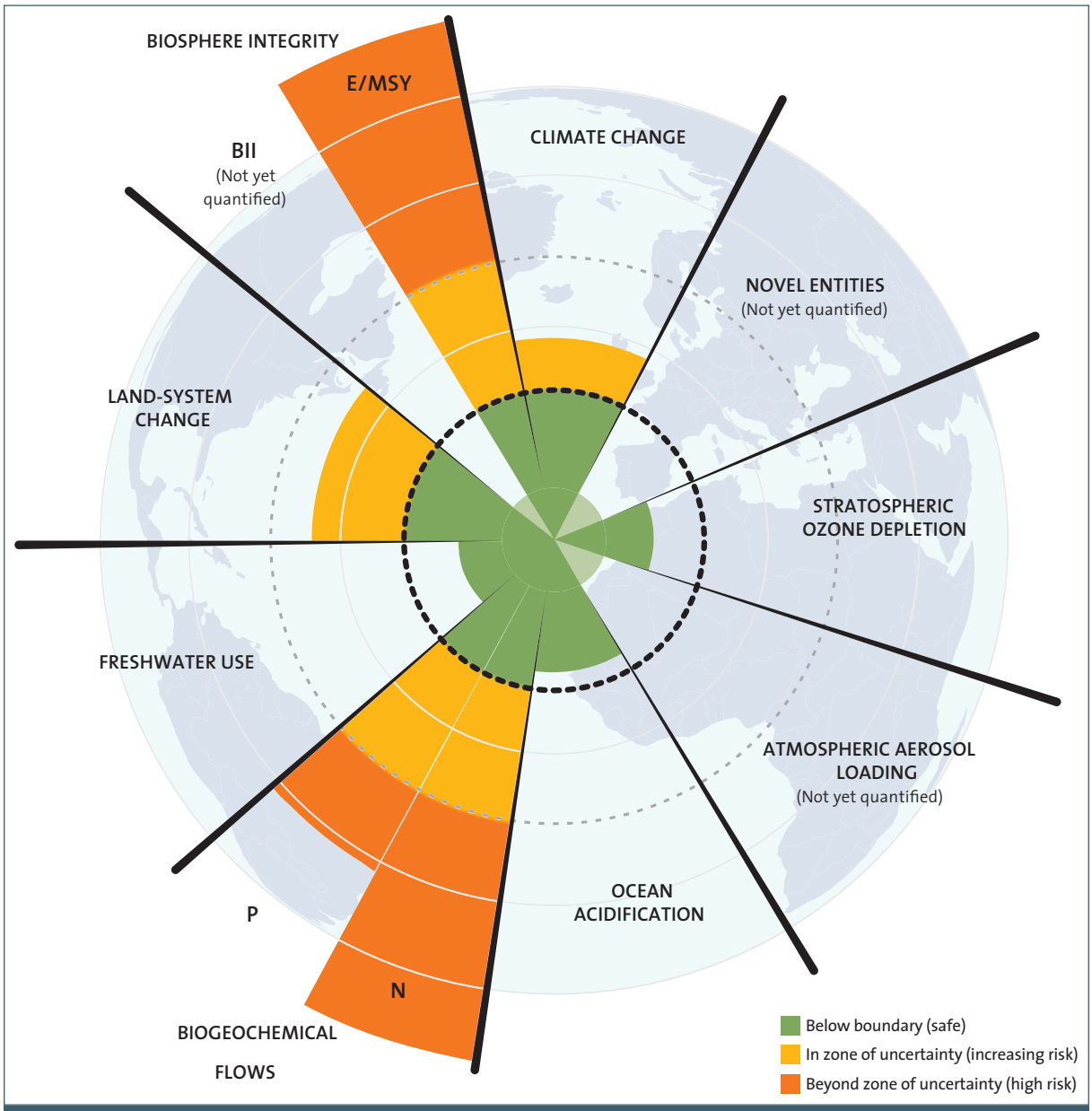
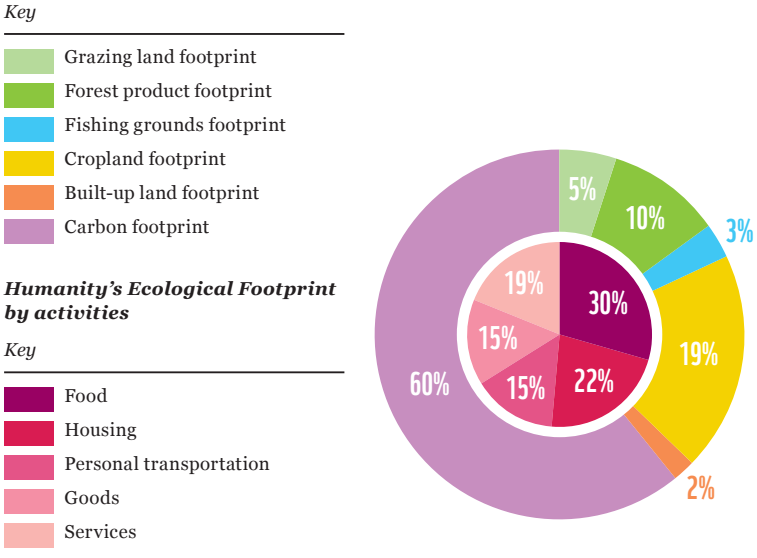


Figure 51: The nine planetary boundaries. Source: J. Lokrantz/Azote based on Steffen et al. 2015.[cxii]

As discussed in this report – see Environmental harms – Node analysis on page 35, the food system is at least partially responsible for the boundary breaches that have already occurred in relation to biosphere integrity, climate change, biochemical flows (nitrogen and phosphorus), and land system change. In addition, it could also be argued that the food system is having an impact on the other five boundaries as well:

- Stratospheric ozone depletion is potentially impacted by nitrous oxide arising from nitrogen fertilizer use.
- Ocean acidification is also potentially increased by nitrogen fertilizer run-off and by the CO_2 released by the food system.
- Atmospheric aerosol loading will be impacted by crop residue burning and fires set to clear land.
- Freshwater use is not yet regarded as having exceeded its planetary boundary but agriculture accounts for 70% of global usage, and there are plenty of examples where water resources are already under stress as a result of agricultural demands.
- Novel Entities includes the effect of plastic pollution and has not been quantified yet, but the food system is clearly one of the drivers behind much of the plastic pollution that is occurring.

Another way to illustrate the impact that the global food system is having is to consider humanity's 'Ecological Footprint' by land use. According to analysis by the WWF,[cxiv] the average footprint per person in 2020 amounted to 2.5 global hectares[104] whereas the biocapacity of the planet amounted to only 1.6 global hectares, with food-related land use (including aquaculture) accounting for 30% of this footprint – see Figure 52.



Humanity's Ecological Footprint by land use and by activities The Ecological Footprint measures how much demand human consumption places on the biosphere and compares it to what ecosystems can renew. In 2020, the world average Footprint amounts to 2.5 global hectares per person, compared to 1.6 global hectares of biocapacity. The Footprint can be broken down by area categories (outer circle) or, using Multi-Regional Input- Output Assessments, by activity fields (inner circle).

Figure 52: Humanity's ecological footprint by land use. Source: WWF Living Planet report 2022.

[104] A global hectare is a biologically productive hectare with world average biological productivity for a given year (as defined by the Global Footprint Network https://www.footprintnetwork.org/resources/glossary/).

From a finance sector perspective, climate change is currently a high priority given initiatives such as GFANZ[105], and the strong focus on the finance sector's role in ensuring an effective transition to a 'net zero' world with the aim of achieving the 1.5°C Paris target.

However the planetary boundaries framework in the context of the doughnut economic model is an important reminder that climate, nature, and health/society are integrated not separate and that there are important (and complex) feedback effects between them. Figure 53 provides a simplistic illustration of one such 'Climate-Planet-People' feedback loop.

