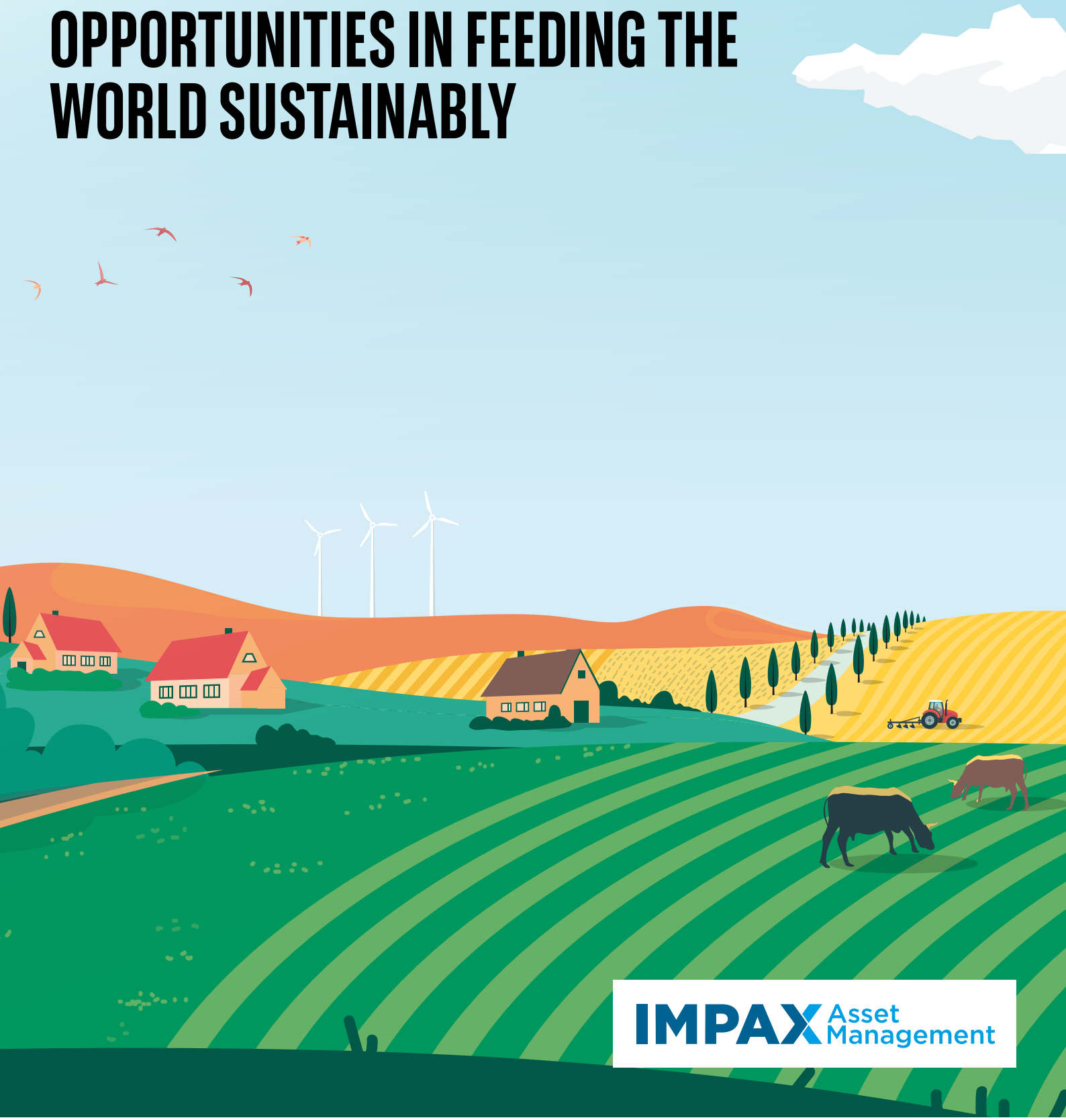
For professional investors - Marketing communication - May 2024

INVESTING IN FOOD AND AGRICULTURE: **OPPORTUNITIES IN FEEDING THE WORLD SUSTAINABLY**



IMPAX Asset Management

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The sustainable investor for a changing world

This paper has been written by Impax Asset Management. Founded in 1998, Impax Asset Management pioneered investment in the transition to a more sustainable global economy and today is one of the largest investment managers dedicated to this area.

Impax Asset Management is a delegated manager of BNP Paribas Asset Management.

About us

BNP Paribas Asset Management (BNPP AM) is BNP Paribas Group's dedicated asset management business that employs more than 3 000 people in more than 30 countries, including a large commercial presence in Europe and the Asia-Pacific region.

BNPP AM manages EUR 524 billion* of assets serving individual, corporate and institutional clients in more than 60 countries. We offer investment solutions for individual investors (through internal distributors within BNP Paribas Group and external distributors), and corporate and institutional investors including insurance companies, pension funds and official institutions. We offer portfolio investment expertise in line with clients' long-term sustainable performance expectations, including active, conviction-based strategies, multiassets and systematic & quantitative investments, liquidity solutions, emerging markets and private assets.

