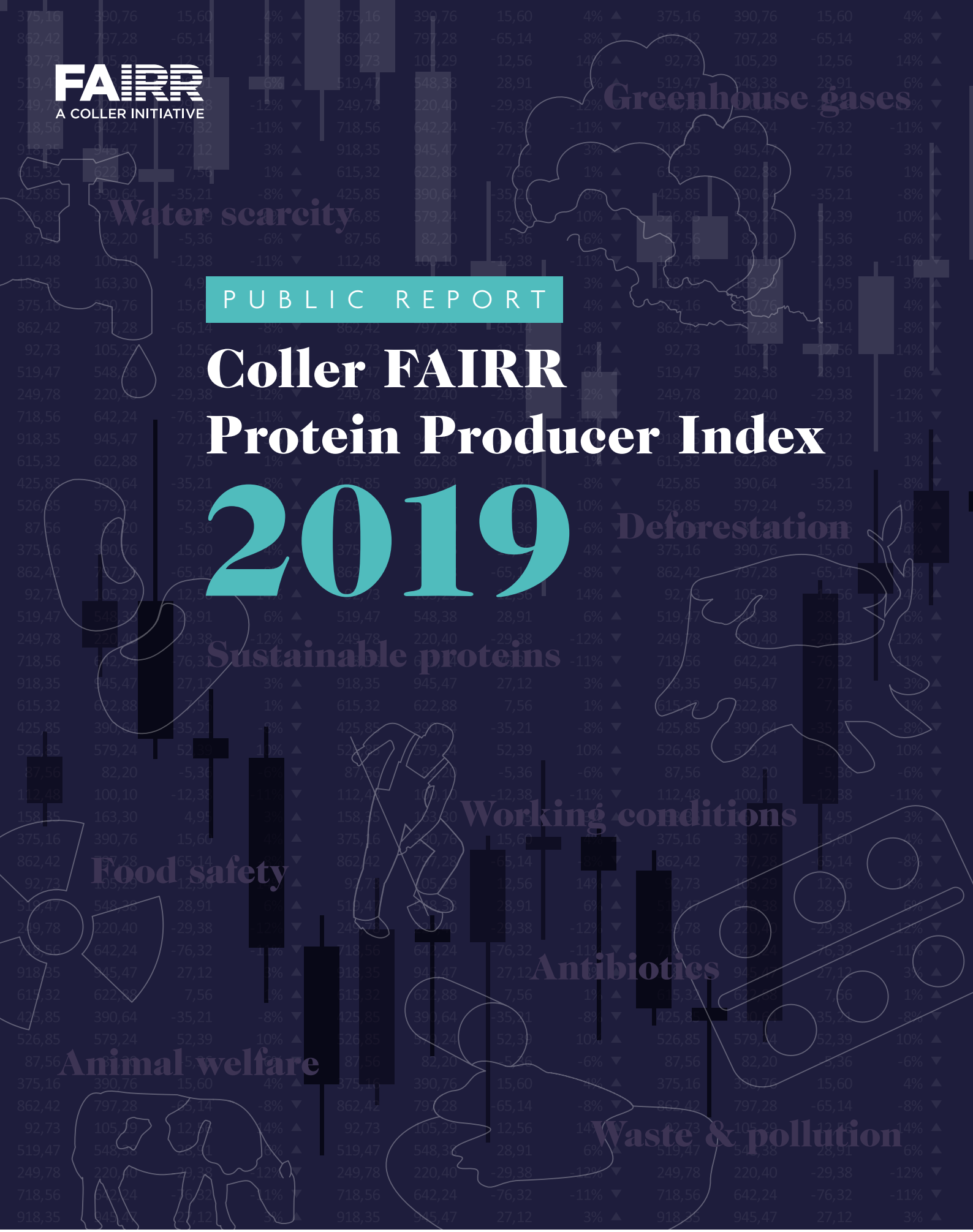
FAIRR
A COLLER INITIATIVE



PUBLIC REPORT

Coller FAIRR Protein Producer Index 2019

AI 2019 Global Excellence Awards WINNER
FAIRR Initiative
Most Outstanding Initiative on Sustainable Animal Agriculture – 2019

IRI SURVEY 2019
Top 3 Provider of Specialist Sustainable Investment Research

PRI Principles for Responsible Investment
Shortlisted, ESG Research Report of the Year

Coller FAIRR Protein Producer Index

The FAIRR Initiative has developed an index to analyse the largest global meat, dairy and aquaculture producers by combining nine environmental, social and governance (ESG) risk factors with the Sustainable Development Goals (SDGs). The benchmark will be primarily a resource for institutional investors and other actors interested in the livestock sector.