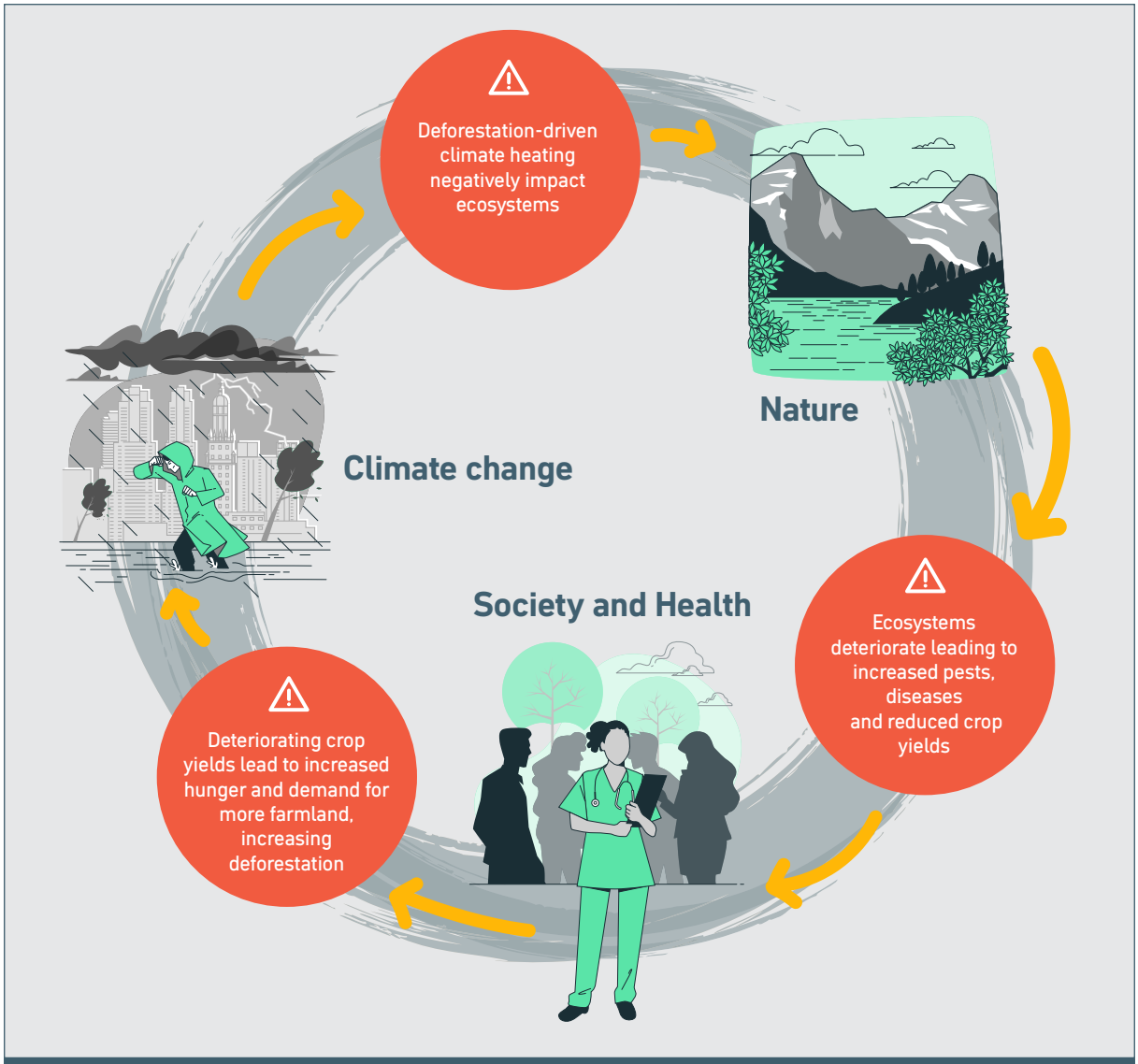


Figure 53: Illustration of climate/nature/society/health feedback loop. Source: Planet Tracker.

[105] The Glasgow Financial Alliance for Net Zero (GFANZ) is a global coalition of leading financial institutions committed to accelerating the decarbonization of the economy.

Climate change

The current food system is estimated to be responsible for a third of global anthropogenic GhG emissions.[cxv] Deforestation is responsible for a significant proportion of that total,[cxvi] with methane emissions from the livestock supply chain and from rice farming accounting for much of the reminder[cxvii] – see Figure 54.

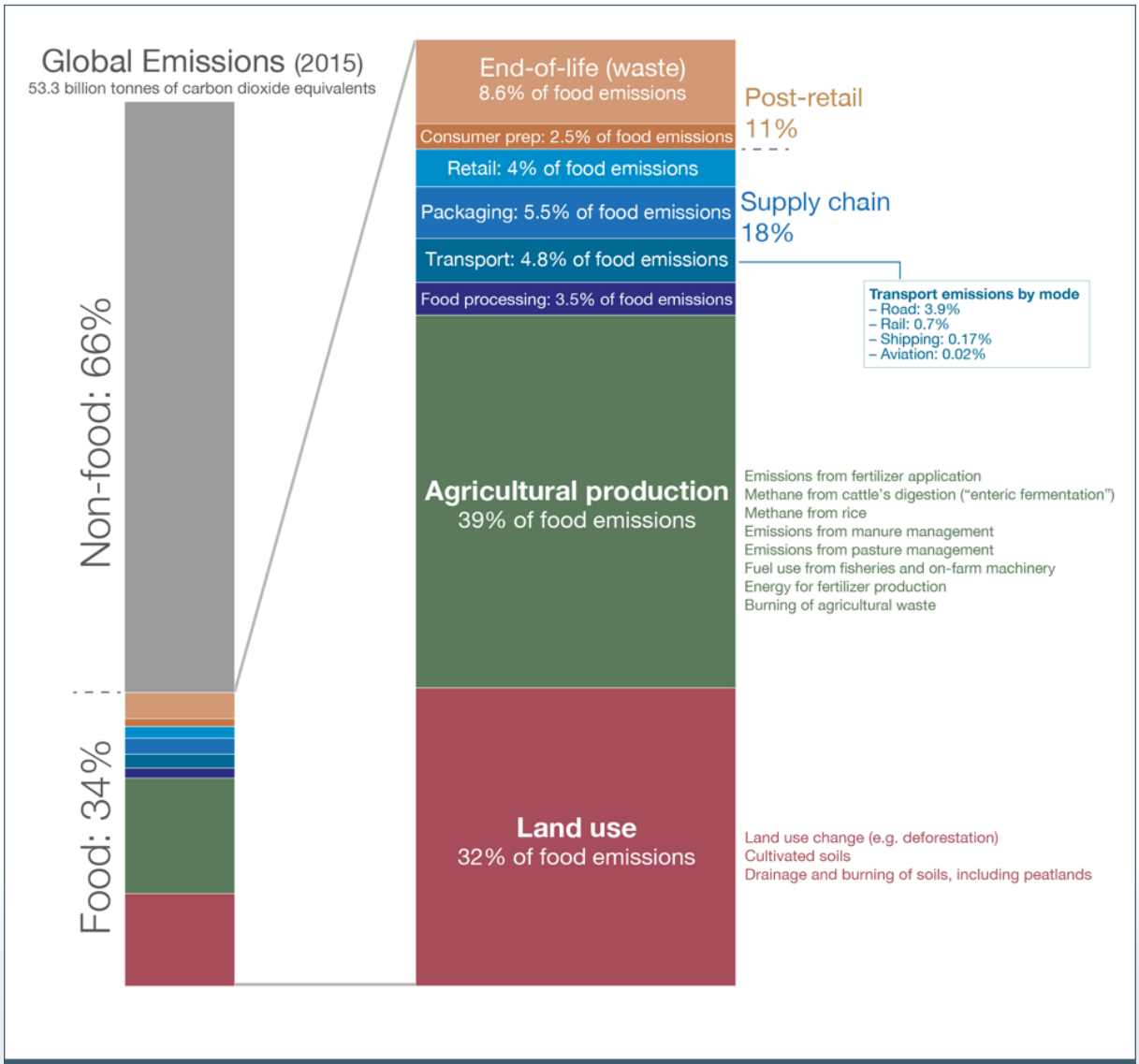


Figure 54: The GhG footprint of the global food system. Source: Our World in Data, Crippa et al. (2021)) Food systems are responsible for a third of global anthropogenic GhG emissions Nature Food.[cxviii]

Not only does the food system threaten our ability to limit climate heating but climate change in turn threatens the functioning of the food system itself.

Based on current projections, if temperatures are allowed to rise beyond the 1.5°C Paris target (and even well before 2°C) the resilience of the global food system will be threatened on multiple levels. Failing crops, worker health, population movements, loss of land to rising sea levels, desertification, soil degradation and warming water leading to declining fish stocks are all potential outcomes.