Our purpose

Our purpose is to achieve long-term sustainable returns for our clients, by placing sustainability at the heart of our strategy and investment philosophy.
Understanding and supporting the transition to a sustainable economy is a core objective. It guides our strategy, our culture, our structure, our products, our processes, the way we engage with our clients and with the companies and the markets we invest in.

* BNP Paribas Asset Management, as of 30 September 2023. Joint Ventures included.

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1. FOREWORD

The food and agriculture sector is central to some of the most pressing challenges facing global society. It is both a major contributor to them and, at the same time, a solution.

Throughout the 20th century, a period of unprecedented population growth, governments and farmers were primarily focused on maximising production. The mechanisation of agriculture and the embrace of fertilisers and pesticides yielded vast gains in productivity: global food supply has risen by three-and-a-half times over the past six decades.[1]

Although growing appetites have largely been sated, albeit unequally and with enormous waste, the environmental costs have been high. Resource-intensive agricultural practices contribute around one-quarter of global greenhouse gas (GHG) emissions and undermine the natural capital – including soil quality and biodiversity – that food production ultimately depends on.[2]

Meanwhile, the overconsumption of certain processed food products has contributed to chronic health issues that undermine progress in life expectancy and reduce quality of life.

The structural forces behind the industry's rapid growth – chiefly an expanding global population, rising living standards and technological innovation – remain intact. However, consumers and policymakers are now encouraging the long-term shift towards more sustainable food products and agricultural practices.

This creates a favourable environment for companies whose products and services can help transform the global food system by enabling better provision of nutritious, healthy and safe food, and reducing the environmental impact of activities across the food and agriculture value chain.

The solutions range from natural feed additives that improve animal health and productivity to precision agriculture technologies that can improve the efficiency and reduce the environmental impact of farming. Sustainable packaging solutions are making food distribution more circular and less resource intensive, and there is vast scope to reduce costly food waste.

Impax has considerable expertise and experience in this sector, having been investing in food-related industries for over 20 years and running an investment strategy dedicated to the theme since 2012. Impax's team of sector specialists have an in-depth understanding of companies in the global agrifood industry and the technologies that set them apart. They also follow policy and regulatory developments around the world and apply this knowledge to their stock selection.

In this paper, we discuss the structural dynamics and trends that are shaping priorities and opportunities in the transition to a more sustainable global food system, supported by evolving consumer tastes and regulation. We then outline how we conceptualise the opportunity set for investors across the food value chain, including examples of innovative companies that we believe are well aligned to long-term trends and that can address some of the pressing environmental and health challenges facing global society.

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1 Impax calculation based on population and food supply data from Our World in Data, 2023.
2 Poore, J., & Nemecek, T., 2018. Reducing food's environmental impacts through producers and consumers. *Science*.

2. THE CASE FOR INVESTING IN FOOD

Overcoming environmental challenges and meeting rising demand for nutritious food will take vast investment across the agricultural industry value chain. It is our conviction that this provides favourable tailwinds for companies operating in the sector, from food producers that embrace more sustainable practices to suppliers of innovative technologies to the industry.

Here, we outline the interrelated structural trends that support long-term investment in a more sustainable global food and agricultural industry.

1. GROWING POPULATION, EVOLVING DIETS

The global population is predicted to rise to almost 10bn people by 2050, meaning there will be about 2bn more mouths to feed than today – and 3bn more than in 2010.[3]

According to the World Resources Institute, there is a 56% 'food gap' to bridge between the amount of crop calories produced in 2010 and anticipated demand in 2050.[4] Under this 'business as usual' scenario, an additional 593mn hectares of land will need to be farmed by 2050 – an amount nearly twice the size of India.

Rising demand and pressure on the land is at odds with growing recognition that the global food industry is already at the heart of a sustainability crisis. Agriculture consumes around 70% of global freshwater, is a major emitter of GHGs and is one of the chief contributors to deforestation.[5]

56%

Projected increase in food demand (by calories), 2010 to 2050

As incomes rise, demand for resource-intensive, animal-based foods that are often a driver of these impacts has historically increased. Global per capita animal protein consumption nearly doubled between 1961 and 2021.[6] Yet, per calorie produced, beef involves roughly 10 times more land and GHG emissions than poultry or farmed fish. Growing plant proteins like beans, peas and lentils is even less resource intensive.[7]

More productive agricultural practices, alongside less resource-intensive proteins, have a key role to play in feeding the world sustainably.

3 UN Department of Economic and Social Affairs, 2017: World population projected to reach 9.8 billion in 2050, and 11.2 billion in 2100
4 World Resources Institute, 2018: How to Sustainably Feed 10 Billion People by 2050, in 21 Charts
5 OECD, 2023: Water and agriculture
6 Our World In Data, 2023: Food Supply
7 World Resources Institute, 2018: How to Sustainably Feed 10 Billion People by 2050, in 21 Charts

2. ACCESS TO HEALTHY FOOD, DECLINING NUTRITION

Around 2.4bn people lacked consistent access to nutritious, safe, and sufficient food in 2022, according to UNICEF.[8] Conflict, extreme weather exacerbated by climate change and elevated fertiliser prices have combined to undermine access to food, especially in less developed economies.