60 global companies

9 risk & opportunity factors

30 KPIs

SUSTAINABLE DEVELOPMENT GOALS

1 **GREENHOUSE GAS EMISSIONS**
Disproportionate amount of GHGs generated by livestock makes companies engaged in factory farming vulnerable to transition and physical risks

2 **DEFORESTATION AND BIODIVERSITY LOSS**
Global movements tracking forest loss target factory farming companies and can lead to shareholder divestment and / or weaken customer loyalty

3 **WATER USE AND WATER SCARCITY**
Beef, pork, dairy, and poultry companies consume large quantities of water both directly and indirectly via their purchase of animal feed

4 **WASTE AND WATER POLLUTION**
Companies are facing greater scrutiny about the impact of waste on surrounding communities and the environment, meaning potential fines and regulation

5 **ANTIBIOTICS**
Drug-resistant infections are a serious public health threat which will likely impact productivity on a national scale

6 **WORKING CONDITIONS**
Operational risks, which can involve worker injuries and reputational risk, as well as food product contaminated by sick workers

7 **ANIMAL WELFARE**
Poor animal welfare presents operational and reputational risks for companies

8 **FOOD SAFETY**
A series of high profile food safety incidents in meat and dairy have focused consumer concerns on threat of food contamination and foodborne illnesses

9 **SUSTAINABLE PROTEINS**
Reduced reliance on animal protein sources is key to sustainable development

*SDG 2: Zero Hunger; SDG 3: Good Health and Well-being; SDG 6: Clean Water and Sanitation; SDG 8: Decent Work and Economic Growth; SDG 12: Responsible Consumption & Production; SDG 13: Climate Action; SDG 14: Life Below Water; SDG 15: Life on Land

Foreword

The benefits of the factory farming sector have been well-known to investors for over half a century but it is only recently that the risks of this $1.5 trillion sector have become visible to the markets.

We now know processing 70 billion animals for 7 billion humans every year produces more than 14% of the world's greenhouse gas emissions -- more than the whole transport sector. We know the livestock industry is the single largest driver of habitat loss worldwide. We also know that 73% of all antibiotics are used in factory farming, in many instances to help animals grow faster, accelerating the development of superbugs.

For investors, these investment risks are becoming increasingly material, yet we know very little about what is being done to mitigate them. High-street restaurants and supermarkets have begun to make commitments to reduce emissions, eliminate deforestation and to better manage antibiotics use. But there is little information on how their biggest meat, fish and dairy suppliers are reacting to these trends.

The Coller FAIRR Protein Producer Index, now in its second year, is critical. It assesses the 60 largest publicly-listed animal protein producers, with a combined market cap of $324 billion, making it the world's only comprehensive sustainability assessment of animal protein producers.

The results show where positive change is happening, such as in alternative proteins. This year's Index finds that 25% of companies are working to diversify their protein portfolio, with 11 announcing investments in new alternative protein products and technologies in the past year.

But the Index also exposes where change is not happening. Despite calls from the World Health Organization to end the practice of giving antibiotics to healthy animals, just four (7%) companies in the Index have committed to phasing out routine use of all antibiotics on all farm animals.

Research from the Intergovernmental Panel on Climate Change (IPCC) has shown that reducing deforestation is critical to mitigating climate change, yet astonishingly, none of the 50 meat and dairy companies in the Index has a comprehensive deforestation policy that covers all the regions in which they operate.

Perhaps most concerning, in stark contrast to the transport sector, only one in four meat, fish and dairy producers even measure their greenhouse gas emissions, let alone act to reduce them. The Paris Agreement is impossible to achieve without tackling factory farm emissions.

For investors, the data reveals which companies are best managing ESG risks effectively and which face the highest risk as consumers look to reduce their environmental footprint and protect their health, and regulators tighten controls.

Now in its second year, we are delighted that the Index has been shortlisted for the ESG Research Report of the Year by the UN-supported Principles for Responsible Investment, and we hope it continues to be an indispensable tool for investors assessing risk in an industry that for too long has been overlooked.

We are grateful for the feedback from all stakeholders on last year's Index. Better never stops, so we do welcome your further feedback and suggestions to help us constantly improve this important investment tool.

Jeremy Coller
Founder, FAIRR and Chief Investment Officer, Coller Capital

Contents

ACKNOWLEDGEMENTS

We would like to thank the following organisations that we consulted for the Index. They gave their insight and expertise on the Index's methodology:

- Aberdeen Standard Investments
- Aviva Investors
- Bakkafrost
- BMO Global Asset Management
- BRF SA
- CDP
- Ceres
- CFA WWF (Collaboration on Forests and Agriculture)
- CGF/GFSI (Global Food Safety Initiative)
- China Water Risk
- Environmental Resources Management (ERM)
- Folksam
- Fonterra Co-operative Group Ltd
- Forest 500
- GFI (Good Food Institute)
- Grieg Seafood ASA
- GSI (Global Salmon Initiative)
- ICCR (Interfaith Center on Corporate Responsibility)
- Institute of Marine Research, Norway
- IUF (International Union of Food, Agricultural, Hotel, Restaurant, Catering, Tobacco and Allied Workers' Associations)
- JBS SA
- Maple Leaf Foods Inc.
- Mowi ASA
- New York University (NYU)
- RCL Foods Limited
- Robeco
- Schroders
- Science-Based Targets initiative (SBTi)
- Shift Project
- Stockholm Resilience Centre
- Sustainability Accounting Standards Board (SASB)
- Tassal
- UBS Asset Management
- UFCW (United Food & Commercial Workers)
- VB Consultancy
- Waterkeeper Alliance

We would like to thank the following individuals and organisations for their contributions to the assessment and report in 2019:

- SustainoMetric
- Selena Lin
- Sara Carvalho
- Rhiannon Baldwin

Executive summary

INTRODUCTION

The age of man could, in fact, be defined by the chicken.