This is not just a future threat - the impact of climate change is already being felt. The IPCC's 2019 report on Food Security[106] notes with 'high confidence' that ***'Observed climate change is already affecting food security through increasing temperatures, changing precipitation patterns, and greater frequency of some extreme events'***.[cxix]

As a result, climate change also represents a threat to the companies operating in the global food system and the investors funding them[107].

[106] Chapter five of the IPCC's 2019 Special Report on Climate Change and Land.

[107] Planet Tracker's recent report Destroying Brazil's Aircon provides a case study on the economic and financial market implications of deforestation-driven climate change in Brazil (where the deforestation is driven by food system demand for soy and beef).

Nature

The global food system is responsible for a significant portion of the depletion of natural resources.

- Agriculture is listed as one of the threats for 86% of the species on the IUCN Red List (24,000 out of 28,000).[cxx]
- Current agricultural practices are leading to soil degradation (compaction, acidification, erosion, loss of moisture, etc). 33% of the Earth's soils are already degraded and over 90% could become degraded by 2050.[cxxi]
- The FAO estimates that soil erosion (a more extreme form of degradation) can lead to crop yields falling by up to 50%, as well as increasing other physical risks such as flooding (which can have severe economic consequences in terms of lost lives, crops and infrastructure), with a negative impact on the global food system.
- 90% of fish stocks are either overfished or already at the limit of what can be sustainably fished.[cxxii]

Figure 55 shows the extent to which a business-as-usual scenario in the global food system threatens species across the globe.

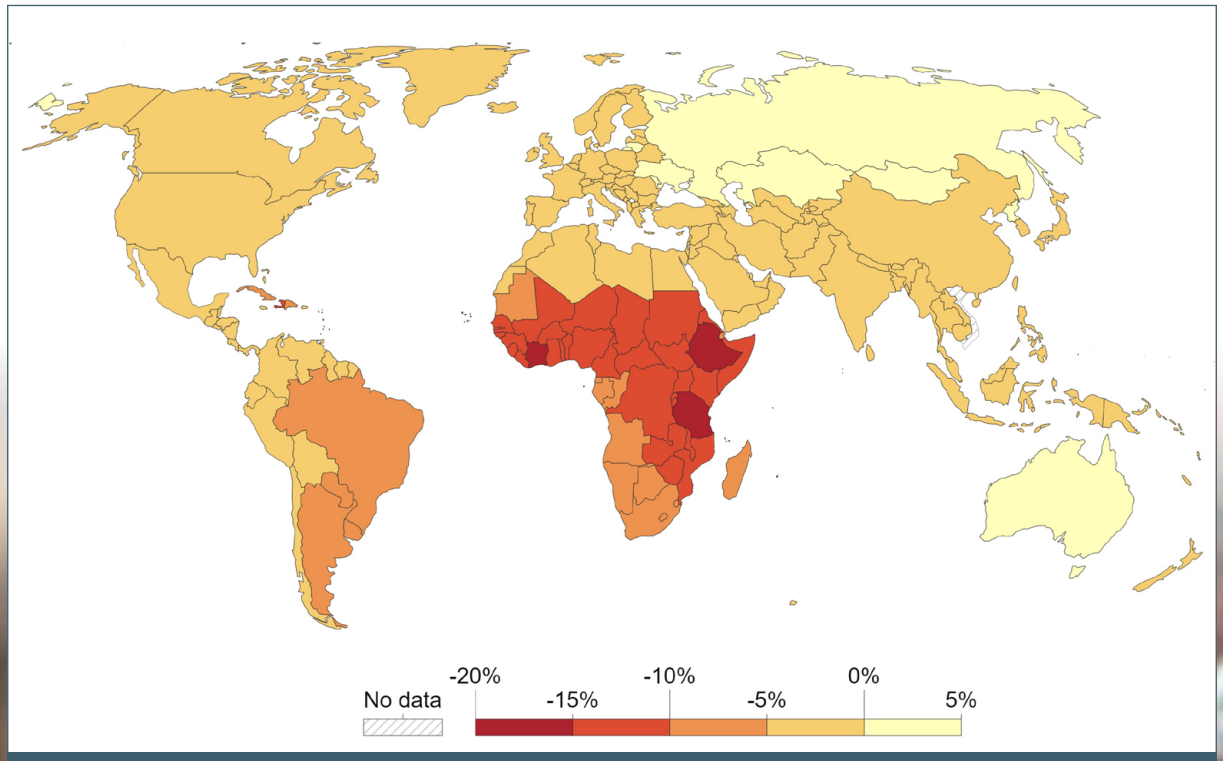


Figure 55: Projected habitat loss for all species by 2050 under a business-as-usual scenario. Source: OurWorldInData; Williams, D. R., et al, 2021, Proactive conservation to prevent habitat losses to agricultural expansion. Nature Sustainability, 4(4), 314-322.

Figure 56 shows the extent to which biodiversity[108] has declined over the last 50 years (both on land and in the sea) as measured by the Living Planet Index (LPI).[cxxiii] The LPI has declined by an average of 69% over that period.

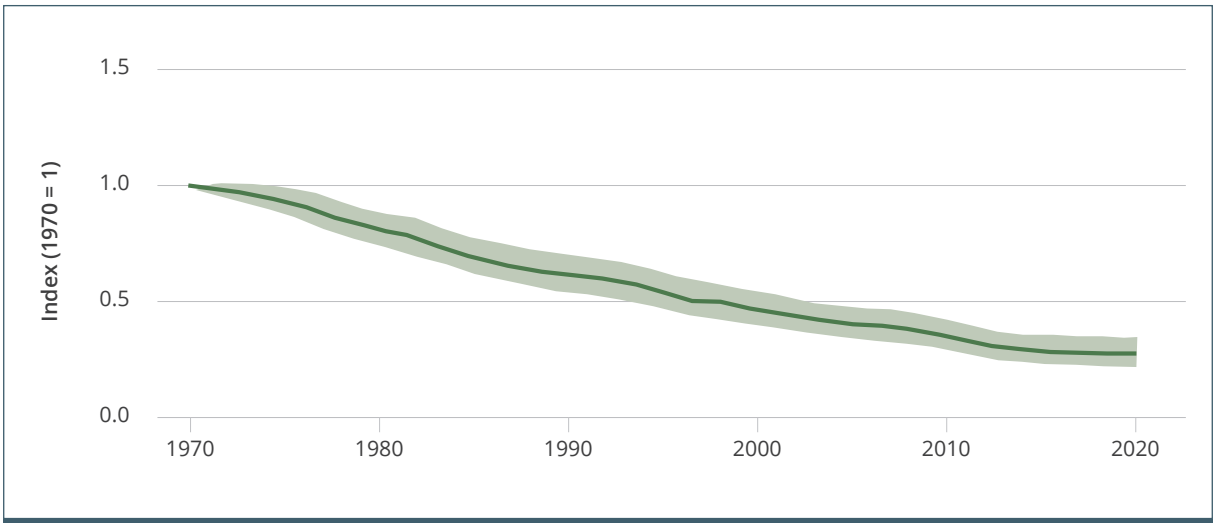


Figure 56: Biodiversity decline from 1970 to 2018. Source: Living Planet Index, WWF, 2022.

For some sectors of the economy it is possible to debate the extent to which they are directly dependent upon nature[109] but it is clear that nature is essential for food production and so it is doubly ironic that the food system is depleting the very resource upon which it depends to function.

In the same way that solving the climate crisis is essential to ensure we have a food system that can feed the world's growing population, so this is also true of nature. If the food system is allowed to continue to negatively impact nature by reducing biodiversity, then the resilience of the food system itself (and all the companies and investment portfolios dependent on it) will be threatened in the same way that an investor holding an undiversified investment portfolio is exposed to risks that could destroy that portfolio.

[108] Strictly speaking the LPI measures the abundance of 31,821 populations across 5,230 species of mammal, bird, fish, reptile and amphibian species from around the world worldwide.

[109] Sir David Attenborough eloquently contradicts this reductionist view in his forward to the Dasgupta review: 'We are totally dependent upon the natural world. It supplies us with every oxygen-laden breath we take' (The Economics of Biodiversity: The Dasgupta Review).

Society (social, health and nutrition, and efficiency and diet)

In addition to the food system's negative impacts on the world's climate and its natural resources, it is clear that the food system is having a negative effect on the very people it aims to feed.