Meanwhile, obesity is a growing problem in both higher- and lower-income economies. Many urban areas have been identified as 'food deserts' that lack easy access to affordable fruit and vegetables due to a combination of poor transport links and few supermarkets. A University of Cambridge study found a correlation between obesity rates and distance from a supermarket among those with low incomes.[9]

The combination of obesity, under-nutrition and micronutrient deficiencies cost an estimated 5% of global income, according to the Food and Agriculture Organization (FAO).[10] The promotion of healthier processed foods, alongside fruit and vegetables, is essential to diets becoming more sustainable.

Obesity rates in adults

	Brazil	China	Europe	US
1975	4.5%	0.4%	10.3%	11.7%
1980	5.7%	0.6%	11.6%	13.5%
1985	7.2%	0.8%	13.1%	15.8%
1990	9.1%	1.1%	14.7%	18.7%
1995	11.2%	1.6%	16.4%	22.3%
2000	13.5%	2.3%	18.2%	26.1%
2005	16.0%	3.2%	20.1%	29.9%
2010	18.8%	4.5%	22.3%	33.4%
2016	22.3%	6.6%	25.3%	37.3%
2022	25.1%	8.9%	n/a	41.6%

Source: World Health Organisation / Global Health Observatory, 2022, World Obesity, 2022: Global Obesity Observatory

3. CLIMATE CHANGE

The agriculture sector is especially vulnerable to the impacts of climate change. As global temperatures rise, it becomes more challenging to produce food in some regions using traditional methods owing to changes in rainfall patterns, more frequent and more extreme weather events, and other environmental disruptions.

Crop yields can be decimated by local heatwaves, droughts, wildfires, floods and water scarcity – all of which are made more likely by climate change. Although rising temperatures are allowing certain crops to be grown in new geographies, they are also contributing to higher levels of crop disease and invasive insects like locusts.[11]

8 Unicef, 2023: The State of Food Security and Nutrition 2023
9 Burgoine, T., et al., 2017: Interplay of Socioeconomic Status and Supermarket Distance Is Associated with Excess Obesity Risk: A UK Cross-Sectional Study. *International Journal of Environmental Research and Public Health.*
10 Food and Agriculture Organization of the United Nations, 2013: State of Food and Agriculture 2013: Food systems for better nutrition.
11 Schneider, L., et al, 2022: The effect of climate change on invasive crop pests across biomes. *Current Opinion in Insect Science*

As well as being impacted by climate change, the agriculture sector is one of the largest contributors to its drivers, and its emissions must be significantly reduced to limit global temperature rises. Food production is responsible for around a quarter of global GHG emissions.[12] Of this, more than half (53%) of the sector's emissions relate to animal farming, including growing crops for animal feed and the conversion of land – one of the main drivers of deforestation.[13]

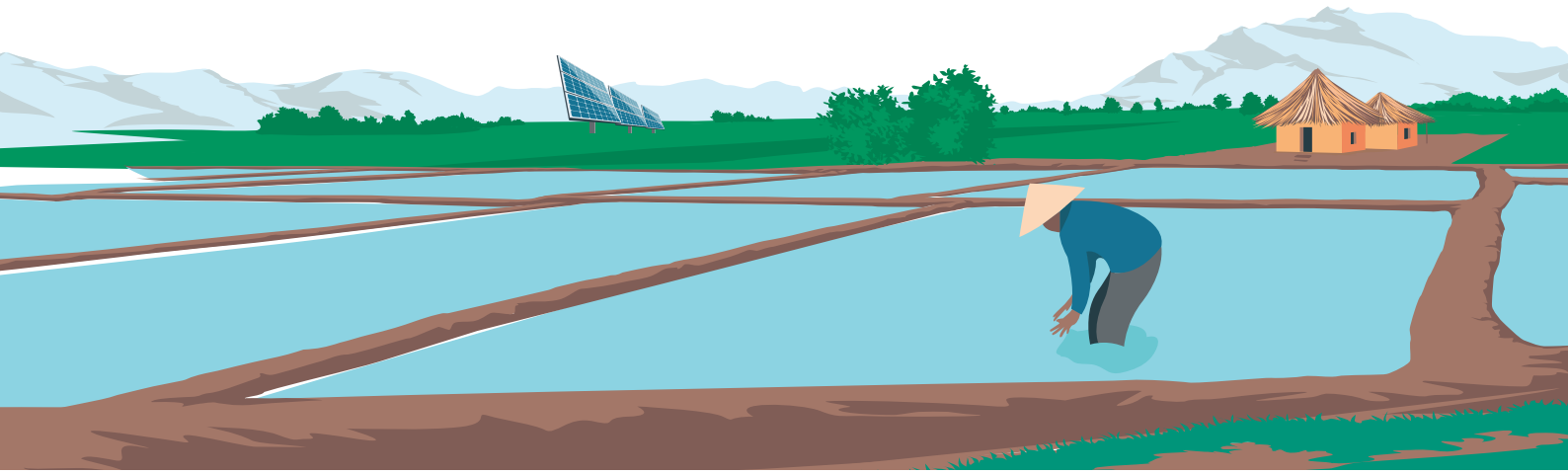
Rearing livestock is responsible for about 32% of human-induced emissions of methane, a particularly potent GHG that must be reduced significantly to meet climate goals.[14] It is not only farmed animals behind agricultural methane emissions, however. Rice paddies, where the constant flooding of fields reduces the amount of oxygen available and leads to methane production, contributes a further 8% of human methane emissions.[15]