At any given time, there are nearly 23 billion domesticated chickens around the world. Humans consume nearly three times that number – 65 billion – every year.[1]

Domesticated chickens have been part of the human diet for over 8,000 years. However, it is only in the last 60 years, with the birth of industrial farming, that chickens have become pervasive. The industrial chicken's lifespan is five to nine weeks. These birds have been bred to gain weight rapidly on a primarily grain-based diet. As a result, they weigh four to five times what their ancestors did in the 1950s, and their bones have a unique chemical signature.[2] They cannot survive without human intervention. Scientists have argued that these factors make chicken bones – ubiquitous and fossilised in landfills – a leading contender as an index fossil for a proposed Anthropocene Epoch.[3]

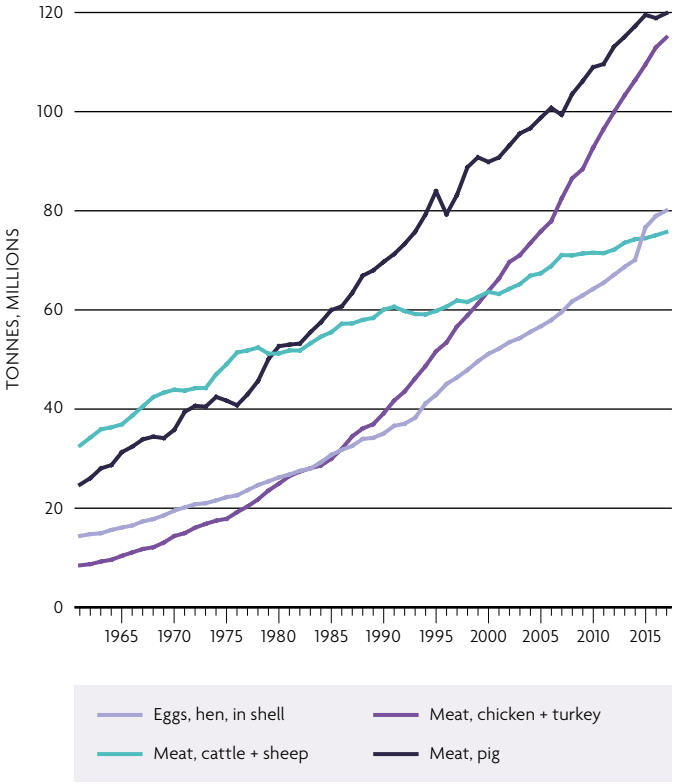
The industrialisation of agriculture is not confined to chickens. Intensive farming – which prioritises feed efficiency and rapid weight gain – is now standard practice across all farmed species. It has helped to increase meat, egg and milk production by 140% since 1961, and make farm animals, led by cattle and pigs, the largest mammalian biomass on the planet. Farm animals now have 33 times the rapidly dwindling biomass of wild land mammals.[4,i]

The rapid growth of this sector has transformed the availability and accessibility of cheap protein sources and resulted in economic and social benefits. However, these benefits have come at a steep cost: the sector is one of the primary drivers of the most serious environmental and social risks facing our planet and society (see case study). Global multinationals that breed, grow, slaughter and process livestock and fish are ultimately on the front lines of managing and mitigating these risks. The lack of scrutiny on the sector has meant that these companies have been allowed to scale their operations, markets and production volumes without clear controls. This creates systemic risks: not just for companies, but also their global food customers, investors, consumers and society at large.

The FAIRR Initiative is working to leverage the power of institutional capital to effect change in the livestock and farmed fish sectors. One of our key research initiatives is the Coller FAIRR Protein Producer Index. This ranks 60 of the world's largest protein producers on their disclosure and management of material environmental and social risks. The Index is the world's only benchmark dedicated to profiling animal protein producers and showcasing critical gaps and areas of best practice in the sector.

i The present-day biomass of wild land mammals is approximately sevenfold lower, at ≈0.003 gigatonnes of carbon (Gt C). The global biomass of livestock turns out to be ≈0.1 Gt C. Source: https://www.pnas.org/content/pnas/suppl/2018/07/13/1711842115.DC1/1711842115.sapp.pdf

Figure 1
Meat and dairy production has increased by 370% and 140% respectively since the 1960s



The primary purpose of this Index is to enable and support investor decision-making on the protein sector. We hope investors will integrate the data and analysis on the performance of these global listed assets into their stewardship and investment decisions. The Index is also a benchmark to help animal protein companies assess themselves against their peers in the sector and improve their management and reporting of risks. Wherever possible, we have tried to contextualise our analysis to compare companies against their closest peers, based on business model and product composition.