These effects take a variety of forms, but in broad terms can be divided into three categories:

- Social (including employment-related issues and land rights);
- Health (including issues such as malnutrition as a result of inadequate provision and obesity caused by excessive consumption of calorie-dense, nutrient poor, foods); and
- Diet (i.e. the types of food we consume).

Social

The global food system is a significant source of jobs and income in many countries. Data from the World Bank shows that a majority of workers in 'low income' countries work in the agricultural sector (agriculture, hunting, forestry and fishing). This proportion drops as countries move up the development scale and their food systems become more complex but the overall proportion of jobs connected to the food system remains high – see Figure 57.

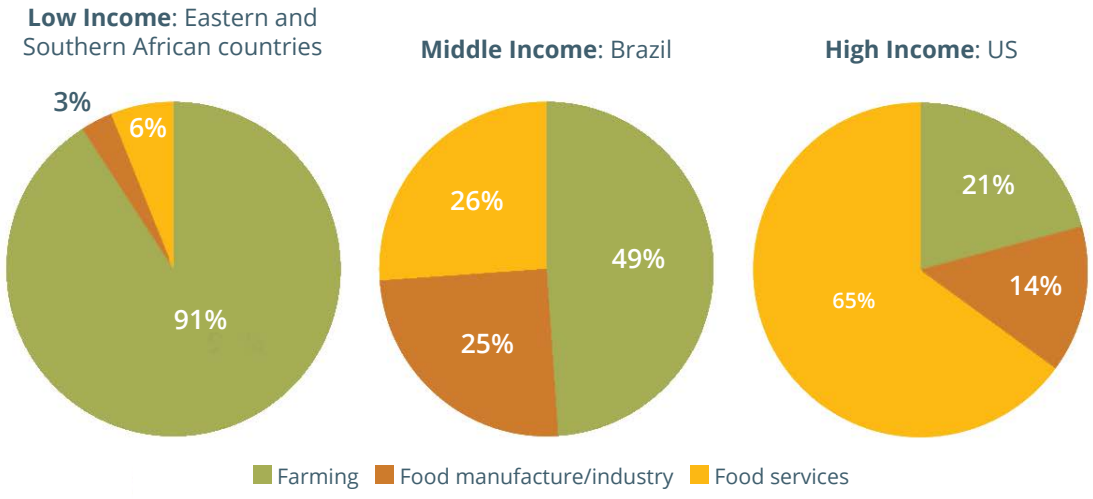


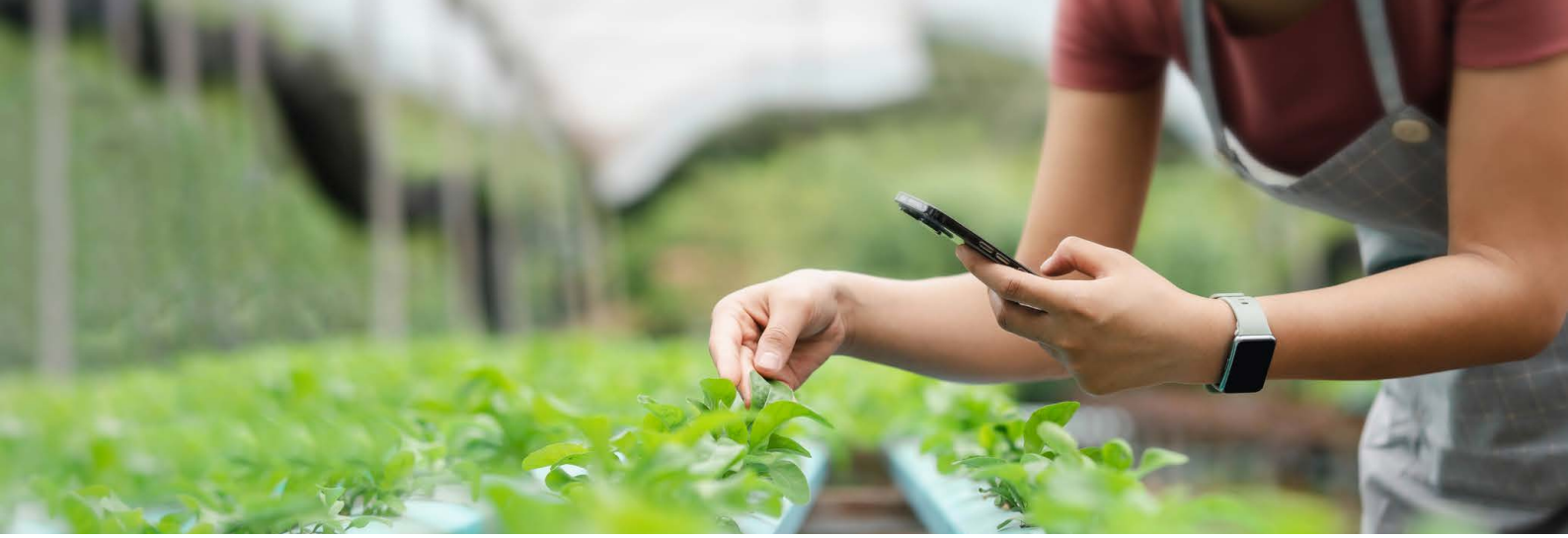
Figure 57: Distribution of jobs in the food systems of different countries[cxxiv]. Source: World Bank, 2017.

Quantifying the number of people who work in the global food system is challenging but in the EU, for example, Eurostat analysis showed that the food system supports 13 million enterprises and 29 million workers to produce, process, distribute, prepare and sell food and beverages in the region[110].

However, many of the jobs provided by the food system are low paid and insecure, and the concentration of power in the hands of a small number of very large companies means that the smaller employers and sole practitioners are at a significant disadvantage when it comes to bargaining for a share of the food system's rewards[111], and lack the resources to implement the changes required.

[110] 9 million workers would equate to c. 15% of the 129 million EU workforce in 2022.

[111] Planet Tracker has conducted an in-depth analysis of the financial structure of the global food system which is summarized later in this report



This power imbalance creates further social issues in countries where land rights are unclear, hard to enforce, or simply not recognised. This in turn means that food system actors are responsible (directly or indirectly) for significant harms to Indigenous Peoples in a number of countries.

The significance of the global food system as a source of income and employment for millions of people means that for any transformation to succeed it must be 'just' i.e. the transformation process must take into account the needs and rights of these individuals and ensure that they are better off as a result.

Health and nutrition

The global food system is currently failing to provide nutrition to the world's population in an equitable and sufficient way.

In the global north food system companies are providing such poor diets to their customers that:

- 20% of global deaths in 2017 were due to dietary risk factors arising from suboptimal diets.[cxxv]
- In 2019 analysis showed that eighteen of the largest food and drink companies were relying on product portfolios of which 85% were so unhealthy as to be considered unsuitable for marketing to children under World Health Organization (WHO) guidelines.[cxxvi]
- Obesity and associated medical conditions are rising rapidly. The latest WHO report on Europe showed that almost 60% of adults and nearly one in three children are obese or overweight, and that this is the fourth most common risk factor for non-communicable diseases in the region, after high blood pressure, dietary risks and tobacco.

However, overweight and obesity[112] are no longer just a 'rich country' problem. Many low- and middle-income countries are now facing what the WHO describes as a "double burden" of malnutrition – parts of their populations are suffering from a lack of nutrition while also experiencing a rapid upsurge in noncommunicable disease risk factors such as obesity and overweight, particularly in urban settings.[cxxvii]

Analysis by World Obesity shows that the greatest number of people living with obesity are in low- and middle-income countries (LMICs), with numbers more than doubling across all LMICs, and tripling in low income countries, compared to 2010.[cxxviii] The WHO attributes this to the prevalence of cheap food that is high-fat, high-sugar, high-salt, energy-dense, and micronutrient-poor.[cxxix]

[112] The WHO defines 'overweight and obesity' as abnormal or excessive fat accumulation that may impair health

Figure 58 shows the obesity trends for the world and various regions[113].