Innovations that improve the resilience of crops to the effects of climate change, and that can reduce agriculture's climate impacts, are needed to align the sector with climate targets while improving food security.

Global GHG emissions from food production

Livestock & fisheries	Livestock & fish farms	31%
Crop production	Crops for human food	21%
	Crops for animal feed	6%
Land use	Land use for livestock	16%
	Land use for human food	8%
Supply chain	Transport	6%
	Packaging	5%
	Food processing	4%
	Retail	3%

Source: Source: Poore, J., & Nemecek, T., 2018. Reducing food's environmental impacts through producers and consumers. *Science*.



12 Our World in Data, 2018: Environmental Impacts of Food Production
13 Poore, J. and Nemecek, T., 2018: Reducing food's environmental impacts through producers and consumers. *Science*
14 UN Environment Programme, 2021: Methane emissions are driving climate change. Here's how to reduce them.
15 UN Environment Programme, 2021: Methane emissions are driving climate change. Here's how to reduce them.

4. SEVERE POLLUTION, ENVIRONMENTAL DEGRADATION

In addition to its climate impacts, agriculture is a significant contributor to air, water and soil pollution and to environmental degradation.

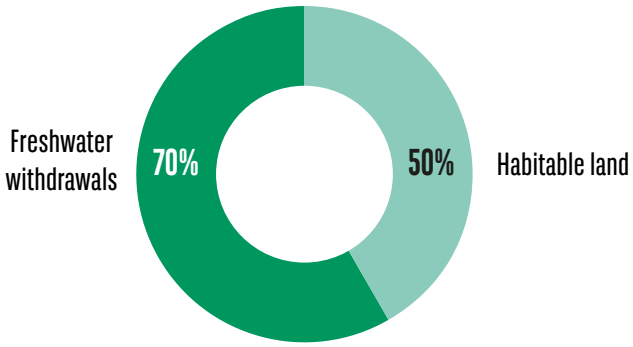
Around 200mn tonnes of nitrogen, phosphorus and potassium fertilisers are applied worldwide each year.[16] Excessive use of fertilisers and pesticides accelerates ecosystem degradation and contributes to biodiversity loss.

Declining soil health is recognised as a major threat to agricultural productivity. Poor irrigation practices, chemical fertilisers and pesticides, and farming practices such as monocropping and overgrazing, are depleting nutrients and soil health. The UN has estimated that a third of the world's cultivatable soil is already degraded.[17]

Another key issue is nutrient runoff. Nutrient-rich material like fertiliser or manure runs into rivers, oceans and lakes, disrupting freshwater and marine ecosystems when excessive algae growth reduces oxygen and sunlight available to water-borne life. Resulting algal blooms can have severe impacts on marine life and coastal communities. For example, each year, high levels of manure and fertiliser flow down the Mississippi River causing a recurring 'dead zone' in the Gulf of Mexico.

More sustainable farming practices, including precision farming technologies, will be essential to addressing these negative environmental impacts.

Agriculture's resource intensity



Source: Our World in Data, 2022

16 Food and Agriculture Organization of the United Nations, 2019: World fertilizer trends and outlook to 2022.
17 UN, 2018: Soil pollution 'jeopardizing' life on Earth, UN agency warns on World Day

5. SUPPLY CHAIN INEFFICIENCIES, FOOD WASTE

Despite the environmental and social costs associated with food waste, the UN estimates that as much as 39% of the world's food goes unconsumed.[18] This means that food loss and waste accounts for between 8% and 10% of GHG emissions worldwide.[19]

As well as having a high environmental cost, wasteful practices carry a high financial price. In the US alone, the value of wasted food totalled US$285bn in 2019.[20] Although most losses are incurred by consumers, they occur at all stages of the food supply chain – in production, processing, retailing, storage and transport.

USD 285 bn

Value of US food waste in 2019

Complex food supply chains encompass ingredient and raw material producers, manufacturers, distributors, logistics providers and retailers, making them vulnerable to disruptions from a range of sources. Challenges include a lack of traceability and transparency; poor communications; maintaining safety and quality; and rising costs for fuel, energy, logistics, labour and technology.

Solutions that can mitigate loss and waste throughout the food supply chain can play a material role in reducing the financial and environmental costs associated with uneaten food.