Ultimately, what these companies produce ends up on the tables and supermarket shelves of consumers around the world. Global food companies, from McDonald's and Nestlé to Walmart, procure their meat, fish and dairy from many of the Index constituents. The Index serves as a powerful engagement tool to help food companies work with their suppliers to minimise reputational and operational risks.

Index constituents supply to the largest global food companies, reaching billions of customers annually[ii]

Figure 2

ii Retrieved from Bloomberg on 9 August 2018. Supplier relationships may not be exhaustive or up-to-date.

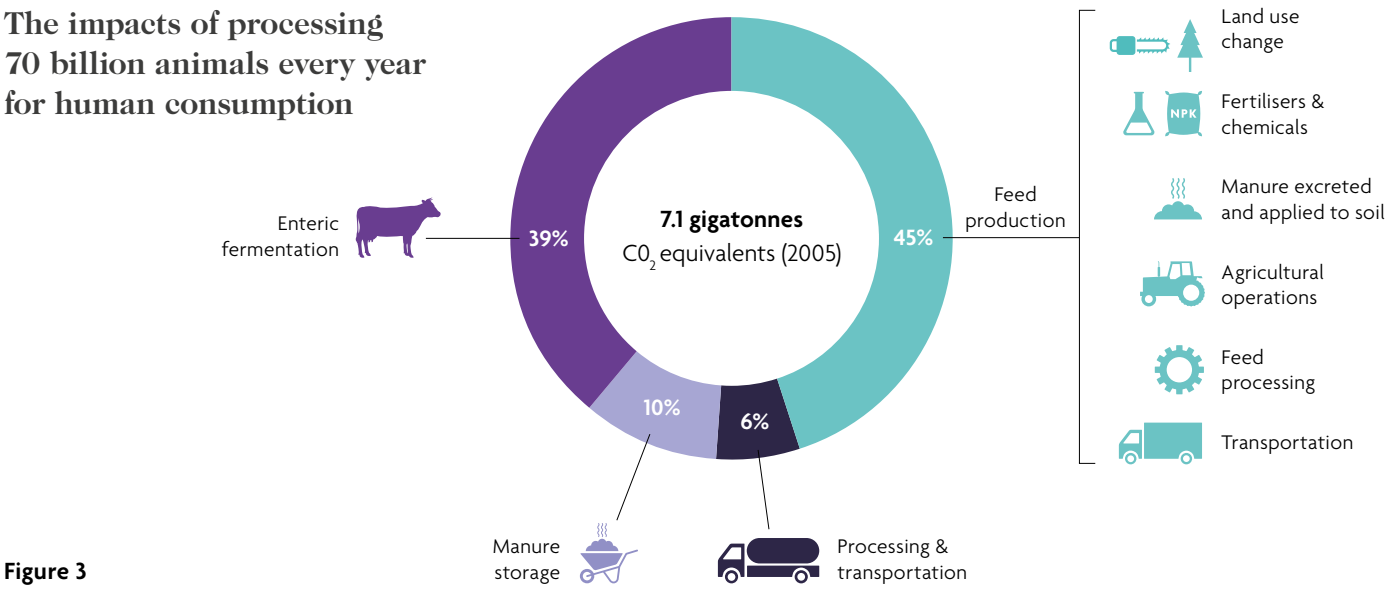


Figure 3
Livestock emissions[5]

Climate change: Livestock supply chains account for 7.1 gigatonnes (Gt) of carbon dioxide (CO_2), equivalent to 14.5% of global anthropogenic greenhouse gas emissions.[6] The biggest sources of emissions are enteric fermentation from cattle, feed production and manure storage.

Biodiversity loss: Livestock production "is the single largest driver of habitat loss".[7] This loss is incurred through direct land conversion: 80% of all agricultural land is used for grazing and to produce monocrops such as corn and soy for animal feed. Some of the world's most biodiverse regions such as the Amazon and the Cerrado are at the centre of an aggressive agri-industrial expansion that threatens millions of native plant and animal species. Inputs into feed and animal agriculture, including fertilisers, pesticides and veterinary drugs, degrade local ecosystems and water sources. Finally, prioritising fast-growing 'competitive' breeds has led to a significant erosion of genetic diversity, even within livestock and aquatic species.[8]

Antimicrobial resistance: More than 73% of all antimicrobials sold in the world are used in livestock and fish.[9] For decades, protein companies have used antibiotics – including those critically important to human health – to help animals achieve slaughter weight and as a way to prevent infection from unhygienic crowded conditions. This indiscriminate use of antibiotics has increased the risk of drug-resistant infections, prompting the World Health Organization (WHO) to urge farmers to stop using antibiotics in healthy animals.[10]