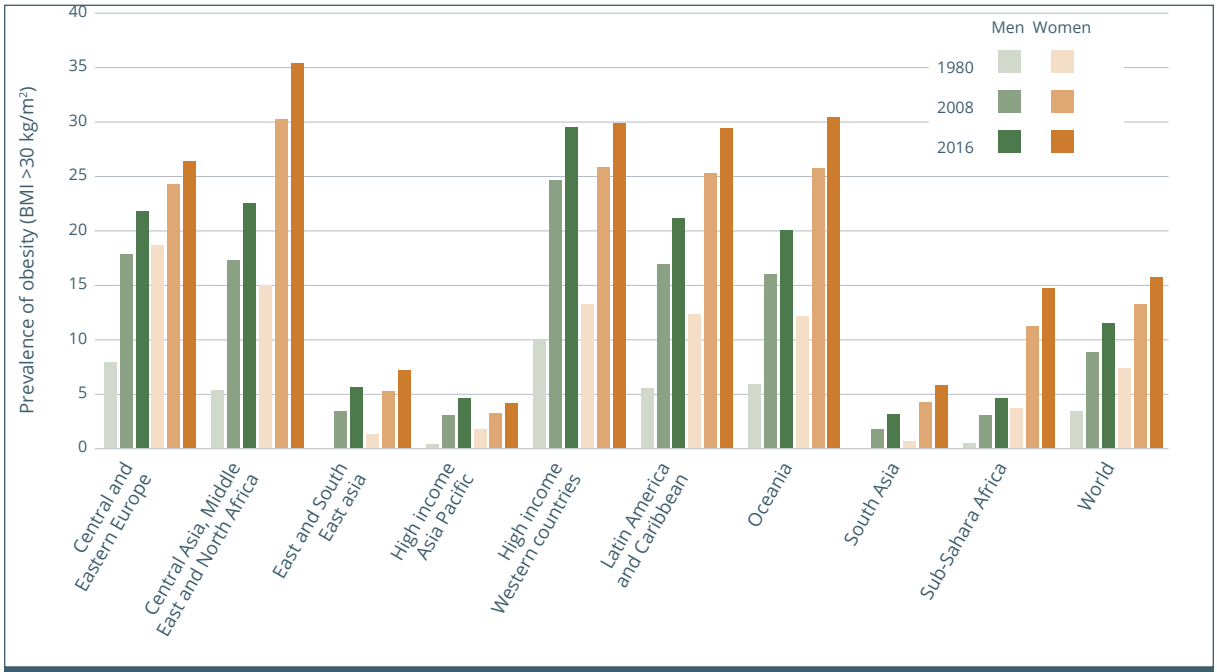


Figure 58: Global obesity trends from 1980 to 2016. Source: Malik, V.S., et al. 2020, Nearly a decade on – trends, risk factors and policy implications in global obesity.[cxxx]

Lack of nutrition is less of a problem in the global north[114] but in the global south 663m people (9% of the global population in 2017) were classified as 'undernourished' by the FAO,[cxxxi] and in 2020 at least 155m people (2%) in 55 countries were estimated to be 'acutely food insecure' (GRFC 2021).[cxxxii]

Efficiency and diet

Finally, the global food system is very inefficient in terms of the way that land is used to produce protein for human consumption, and the losses that occur across the supply chain.

- The FAO estimated a third of food was lost or wasted globally in its 2011 report.[cxxxiii] In 2016 the FAO estimate of food loss from harvest to distribution was 14%.[cxxxiv]
- FAO data show that 77% of the land that is used for agriculture is used for livestock (direct grazing and growing crops to feed livestock) but this only generates 18% of the global calorie supply and 37% of global protein supply.
- Crops for human consumption use 23% of the agricultural land but generate 82% of global calories and 63% of global protein supply. Only 1% of land is used for urban living – see Figure 59.[cxxxv]

[113] A person is defined as overweight if they have a body-mass index (BMI) equal to or greater than 25. BMI is a person's weight in kilograms divided by their height in metres squared.

[114] But that is not to say that lack of nutrition is not a problem in developed countries among poorer sections of the population

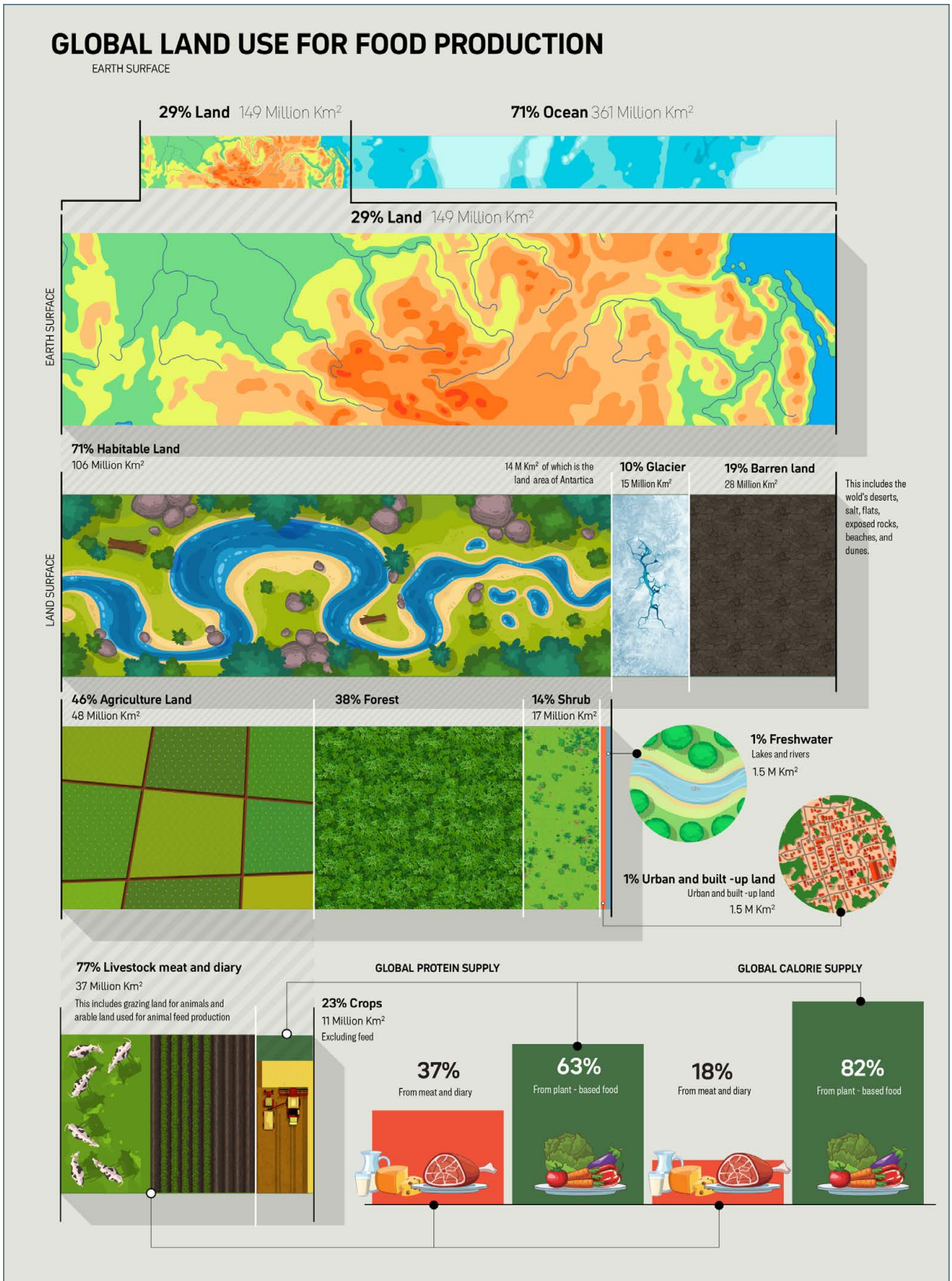


Figure 59: Global land use for food production. Source: Our World In Data using FAO data.[cxxxvi]

Unfortunately, the current trend is for meat consumption to increase, putting significant pressure on land resources given the inherent inefficiencies of converting crops into animal proteins for human consumption – see Figure 60.