6. FOOD SECURITY

The number of people facing food insecurity worldwide rose by roughly 150% between 2019 and 2022, due in large part to high food price inflation.[21]

A major driver of food insecurity is the vulnerability of global food supply chains to extreme weather and other climate impacts. The exceptionally hot summer of 2023 in Asia, Europe and North America led to poor yields for staple crops including olive oil, rice and soybeans.[22]

Reduced harvests helped push food prices up by 15% in 2022.[23] Other factors have also played an important part in recent food price inflation, not least supply chain disruptions caused by the COVID-19 pandemic and the Russian invasion of Ukraine. Prior to the conflict, Ukraine was one of the world's largest exporters of agricultural staples including sunflower oil, corn and wheat.[24]

Although global food prices have since fallen back from their peaks, the vulnerability of agricultural supply chains to political disruption has been highlighted by the Indian government's decision to ban rice exports in response to domestic food price inflation.

18 Champions 12.3, 2021. SDG Target 12.3 on Food Loss and Waste: 2021 Progress Report
19 United Nations Environment Programme, 2021: UNEP Food Waste Index Report 2021
20 ReFED, 2023: What is Food Waste.
21 World Economic Forum, 2023: How to mitigate the effects of climate change on global food security
22 World Economic Forum, February 2024: Extreme weather is driving food prices higher. These 5 crops are facing the biggest impacts.
23 Food and Agricultural Organization of the United Nations, April 2024: FAO Food Price Index
24 World Economic Forum, 2022: Ukraine's food exports by the numbers

3. SUPPORTIVE TRENDS

In the context of these challenges, we consider two overarching trends that support the shift to a more sustainable food production system: consumer preferences and top-down government regulation.

1. EVOLVING CONSUMER DEMANDS

A 2020 survey found that 65% of consumers look for products that can help them live a more sustainable and socially responsible life[25].

Increasingly health-conscious consumers are opting for food products that support their physical and mental wellness. McKinsey predicts that the global wellness market, which it estimates at more than US$1.5 trillion, will continue to grow at between 5% and 10% a year.[26] Better nutrition is a core element of this market: in the US, roughly 9% of spending on products and services that promote health goes on food and drink.

Consumers are also increasingly environmentally conscious in their food choices, particularly younger generations.[27] A 2023 survey of US consumers found 42% said they always or usually consider the environment impacts of their food purchases – double the proportion in 2019.[28] The popularity of plant-based milk alternatives has surged, now constituting 15% and 11% by value of all milk sales in the US and Western Europe respectively.[29]

15%

Plant-based alternatives' share of US milk sales by value

The COVID-19 pandemic reinforced a pre-existing trend of growing interest in healthy food, with about 50% of respondents to a McKinsey survey saying that healthy eating was a top priority for them, and that the pandemic had changed the way they eat.[30] For these consumers, healthy eating entails lower consumption of processed foods and sugar, as well as fat and salt.

25 Barkley consumer research, 2020, cited by World Economic Forum, 2023: Consumers want sustainable options. What food producers, suppliers, and retailers can do now
26 McKinsey, 2021: Feeling good: The future of the $1.5 trillion wellness market
27 McKinsey, 2022: Hungry and confused: The winding road to conscious eating
28 Kearney, 2023: Four scenarios for the rapid adoption of climavorism
29 Economist, 20 July 2023: Startups are producing real dairy without a cow in sight
30 McKinsey, 2022: Hungry and confused: The winding road to conscious eating

2. TIGHTENING REGULATIONS

Recognising the social and financial costs associated with poor human health, many governments are taking steps to promote healthier food choices through regulation. For example, the UK government became the first country to introduce strict restrictions on the promotion of food and drink that is high in fat, salt or sugar in larger shops.[31]

There are also several national initiatives to address food waste. The US, Japan, Australia and others have set targets to halve food loss by 2030. Some countries have enacted legislation: Spain, for instance, has mandated that companies throughout the food supply chain (except for small shops) must have food waste reduction plans.[32]

There is meanwhile growing political recognition that the environmental impacts of agriculture must be reduced, given the sector's contribution to global GHG emissions and its dependencies on nature. At the COP28 climate summit in 2023, national governments representing 75% of the world's population signed a declaration including commitments to shift to more sustainable food production and consumption, to protect and restore natural ecosystems, and to scale up climate adaptation and resilience for food producers.[33]

Initiatives to introduce stricter regulations include the EU's Farm to Fork initiative, which aims to accelerate the transition to a more sustainable food system that ultimately has a neutral or positive environmental impact while ensuring access to safe, nutritious and affordable food across the economic bloc.[34]

Such legislative efforts, including the EU's, have come under pressure over the past year. Alongside public concerns over food inflation and the cost of living, farmers have protested against rising production costs and climate policies that force them to change how they operate. There has been a wave of protests across Europe, including in the Netherlands where a requirement for farmers to reduce their nitrogen footprint or sell land to the government has become a totemic political issue.[35]

Despite the politicisation of agricultural reforms, it is our conviction that the ratchet of legislation will continue to tighten in response to the environmental challenges facing the sector.