Food security: By 2050, it is estimated that the world will require 56% more crop calories, and additional agricultural land area equivalent to nearly twice the size of India, compared with 2010.[11] The resource intensity of meat and dairy make them inefficient sources of calories and proteins. The livestock sector consumes around one third of global cereal production and uses 40% of global arable land. "Producing 1 kg of boneless meat requires an average of 2.8 kg human-edible feed in ruminant systems and 3.2 kg in monogastric systems."[12]

Obesity and cancer: Various studies have linked the overconsumption of animal protein, especially red and processed meat, to a variety of non-communicable diseases. A British Medical Journal study of half a million Americans found the risk of dying from cancer, heart disease, stroke, diabetes, infections, kidney disease, liver disease or lung disease all increased with the amount of meat consumed.[13] On average, consumers in OECD countries consume around 164 kg of red meat, poultry and dairy products each year – 450 g per day. In Europe, the average consumer eats over 180 kg of red meat, poultry and dairy products each year – nearly 500 g per day.[14] This is approximately five times the amount recommended by most national dietary guidelines.[15]

Water use and pollution: One third of the fresh water that is used for agriculture today goes towards livestock, primarily to produce feed.[16] Agricultural runoffs – from excessive fertiliser use in corn and soy feed farms to manure from animal farms – is overwhelming local water sources. According to the United States Environmental Protection Agency, manure is the primary source of nitrogen and phosphorous to surface and groundwater.[17] The US is one of the world's largest producers of beef, pork, poultry and dairy. Nitrate and phosphorus loads from animal and feed agriculture along the Mississippi River is thought to have created a the largest ever 'dead zone' in the Gulf of Mexico.[18] This refers to overgrowth of algae from excessive nutrients that kills all aquatic life.

ABOUT THE INDEX

Index constituents

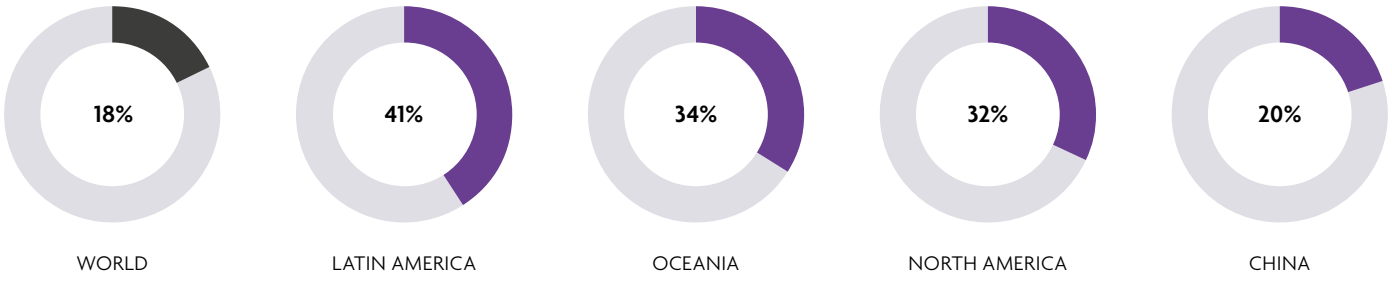
The scope of this Index focuses on listed companies primarily involved in breeding, processing, distributing and selling meat, dairy or aquaculture products.[iii] The 60 Index constituents have a combined market capitalisation of $324 billion[iv] as of 31 May 2019.[v] Nearly 86% of their $319 billion worth of revenues are derived from producing and processing intensively farmed livestock and fish.

There are no clear estimates on the economic value of the global protein market. Values range from $1.4 trillion[19] to $1.9 trillion.[20] For this report, we value the global protein market at $1.5 trillion. This is based on FAIRR's estimate of data from the United Nation's Food and Agricultural Organization (FAO) (see Appendix for the methodology). The consolidated revenues of the 60 Index constituents cover approximately 18% of the global livestock and aquaculture market. As some of the largest protein suppliers globally and regionally, these companies play a significant role in meeting – and building – global consumer demand for animal proteins. The full list of companies is in Appendix 1: List of companies.

Nearly half (47%) of companies in the Index are based in Asia, including 14 companies located in China. The concentration in Asia is significant, given the forecast growth in consumption of animal protein in the region. Chinese protein demand alone is projected to account for 35% of the global protein market value in 2025.[21] Inner Mongolia Yili Industrial Group, a China-based dairy producer, has the largest market capitalisation in the Index at $27 billion. Brazilian meat conglomerate JBS has the largest revenues at $50 billion (based on 2018 filings).

The 60 companies have material exposure to five main animal protein categories: beef, dairy, pork, poultry and eggs, and farmed fish. Companies with poultry supply chains continue to have the largest representation at 24% of the total revenues of Index constituents. This reflects the growing global popularity of chicken, which overtook pork in 2009.[22]

Figure 4
Index constituents have a large footprint within their regions



iii Two companies in the Index, Grupo Nutresa and Fonterra, source their proteins from suppliers. They are not involved in the breeding, raising or slaughtering stages. However, they are among the world's largest processors of animal proteins and have extensive buying power in the regions where they operate.
iv All currency is in US dollar unless otherwise stated.
v All market capitalisation figures in this report are as of 31 May 2019 unless otherwise stated.