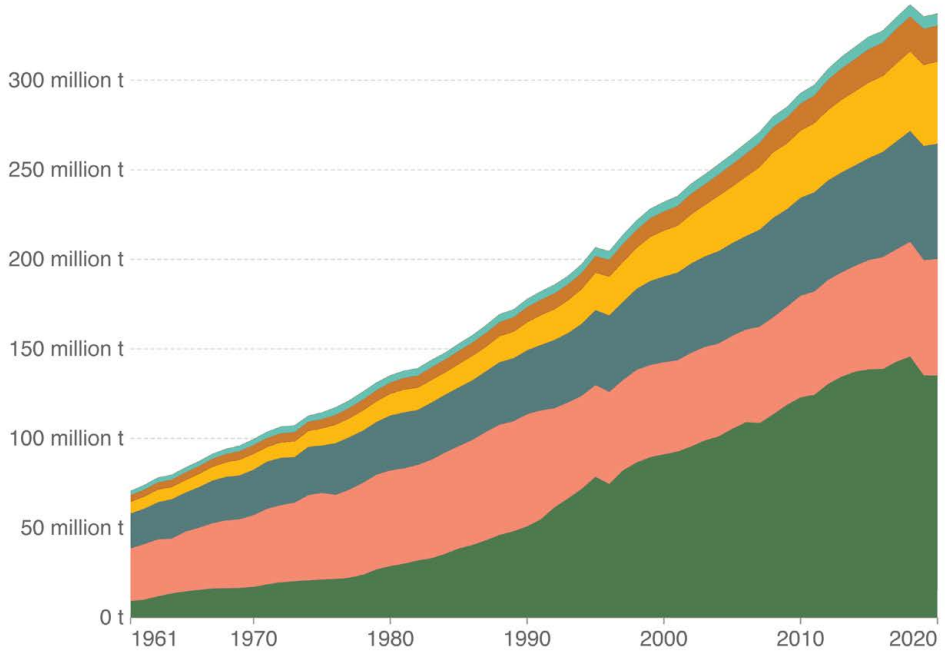


Figure 60: Global meat production, 1961 to 2020. Source: Our World In Data, FAO.[cxxxvii]

A similar pattern can be seen in relation to seafood. Global production of seafood has quadrupled over the past 50 years and the average person now eats almost twice as much seafood as half a century ago. To support this increased demand, aquaculture has increased dramatically adding to the demand for crops to feed the fish being farmed – see Figure 61.

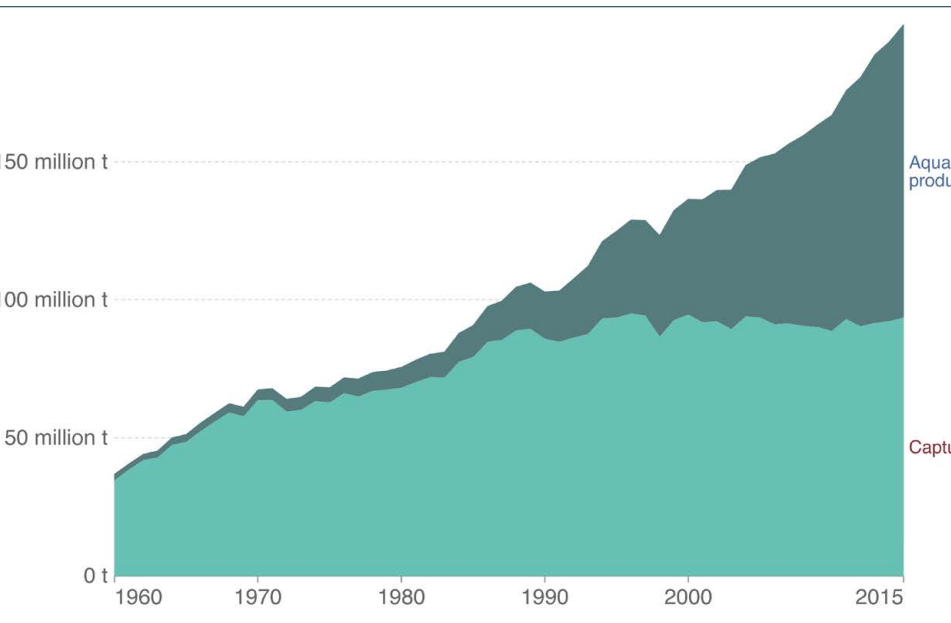


Figure 61: Global seafood production: wild fish catch vs aquaculture. Source: Our World In Data, FAO.

APPENDIX 2
The global food system's disastrous trajectory

The World Resources Institute (WRI) highlighted 'three gaps' in their 2019 report, 'Creating a sustainable food future'.[cxxxix] These 'gaps' are the estimated consequences of an untransformed food system expanding to meet the needs of a growing population, and highlight the extent to which transformation is urgently required.

The food gap – calorific output must increase by 55%

The food gap is the difference between the crop calories produced in 2010 and those that the world will likely require in 2050 based on projected demand.

The WRI estimate that the calories required by the estimated global population of 10 billion people in 2050 will be 55% greater than the requirement in 2010. The required increase in crop production (for food and animal feed including for aquaculture) would be similar (56%).

Failing to close this gap will result in a significant increase in the number of people who are undernourished or starving, and the burden will fall disproportionately on the poorest in the Global South.

The land gap – another USA will be required

The land gap is the difference between the projected area of land needed to produce all the land-based food the world will need in 2050 and the amount of land in existing agricultural use in 2010.

Using their own conservative estimates for the rate at which crop yields will improve in the future, the WRI report estimates that the global area of cropland and aquaculture ponds would expand by 332 Mha between 2010 and 2050. Pasture land for feeding livestock is estimated to increase by 523 Mha over the same period (and using similarly conservative assumptions for efficiency improvements). These two effects combined result in a total estimated expansion in the land used for food production of 846 Mha – an increase of nearly 20%, equivalent to an area nearly the size of the United States[115].

Combined with the requirements of a growing world population for housing and other non-food land requirements, it is clear that this level of land use change will consume forests and other ecosystems that are essential for climate mitigation and biodiversity preservation.

[115] Total agricultural land area: 4,200 Mha; total area of the USA: 918 Mha; total area of Brazil: 836 Mha

The GhG mitigation gap – cut forecast emissions by 76%

The GhG mitigation gap is the difference between agriculture-related GhG emissions projected in 2050 and an emissions target for agriculture and related land-use change in 2050 necessary to limit the global average temperature rise to below 2ºC.

The WRI report estimates that GhG emissions from food production and land use change would rise from 12 Gt CO_2e per annum in 2010 to 17.1 Gt CO_2e per annum in 2050 – a 43% increase. This would take GhG emissions from the food system far beyond those required to limit climate heating to +1.5ºC by 2050.

Estimating the GhG emissions that the food system should aim for by 2050 is challenging. The WRI report proposes an emissions target of 4 Gt CO_2e per annum in 2050, including a target of zero emissions from land use change (implying zero deforestation).

This would imply that the GhG gap estimated for 2050 is 13 Gt CO_2e per annum, equivalent to a reduction of 76% compared to the forecast 2050 emissions without action.

APPENDIX 3
Varied estimates for the food system's GhG footprint

Estimating the annual GhG emissions from the global food system is complicated and difficult. As a result estimates vary widely

The papers discussed here all used an estimate of current annual anthropogenic GhG emissions of **52 Gt CO_2e**. However, the IPCC's 2022 report ('Climate Change 2022 - Mitigation of Climate Change Summary for Policymakers')[cxl] estimates that 'Global net anthropogenic GhG emissions were **59** ± 6.6 Gt CO_2e in **2019**, about 12% (6.5 Gt CO_2e) higher than in 2010 and 54% (21 Gt CO_2e) higher than in 1990. The annual average during the decade 2010–2019 was **56** ± 6.0 Gt CO_2e, 9.1 Gt CO_2e per annum higher than in 2000–2009'.

The frequently quoted statistic that the food system accounts for one third of anthropogenic GhG emissions comes from the 2021 academic paper produced by Crippa et al (Crippa, M., Solazzo, E., Guizzardi, D. et al. Food systems are responsible for a third of global anthropogenic GhG emissions. Nat Food 2, 198–209 (2021). This paper estimates a total GhG footprint of **17.9 Gt CO_2e** (see Figure 54 on page 118).

An equally important paper by Poore and Nemecek, 'Reducing food's environmental impacts through producers and consumer' (2018, Science)[cxli] estimates the GhG footprint at 26% based on an estimated footprint of **13.6 Gt CO_2e**.

The 2019 WRI report ('Creating a sustainable food future') referred to in this paper when discussing the GhG emissions gap uses an estimate of **12 Gt CO_2e** per annum in 2010.

The Intergovernmental Panel on Climate Change (IPCC) Special Report on Climate Change and Land reports a range from **10.8 to 19.1 Gt CO_2e** emissions per year or 21-37% of anthropogenic GhG emissions based on a paper by Rosenzweig, C., et al. (2020), 'Climate change responses benefit from a global food system approach' published in published in Nature Food.[cxlii]

The differences in the estimates are mainly due to what the authors regard as the scope of the food system – for example, Crippa et al include post-retail emissions whereas Poore and Nemecek do not.