31 Muir, S. et al, 2023: UK government's new placement legislation is a 'good first step': a rapid qualitative analysis of consumer, business, enforcement and health stakeholder perspectives. BMC Medicine
32 La Moncloa, 2022: Government of Spain approves pioneering law against food waste
33 World Resources Institute, 2023: 6 Major Food Breakthroughs at COP28 — and What Comes Next
34 European Commission, March 2024: Farm to Fork strategy
35 Boztas, S., 25 June 2023: Farmers on frontline as Dutch divided by war on nitrogen pollution. *The Guardian*

4. INVESTMENT OPPORTUNITIES ACROSS THE FOOD VALUE CHAIN

As investors focused on the transition to a more sustainable economy, we perceive a range of long-term opportunities for companies that can help meet rising demand for safe, nutritious food while lowering the industry's environmental footprint.

Specifically, we see opportunities for companies whose products and services play a role in solving the challenges outlined above by:

- Helping to lower the environmental impact of agriculture and food production
- Focusing on providing nutritious and healthy food
- Enabling the wider availability of safe food
- Helping promote animal welfare standards.

1. GROWERS & INPUTS

Natural feed additives derived from plants, minerals and micro-organisms can improve the health and welfare of animals, without many of the negative environmental externalities associated with inorganic nutritional additives and antibiotics.

Prebiotics, probiotics and enzymes can improve animal gut health, digestion, nutrient absorption and improve immunity, which in turn reduces antibiotic use. Meanwhile essential oils extracted from plants have antimicrobial, antioxidant and anti-inflammatory properties. Other natural additives include organic acids and seaweeds. The latter can not only reduce digestive disorders in animals but also reduce enteric methane from livestock.

Natural feed additives can also increase yields from livestock farming and so ultimately reduce the volume of crops needed to feed them. This reduces pressure to change land use to grow crops for animal consumption.

Stock example

Leaders in this sector produce bio-based nutritional ingredients, including enzymes and vitamins, that can replace synthetic or chemical additives in animal and human food. These products can improve animal digestion and health more broadly, helping livestock to grow more efficiently with less feed – thereby reducing input-related GHG emissions – and limiting harmful by-products including nitrogen-rich run-off that contributes to the suffocation of water ecosystems.

Some companies in this sector have developed innovative feed additives. These can reduce the methane emissions associated with beef and dairy products by 45% and 30%, respectively, by suppressing the enzyme that triggers methane production in cattle's stomachs.

2. TECHNOLOGY

The adoption of precision agriculture techniques has been shown to make farming operations more efficient, reducing the volume of agricultural inputs needed, thereby cutting the environmental and financial costs of food production.

Digital technology is a key part of many precision agriculture techniques, enabling 'smart' machines to connect to the cloud. Farm management software – which can use real-time weather information and historical local crop information – can optimise farm operations, from pre-planting to harvest. Drones are also now being employed to better target crop spraying and watering.

By enabling farmers to plant crops more precisely and apply fertilisers and pesticides more accurately, precision agriculture technologies can reduce agricultural inputs and so the resource intensity and environmental impact of each calorie of food produced. There is enormous scope for the efficiency of farming operations to improve: studies show that up to 90% of all pesticide spraying does not affect targeted areas, for example.[36]

90%

Pesticide spraying estimated to be wasteful

By improving the efficiency of farming operations, these solutions can also save farmers money. We believe the compelling economics of precision technologies will drive rising adoption.

Stock example

The world's largest makers of agricultural equipment have a particular focus on precision agriculture solutions. Their products include precision seed planting equipment and nozzles for more targeted application of fertilisers, as well as software-based solutions for connected farm machinery. In 2023, 85% of the agriculture fleet that rolled off production lines of the sector's leaders were connected machines. It has been calculated that one of the intelligent farm equipment guidance technologies can save a typical customer 10% of its diesel consumption through route optimisation, while a new product for targeted weed spraying reduces herbicide use by as much as 30%. A 'retrofit-first' approach, whereby precision tools can be added to almost any brand of existing equipment, expands the commercial opportunity as only 7% of planters and sprayers are replaced each year.

36 FAO study (2009) cited by European Parliament, 2016: Precision agriculture and the future of farming in Europe

3. FOOD SAFETY

Ensuring that food is safe to eat is crucial. Risks for the industry are periodically highlighted by issues like the contamination of baby formula and the perennial threat of harmful bacteria contaminating food products. Complex global supply chains increase both the risks and the importance of managing them.

Laboratory testing can play an important role in ensuring that food is safe for consumption, reassuring consumers that produce can be trusted. We believe this creates long-term opportunities for companies that run testing facilities and those that supply them with innovative equipment. Advanced tests can identify contaminants, pathogens and the origin of produce with growing accuracy.

Stock example

One of the world's largest global testing, inspection, and certification companies, runs a network of laboratories whose clients span sectors including food and agriculture. The company's services include food testing, to ensure health and safety standards are met, and certification, to provide assurance that food products meet quality standards and conform to regulations.

As well as microbiological tests (most often used for salmonella and listeria bacteria), the company's laboratories provide chemistry testing data that enable food producers to monitor their products' quality.