Figure 5
Regional distribution of 60 Index constituents[vi]

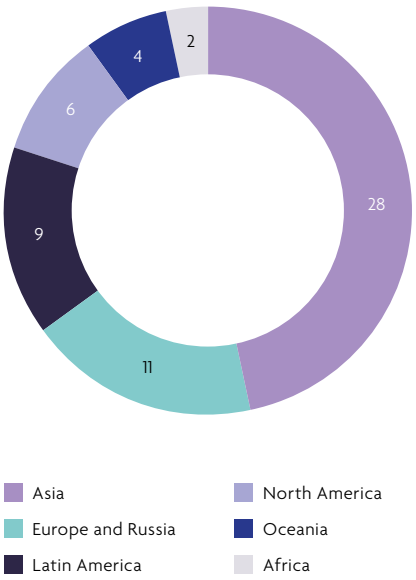


Figure 7
Revenue by product type[viii]

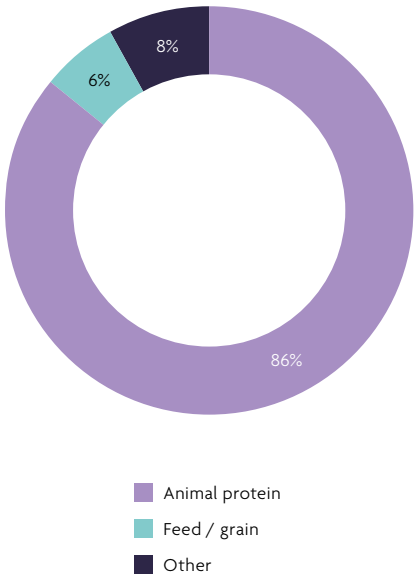


Figure 6
Protein distribution of 60 Index constituents by main protein category[vii]

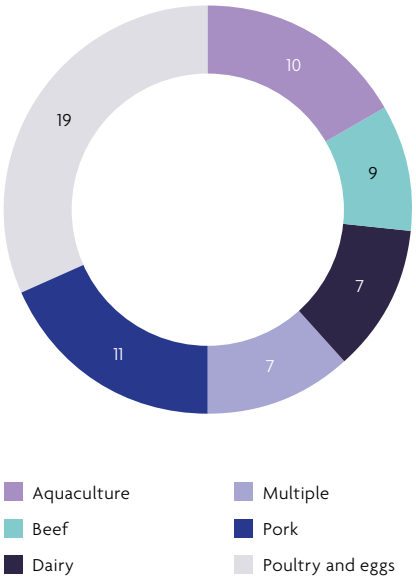
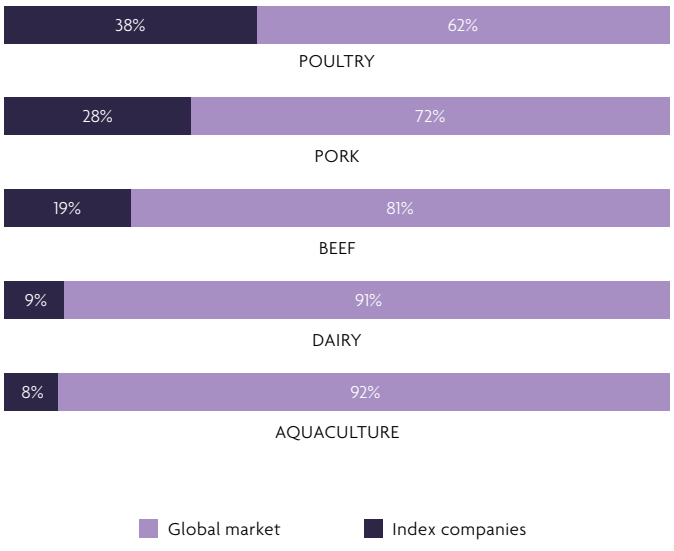


Figure 8
Revenues of Index companies as a proportion of global protein markets[ix]



vi Region is determined by the location of the company's headquarters. Many companies have operations and sales across multiple geographies.

vii We assigned companies a 'main protein category' where a company derives most of its revenues from a particular protein. 'Multiple' companies derive revenues from more than one protein source (none of the sources particularly dominates).

viii 'Other' includes other types of food, beverages and non-food products or services.

ix These are estimates based on calculations by FAIRR. The company revenues by proteins are calculated from 2018 company financial reports. Where available, we disaggregate revenues to specific proteins as assigned by the company. In cases where revenue distribution by protein is not provided, and the company derives revenue from multiple proteins, we disaggregate revenues based on our best understanding of the company's business model. For data limitations on estimating the global protein market size, see the discussion in the Appendix.

Who owns the Index companies?