Our World In Data has a clear discussion of the differences between these two papers and the challenges of estimating a GhG footprint for the food system.

APPENDIX 4

Priority Actions – assessing the progress of the finance sector

The latest target date for achieving each of the Priority Actions is 2030 (to align with the SDG target date and other climate and nature goals).

The following KPIs and milestones will be relevant for assessing the progress of the financial sector in supporting these actions.

Table 5: KPIs and milestones. Source: Planet Tracker.

Priority Action	Finance sector – 2025 milestone	Finance sector – 2027 milestone	Finance sector – 2030 target	Reference framework
#1 Fully traceable supply chains	Questions regarding traceable supply chains are routinely included in due diligence questionnaires. At least 25% of funding deals include fully traceable supply chains as a pricing factor. Traceability is discussed in over half of company engagements.	Questions regarding traceable supply chains are included in all relevant due diligence questionnaires. At least 50% of funding deals include fully traceable supply chains as a pricing factor. Traceability is discussed in over 75% of company engagements. Traceability is recorded and assessed at a portfolio level.	Price of funding is impacted by the investee company's supply chain traceability. 90% of funded companies have fully traceable supply chains. The rest have a plan in place to achieve this by 2033.	Planet Tracker
#2 Halve food loss and waste	All FIs should have processes in place to gather Food Loss & Waste (FLW) data from funded companies. All FIs should have proactive engagement processes in place to address FLW in their funded companies (including supply chains) with targets for reducing FLW. At least 25% of FIs should include FLW in funding decisions.	At least 50% of FIs should include FLW in funding decisions. All FIs should report progress across their portfolios with respect to reducing FLW.	All FIs should include FLW in funding decisions. All FIs should report progress across their portfolios with respect to reducing FLW. All FI funding portfolios should be aligned with the 45% FLW reduction target.	UN SDG 12.3 - halve food waste and reduce food loss by 2030
#3 Stop deforestation	All financial institutions (FIs) should have a zero deforestation policy. At least 25% of FIs publicly report on their progress towards zero deforestation.	All financial institutions should have an active engagement programme with funded companies to eliminate deforestation by 2030. All FIs should be participating in collective engagement efforts relating to deforestation. At least 50% of FIs should be publicly reporting progress.	All FIs should have zero deforestation risk across their investment and lending portfolios supported by full public reporting. All FIs should have due diligence processes in place to ensure that no new funding is provided to companies with deforestation risk.	Forest 500

Table 5: ...continued from previous page				
Priority Action	Finance sector – 2025 milestone	Finance sector – 2027 milestone	Finance sector – 2030 target	Reference framework
#4 Cut methane emissions by 45%	Sovereign bond investors should have active monitoring and engagement processes in place to hold governments to their Global Methane Pledge.	Sovereign bond investors should join collective engagement initiatives to hold governments to their Global Methane Pledge. Sovereign bond investors should have plans in place to disinvest from countries that are not supporting the Global Methane Pledge.	Sovereign bond portfolios should be fully aligned with the Global Methane Pledge.	Global Methane Pledge Global Methane Assessment
	FIs should have monitoring and assessment processes in place to assess the methane risk in their portfolios. At least 25% of FIs should avoiding providing new funding to companies that have failed to commit to reducing methane emissions (including Scope 3) by at least 45% by 2030.	At least 50% of FIs should avoiding providing new funding to companies that have failed to commit to reducing methane emissions (including Scope 3) by at least 45% by 2030.	All FIs have processes in place to ensure no new funding is provided to companies that are not effectively reducing methane emissions FI portfolios exclude any companies that have not cut their methane emissions (including Scope 3) by 45%	Planet Tracker
#5 Make agricultural systems regenerative	All FIs should have assessed funded companies' approach to agriculture (including their supply chain policies). All FIs should have portfolio evaluation processes in place to assess the extent to which their capital supports regenerative agriculture. 25% of FIs should have processes in place to include regenerative agriculture as a component in funding decisions (of food producers and their customers).	50% of FIs should have processes in place to include regenerative agriculture as a component in funding decisions (of food producers and their customers). 50% of FIs should have processes in place to shift capital from extractive to regenerative agricultural practices.	All FIs should have processes in place to include regenerative agriculture as a component in funding decisions (of food producers and their customers). All FIs should have portfolios that are completely aligned with supporting regenerative agricultural practices.	FAO SDG Target 2.3.2 - https://www.fao.org/sustainable-development-goals/indicators/232/en
#6 Invest in alternative proteins	All FIs should have assessed funded companies' approach to alternative proteins (including their supply chain policies). All FIs should have portfolio evaluation processes in place to assess the extent to which their capital supports the development of alternative proteins. 25% of FIs should have processes in place to include alternative proteins as a component in funding decisions where relevant.	50% of FIs should have processes in place to include alternative proteins as a component in funding decisions where relevant. 50% of FIs should have processes in place to shift capital from industrial meat and dairy companies to those supporting the development of alternative protein sources.	All FIs should have processes in place to include alternative proteins as a component in funding decisions where relevant. All FIs should have eliminated industrial meat and dairy companies from their portfolios.	Planet Tracker

APPENDIX 5
Planet Tracker's food system database

This appendix briefly summarises the structure of the Planet Tracker food system database, the limitations caused by poor company disclosures, and the gaps we have identified between company reported GhG and waste data and the estimates published for the food system as a whole.

Database summary

The Planet Tracker food system database captures financial information for c.400,000 food system companies generating over USD 10 trillion of revenues. 99% of the companies included are private and they are headquartered in around 160 countries.

The universe of companies from which the database is drawn is defined using NAICS codes to identify companies connected to the food system.

The database captures financial environmental and funding data relating to each company where that information has been reported by the companies concerned or can be drawn from other publicly available sources.

Database limitations

The Planet Tracker food system database relies on company reported information. This gives rise to a number of limitations which are also faced by financial institutions when undertaking financial analysis.

Scope – our food system financial data source only captures information reported by companies - private companies are usually exempt from publishing their financial data or are only required to provide a very limited data set - as a result, beyond revenues, only c.20,000 of the companies provided EBITDA data and the proportion was often lower for the other financial metrics.

Skew – the limitations to company reporting mean our database is skewed towards larger companies and has a larger number of downstream companies headquartered in more economically developed countries.

Quality – we have revenue data from over 400,000 companies across more than one database which means we are reliant on the data providers to ensure its accuracy (where we have been able to identify errors we have corrected them).

Allocation – in order to best align metrics with business activities we have evenly allocated financials by the NAICS code(s) associated with the business. For example, a company with 3 NAICS codes in Node A, 1 in Node D and 2 in Node F will have its revenue etc allocated 3/6 : 1/6 : 2/6 to Nodes A, D, and F respectively. This method will approximate the actual distribution of economic activities, but companies do not disclose sufficient detail to enable a more accurate approach. The aggregation process across 400,000 companies smooths out the rough edges inherent in this approach to provide clear results on a Node basis.

Geographic data is poor – companies report very limited data on where their revenue and profit is earned and almost no data on the location of their production facilities or suppliers. When this information is provided, the reporting is not consistent between companies making the data misleading to analyse geographically (we have not attempted to do such analysis with this version of the database)

Dynamic – the version of the database used for this report was taken at the end of September 2022. We are continuing to refine the analysis and the dataset so our findings may shift in the future as a result of these refinements. We intend to provide updates and more in-depth analysis as our Roadmap project develops over the coming years.

GhG emissions reporting gaps

Crippa et al, 2021, estimates that 34% (18 Gt) of total annual GhG emissions comes from the food system.[cxliii] Our factor model estimate of global food system emissions based on company reported figures is c.1.6 Gt of CO_2e each year - 11x smaller than Crippa et al.'s estimate.

There are a number of reasons for this difference, summarised in Figure 62 and discussed below.