4. SUSTAINABLE PACKAGING

Food packaging, particularly single-use plastic, is a major contributor to landfill waste and plastic pollution on land and in waterways. Around one-third of plastic packaging waste leaks into the environment, degrading over time into microplastics that can enter land and water-based food chains, posing long-term biodiversity risks.[37] As it accounts for half of all fossil fuel-derived plastics use, plastic food packaging is also a significant contributor to GHG emissions.[38]

50%

Plastic food packaging's share of all fossil fuel-derived plastics use

Packaging companies whose products advance the circularity of materials' use can supply alternatives to single-use plastics and also contribute to reducing the unnecessary use of virgin materials – a driver of deforestation. Circular alternatives range from reusable pallets to recycled and recyclable paper-based packaging. Emerging solutions also include plant-based packaging made from microbial, degradable polymers and plants such as seaweed.

Stock example

A vertically integrated paper and packaging company is one of Europe's largest producers of fully recyclable, fibre-based packaging. The company aims for 100% of its packaging and paper products to be reusable, recyclable or compostable by 2025. In many cases, innovative paper-based packaging can replace resource-intensive and non-recyclable plastic packaging without undermining functionality or food safety. For example, some companies have developed paper-based food packaging solutions, including dry rice packets, that have barrier properties to protect products from moisture and ensure long shelf lives.

37 WRAP, 2024: Plastic packaging

38 Ncube, L.K., et al., 2020: Environmental Impact of Food Packaging Materials: A Review of Contemporary Development from Conventional Plastics to Polylactic Acid Based Materials. *Materials.*

5. DISTRIBUTION

A large slice of the food produced for human consumption is lost at each stage of the value chain, from farm to kitchen. Given the high financial and environmental costs of food waste, wasteful practices are ripe for disruption.

More efficient solutions for food distribution can help reduce GHG emissions and improve access to safe, nutritious and affordable food.

Professional kitchen operators and caterers, given their scale and commercial incentive, should be much less wasteful with ingredients and portion sizing than households inevitably are. Companies that supply commercial kitchens with equipment that improves the efficiency of operations can also help directly mitigate food waste.

Stock example

One of the world's largest catering companies by revenues, is targeting a 50% reduction in food waste by 2030 through efficiencies in distribution. Investment in technology is enabling the company to leverage data-driven insights to make progress towards this goal, reducing waste and costs.

By the end of 2023, food waste tracking technology had been adopted in almost 8,000 kitchens worldwide. A proprietary online tracking tool for chefs enables kitchen teams to identify opportunities to minimise food waste using real-time tracking and dashboard reporting. In turn, analysis of the data collected can reduce future kitchen waste.

6. BASIC FOODS & INGREDIENTS

Foods derived from natural ingredients generally use fewer resources than ultra-processed foods and generate less hazardous waste during their production. Natural food colourings derived from turmeric, beetroot, carrot or safflower are, for example, considered less harmful to the environment (and human health) than synthetic food dyes, which are mostly derived from petroleum.[39]

Rising awareness of the impacts of ultra-processed foods has fuelled appetite for products based on natural ingredients, which tend to contain higher levels of essential nutrients and antioxidants. As consumers demand healthier food products, leading suppliers of produce such as fruit, vegetables and sustainable aquaculture are well placed to support better nutritional outcomes.

A recent Mintel study identified rising demand for food and drinks that can boost cognitive health and functionality and help manage stress using plant-based ingredients. It also found more interest in probiotics, prebiotics and postbiotics to support digestive health.[40] Some companies are responding to this trend by adding vitamins and probiotics to food products.

Other innovative companies are employing natural preservative processes, such as fermentation and the use of enzymes, to ensure food products stay fresh for longer, reducing food waste and resource use. Certain natural ingredients, including vinegar and citrus fruits, have antimicrobial and antioxidant properties and can substitute for synthetic preservatives like nitrates that have been associated with long-term health risks.[41]

Stock example

A supplier of ingredients and nutritional solutions to the global food and beverage industries, collaborates with companies on new innovations and reformulations to create healthier products and help achieve their own sustainable nutrition targets. The company's smoking technology – which uses wood, heat, water and filtration to flavour meat and plant-based meat substitutes – is one example of how innovations using natural inputs and processes can replace artificial ingredients and replicate authentic flavours.

39 BBC, 2021: The truth about processed foods' environmental impact
40 Mintel, 2022: 2023 Global Food and Drink Trends
41 Queen's University Belfast, 2019: Strongest link yet between nitrites and cancer – but 'not all processed meat has same risk'

7. VALUE-ADDED FOODS

Although many ultra-processed foods have been shown to increase health risks, including cancer, heart disease and diabetes, not all should be tarnished with the same brush.[42] Specifically, processed foods can deliver health benefits if they substitute for products high in sugar or salt. They can also deliver a positive environmental impact if they replace resource-intensive foods, such as beef and dairy products, whose production is water- and land-intensive and produces significant GHG emissions.