A review of ownership using shareholder data shows that insiders own approximately 63% of companies in the Index. This means that individuals with access to sensitive company information – such as board members, senior management, controlling families, entities and trusts – have a stake in the company. For example, the founding families of Charoen Pokphand Foods and Industrias Bachoco are controlling shareholders. Cal-Maine Foods' Chairman and CEO have a combined stake of more than 50%.

Institutional investors are the second largest group of shareholders, closely followed by the state. US-based institutional investors have the largest number of absolute company holdings, representing 75% of the top 20 institutional investors in the Index.

The state is also a majority shareholder in several Asia-based companies, particularly those in China. For example, the state-owned China National Cereals, Oils and Foodstuff Corporations (COFCO) has a majority stake in China Mengniu Dairy and COFCO Meat Holdings.

Figure 9
Ownership of Index companies by type

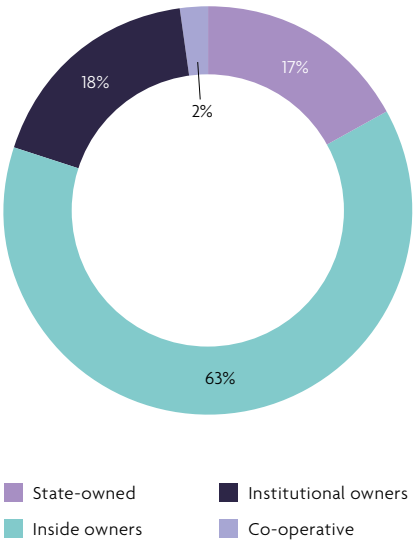


Table 1
Top 20 institutional investors by number of absolute company holdings in the Index[x]

	Institutional investor by number of absolute company holdings	Country
1	The Vanguard Group, Inc.	USA
2	State Street Global Advisors, Inc.	USA
3	BlackRock, Inc.	USA
4	Dimensional Fund Advisors LP	USA
5	Teachers Insurance and Annuity Association of America – College Retirement Equities Fund	USA
6	BNY Mellon Asset Management	USA
7	Northern Trust Global Investments	USA
8	Goldman Sachs Asset Management, LP	USA
9	Geode Capital Management, LLC	USA
10	Parametric Portfolio Associates LLC	USA
11	Norges Bank Investment Management	Norway
12	Credit Suisse Asset Management	Switzerland
13	Charles Schwab Investment Management, Inc.	USA
14	Mirae Asset Global Investments Co., Ltd	South Korea
15	Invesco Capital Management LLC	USA
16	Deutsche Asset & Wealth Management	Germany
17	AllianceBernstein LP	USA
18	GWL Investment Management Ltd.	Canada
19	DBX Advisors LLC	USA
20	SEI Investments Company	USA

x The list is based on shareholder data from the S&P Capital IQ platform as at 18 July 2019.

Financial materiality

The nine risk and opportunity factors assessed by the index are increasingly playing out in financially material terms.

FUNDAMENTAL REQUIREMENT → **LICENSE TO OPERATE**

FOOD SAFETY

FOOD SAFETY SYSTEMS | RECALLS & BANS

Research has shown that meat and poultry companies experience a negative stock price after a recall event. One study showed that shareholders' wealth reduces by an average of $109 million after a severe recall.[23]

In October 2018, JBS recalled 6.5 million pounds of raw beef due to risks of salmonella contamination. The company's share price fell as much by 5%.[24]

WASTE AND POLLUTION

WASTEWATER DISCHARGE | NUTRIENT MANAGEMENT | MANURE MANAGEMENT

Manure can be nutrient, but the scale of production today makes it a pollutant. Excessive application of manure not only harms local ecosystems and water sources, it also leads to poor health outcomes for communities that live next to these facilities due to poor air quality and groundwater contamination. Communities are beginning to push back, with increased incidences of protests and lawsuits against producers.

Smithfield Foods, subsidiary of Hong Kong-listed WH Group, has faced up to 26 lawsuits for nuisances suffered by neighbours due to hog waste generated. Penalties totalled over $550 million at the time of writing.[25]

Tyson Foods was fined $2 million by EPA over water pollution in Missouri in 2017.[26] In July 2019, property owners and organisations filed a lawsuit against the company for negligence, nuisance and wanton conduct.[27]

WORKING CONDITIONS

HUMAN RIGHTS | INJURY & FATALITY DATA | FAIR WORKING CONDITIONS | FREEDOM OF ASSOCIATION | SAFE WORKING CONDITIONS

In the US, the world's largest producer of animal proteins, serious injuries that require days away from work or work restrictions are three times higher in the meatpacking industry than in other industries.[28]

WATER SCARCITY

SCARCITY IN FACILITIES | SCARCITY IN ANIMAL FARMING | SCARCITY IN FEED FARMING

Feed prices for Singapore-listed company QAF (which owns pig farms in Australia) increased 55% from A$225/ton to A$350/ton in 2018 due to drought (QAF Annual Report 2018).