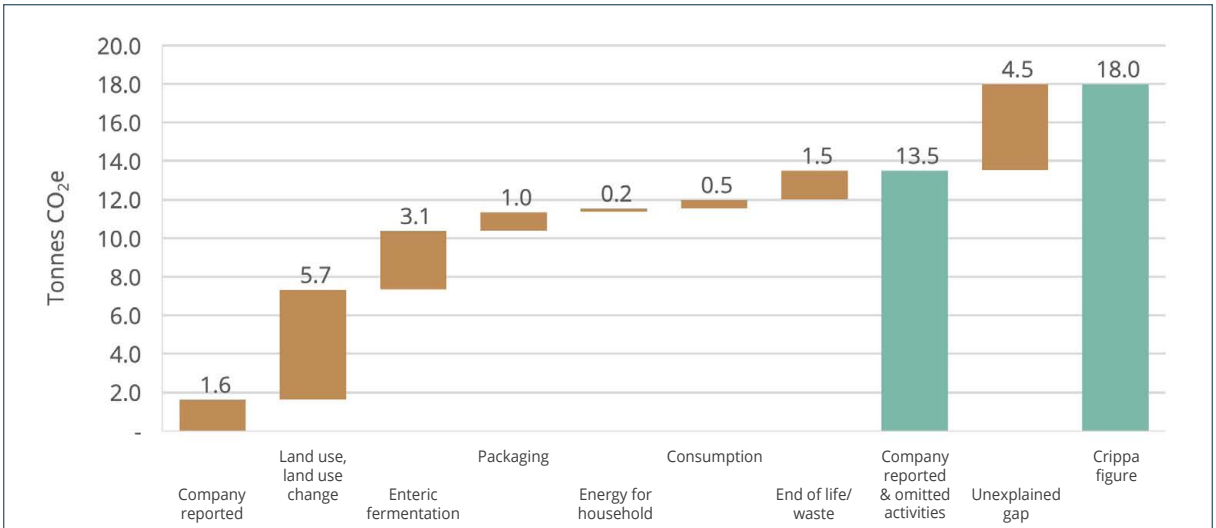


Figure 62: Company disclosed based factor model estimate of total food emissions vs Crippa et al. 2021. Source: Planet Tracker and Crippa et a.l, 2021; Planet Tracker analysis.

- **Land-use change (including deforestation) is not captured by Scope 1 and 2**. To avoid double counting we exclude Scope 3 emissions from our model. This is likely to explain a significant part of the gap between the aggregate GhG footprint captured from company disclosures in our database and the estimate produced by Crippa et al.).
- **Enteric methane emissions** should be included within the Scope 1 and 2 emissions of the companies responsible but our analysis of 15 of the largest meat and dairy companies suggests their methane footprint could be between 54x and 19,000x higher than reported. Given that these are among the largest (and best equipped) companies it is reasonable to assume that other smaller companies are also under-reporting their methane emissions. We believe it explains 3.7 Gt CO_2e of the gap between our dataset and Crippa et al.'s estimate.

- **Companies do not disclose emissions relating to packaging**. The Crippa et al. estimate includes the emissions relating to packaging. Companies do not disclose this, but since we exclude Scope 3 from our analysis this would not be captured. This accounts for 1 Gt CO_2e of the gap between our dataset and the Crippa estimate.
- **Differences in the scope of Crippa et al. vs Planet Tracker's dataset**. Our dataset only captures data reported by companies and so does not include the Scope 3 emissions relating to household energy use when preparing food, energy relating to food consumption and emissions caused by food waste, accounting for a further 2.2 Gt CO_2e of the gap.

Taking account of these differences between our approach and that used by Crippa et al., it can be seen that the unexplained gap between our dataset and the estimate produced by Crippa et al. is 4.5 Gt CO_2e. There are a number of possible explanations for this gap (but the lack of reported data prevents us from verifying any of these):

- **Our analysis excludes Scope 3 emissions** to avoid double-counting along the supply chain[116], but this means our focus is primarily on direct and indirect energy use (and the GhGs it creates). Our decision to exclude Scope 3 emissions avoids double-counting within our database but does mean that the emissions generated by the many small producers supplying larger companies in Nodes B, C, and D are not captured. Neither are the emissions associated with the suppliers to the input providers in Node A (such as steel, and petrochemicals) which could be material.
- **Our model extrapolates data from 3,500 larger companies** – if larger companies are more efficient than the smaller companies in our database then our estimate will understate the GhG emissions for the smaller companies in our database (the vast majority) and thus for the system as a whole.
- **Our database excludes millions of small businesses, including smallholders**[117]. It is possible that the aggregate GhG footprint of the millions of smaller farms and other food-related businesses that lie outside our database is more material than our analysis suggests (i.e. their emissions intensity is much higher than is the case among the companies in our database).
- **Companies may be under-reporting emissions** – companies are not incentivised to report high emissions and GhG reporting is, in general, not audited. Estimating this potential gap is difficult but it could be material as indicated by our detailed methane analysis referenced earlier[118].

[116] Scope 3 emissions are those from suppliers and customers above and below a particular company so, for example, a company's own emissions (Scope 1 and 2) will count as Scope 3 emissions for its customers. Because our database captures both suppliers and customers including Scope 3 would risk double-counting emissions.

[117] Lowder et al. (2021) estimates there are 510 million smallholders worldwide (source: Which farms feed the world and has farmland become more concentrated?, https://doi.org/10.1016/j.worlddev.2021.105455). We estimate there could be another 200 million non-farm food businesses - refer to the Planet Tracker blog: How much is your food worth?

[118] Planet Tracker is not alone in estimating that companies are under-reporting methane and thus potentially other GhGs - the IATP estimated JBS's methane footprint was 62x higher than reported (https://www.iatp.org/media-brief-jbs-increases-emissions-51-percent).

Waste reporting gaps

Our estimate based on company reported data is that food loss amounts to 233 Mt (at most) – equivalent to a quarter of the total estimated food loss in the system. Given that we estimate our database captures 53% of the food system's overall revenues we might expect the reported figure to be lower than the overall estimate for the system, but there would still appear to be a material reporting gap.

Similarly, at the food retail and food service stage, our estimate based on company reported data is 37 Mt compared to the 931 Mt of food waste that UNEP estimates arises at that stage[119]. Even if one adjusted the figures to account for all the companies outside our database that would still suggest that companies are reporting less than a tenth of what might be expected.

However, there could be other reasons for at least part of the gaps identified. There are potentially differences in efficiencies between the larger companies in our database and the millions of small companies outside it There might also be different scope definitions between the systems-wide analyses and our analysis which we have not been able to identify.

[119] Total food waste is estimated as 931 Mt, with 26% coming from food service and 13% from food retail (source: UNEP Food Waste Index report, 2021).

APPENDIX 6
further reading

There is a confusingly wide range of reports and academic papers that discuss aspects of the required transformation of the food system. However the following reports are particularly useful as detailed and comprehensive reviews of the issues and potential solutions.

Accelerating the 10 Critical Transitions: Positive Tipping Points for Food and Land Use Systems Transformation (Food and Land Use Coalition, 2021)

Creating a Sustainable Food Future (World Resources Institute, 2019)

Climate Change 2022: Mitigation of Climate Change (IPCC, 2022)

Actions to Transform Food Systems Under Climate Change (CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), 2020)

Global food policy report: Climate change and food systems (International Food Policy Research Institute, 2022)

State of Climate Action (World Resources Institute, UN High-Level Climate Champions, Climate Action Tracker, ClimateWorks Foundation, Bezos Earth Fund, 2021)

Solving the great food puzzle (WWF, 2022)

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ABOUT PLANET TRACKER

Planet Tracker is a non-profit financial think tank producing analytics and reports to align capital markets with planetary boundaries. Our mission is to create significant and irreversible transformation of global financial activities by 2030. By informing, enabling and mobilising the transformative power of capital markets we aim to deliver a financial system that is fully aligned with a net-zero, nature-positive economy. Planet Tracker proactively engages with financial institutions to drive change in their investment strategies. We ensure they know exactly what risk is built into their investments and identify opportunities from funding the systems transformations we advocate.

FOOD AND LAND USE PROGRAMME

Programme goal: to align capital markets with a sustainable global food system. Before 2050, Planet Tracker's Food and Land Use Programme will highlight the investment risks and opportunities associated with the just and equitable transformation of the global food system that eliminates negative externalities with respect to climate, nature, and health so that it is fit to feed the world's growing population within planetary boundaries. By highlighting these risks and opportunities, Planet Tracker's Food and Land Use programme will influence financial markets actors to actively support and fund this transformation.

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For further information please contact:
Nicole Kozlowski, Head of Engagement, Planet Tracker
nicole@planet-tracker.org

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