Innovations in plant-based alternatives to animal proteins are providing substitutes for resource-intensive meat products. One company's plant-based burger requires 99% less water and 93% less land to produce than beef alternatives.[43]

Stock example

The world's largest producer of fresh dairy products is also the largest producer of plant-based food and drinks. Its portfolio of plant-based alternatives includes market-leading brands including a nut and soya milk range.

The company has made a strategic shift towards plant-based products to align with consumers' growing preference for diversified protein sources and to reach consumers with lactose intolerances. Their efforts to improve the health outcomes of its products also include zero-added-sugar yoghurts and yoghurts enriched with grains and fruits.

Dairy vs plant-based milks
Environmental footprints per litre consumed.

	Dairy	Almond	Oat	Rice	Soy
Land use (m^2)	8.95	0.5	0.76	0.34	0.66
Freshwater use (litres)	628	371	48	270	28
GHG emissions (kg)	3.15	0.7	0.9	1.18	0.98

Source: Poore, J., & Nemecek, T., 2018. Reducing food's environmental impacts through producers and consumers. ***Science.*** Impacts are measured per litre of milk. These are based on a meta-analysis of food system impact studies across the supply chain which includes land use change, on-farm production, processing, transport, and packaging.

42 Cordova, R., et al., 2023: Consumption of ultra-processed foods and risk of multimorbidity of cancer and cardiometabolic diseases: a multinational cohort study. *The Lancet*.
43 University of Michigan Center for Sustainable Systems, 2018: Beyond Meat's Beyond Burger Life Cycle Assessment

8. IMPROVING FOOD HEALTH OUTCOMES

Dietary trends have contributed to a rising prevalence of chronic health conditions. More than half a billion people worldwide now suffer from diabetes, placing major health and financial burdens on society. In the US, diabetes-related health expenditure reached US$380bn in 2021, about 9% of total healthcare spending.[44]

Medical devices that help people monitor and manage their blood sugar levels can deliver profound day-to-day health benefits and cut the cost of treatment by avoiding hospital visits arising from glucose spikes.

A relatively recent development in medical science has seen the emergence of anti-obesity drugs that suppress appetites and can help to drive permanent changes in unhealthy eating habits. These medications can provide a range of other benefits beyond weight loss. Novo Nordisk says that its drug, Wegovy, cut serious cardiovascular events such as strokes and heart attacks by one-fifth in overweight patients with a history of heart disease, for example.[45] They can also reduce the incidence of diabetes as well as lower blood pressure.

Stock example

A medical device company produces small continuous glucose monitoring (CGM) devices that measure glucose levels every five minutes, removing the need for finger prick tests. Studies have shown that highly accurate CGM systems can help diabetics keep blood sugar levels more stable, and so reduce potentially harmful hypo- and hyperglycaemic events.[46]

CGM devices may also play a role in enabling behavioural shifts, in the form of better-informed lifestyle and dietary choices, among the pre-diabetic population.[47] This not only expands the addressable market for device manufacturers but also expands the potential positive impact – health and financial – of these innovations.

44 International Diabetes Federation, 2021: IDF Diabetes Atlas
45 https://www.reuters.com/breakingviews/anti-obesity-drugs-can-shrink-more-than-patients-2023-09-20/
46 Hermanns, N. et al., 2019: Impact of CGM on the Management of Hypoglycemia Problems: Overview and Secondary Analysis of the HypoDE Study. *Journal of Diabetes Science and Technology*
47 Ehrhardt, N. & Al Zaghal, E., 2020: Continuous Glucose Monitoring as a Behavior Modification Tool. *American Diabetes Association.*

OUTLOOK

We firmly believe that the transition to a more sustainable food system represents an exciting opportunity set for investors in listed equities. Feeding a rising global population more equitably and nutritiously with limited natural resources, while also reducing the environmental impacts of agricultural production, requires innovative solutions.

In our view, this creates long-term investment opportunities throughout the food and agriculture sector – from suppliers of natural ingredients and alternative proteins to leaders in sustainable packaging and precision farming technologies.

The breadth of solutions along the length of the food value chain enables investors to gain diversified exposure to sustainable agriculture. By carefully choosing from a select universe of listed companies aligned to the theme, we think it is possible to build a stock portfolio that is well balanced between economically resilient businesses and firms that are more growth oriented and cyclical in nature.

In addition, we believe that companies involved in producing food more sustainably are likely to be more aware of, and resilient to, increasingly severe climate and environmental impacts than those that are not.

It is our conviction that evolving consumer tastes for healthier and more sustainably produced food, combining with the tightening ratchet of regulation, will continue to drive the long-term shift towards a more sustainable food system. We believe this will support opportunities for active investors with expertise in this sector to pursue robust risk-adjusted returns over the years and decades ahead.

Case studies are provided for illustrative purposes only.

Impax Asset Management, May 2024

This paper has been written by Impax Asset Management. Founded in 1998, Impax Asset Management has pioneered investment in the transition to a more sustainable global economy and today is one of the largest investment managers dedicated to this area.

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VIEWPOINT

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The sustainable investor for a changing world