EMERGING ISSUES

ANTIBIOTICS

ANTIBIOTICS POLICY | DATA ON USAGE

Companies that do not use antibiotics responsibly will face regulatory risks. From 2022, the European Union will ban the use of human antibiotics in veterinary medicine, and the prophylactic (routine) dosing of livestock with antibiotics.[29] In July 2019, India banned the use of colistin – a 'last resort' antibiotic – on farms.[30] The Chinese government has also launched a pilot to eliminate use of antibiotics in livestock by 2020.[31]

ANIMAL WELFARE

WELFARE POLICY | AUDITING & ASSURANCE

CONFINEMENT | AQUATIC ANIMAL WELFARE

Welfare commitments are critical for market access. For example, over 236 companies now have commitments on cage-free eggs. These include McDonald's, Walmart, Kraft Heinz, Kroger, Denny's, Nestlé, Unilever and General Mills.[32]

BUSINESS RESILIENCE

GREENHOUSE GAS EMISSIONS

SCOPE 1 & 2 TARGET | SCOPE 3 TARGET

QUALITY OF GHG INVENTORY | EMISSIONS PERFORMANCE

In 2018-19, Australian Agricultural Company (AACo) suffered losses of over $100 million, partially due to extreme weather events (flooding) in Queensland. In addition to damage to properties, the company lost 43,000 heads of cattle (half the herd on four affected farms) worth $32 million. Further, the company's cost of production increased by 46% due to increased feeding and transport costs resulting from drought (AACo FY19 Financial Report).

DEFORESTATION & BIODIVERSITY LOSS

DEFORESTATION / CONVERSION | SUPPLIER ENGAGEMENT

Cargill, one of the world's largest commodity traders, including soy for animal feed, has said it will not meet its 2020 commitment to eliminate deforestation. The company will now spend $30 million to "fund new ideas for ending deforestation in Brazil".[33] This is part of a broad industry trend: despite growing investment from companies, there is a lack of progress on halting deforestation due to rapidly growing demand for soy and beef.

AQUATIC CERTIFICATION | FEED & CONVERSION RATIOS

DISEASE OUTBREAKS | ECOSYSTEM IMPACTS

Certification is key for market access: Large restaurant chains and retailers such as Walmart, Sainsbury's, Whole Foods and IKEA have made commitments to sourcing certified sustainable seafood.[34]

Fish feed accounts for 33-43% of the production cost of farmed salmon.[35] The World Bank finds that over 2010-30, fish meal and fish oil prices may rise by 90% and 70% respectively.[36]

Sea lice infestations cost $600 million annually.[37] Norwegian salmon farms are estimated to lose around 9% of revenues each harvest to sea lice-related costs.[38]

Mowi incurred costs of up to $3.4 million in Q3 2018 after ten cages collapsed and nearly 700,000 fish escaped.[39]

FORWARD THINKING

SUSTAINABLE PROTEINS

DIVERSIFICATION TO ALTERNATIVES

Barclays Capital estimates that sustainable proteins could grab as much as 10% of the $1.4 trillion meat market within 10 years.[40] Beyond Meat, the world's first listed plant-based meat company is now valued at more than $160 per share (at time of writing), more than six times its launch price of $25 a share.

Company assessment

The Coller FAIRR Protein Producer Index was launched in 2018 as a pilot Index. The nine factors and associated indicators included were derived from a top-down analysis of established standards and benchmarks. These included the Sustainability Accounting Standards Board's (SASB's) materiality matrix for the sector.

In 2019, we built on our pilot methodology to deepen our coverage of the sector. We consulted over 40 stakeholders, including issue experts, investors and company representatives, to refine this year's methodology. To ensure that indicators capture sector-specific issues against the most material risks, some risk factors and indicators are only applicable to individual protein sources.

Wherever possible, we have aligned individual indicators with existing methodologies and standards. This is to align with best practice and avoid increasing the reporting burden on companies.

Table 2
Risk and opportunity factors and alignment with other frameworks

Factor	Alignment with other frameworks	
GHG emissions	• GHG Protocol • CDP Climate Change Questionnaire • GRI • SBTi • SASB Meat, Dairy and Poultry Standard	
Deforestation and biodiversity	• Forest 500 • ASC • ASC Feed Standards • CDP Forests Questionnaire • GHG Protocol	• Ocean Disclosure Project • Global Salmon Initiative • BAP
Water use and scarcity	• CDP Water Questionnaire • Ceres Feeding Ourselves Thirsty 2017 • SASB Meat, Dairy and Poultry Standard	
Waste and pollution	• SASB Meat, Dairy and Poultry Standard • Ceres Feeding Ourselves Thirsty 2017 • Environmental Integrity Project	• CDP Water Questionnaire • GRI
Antibiotics	• WHO • ICCR • SASB Meat, Dairy and Poultry Standard	
Animal welfare	• SASB Meat, Dairy and Poultry Standard • Humane Society International Compassion in World Farming • EU Legislation	• Institute of Aquaculture University of Stirling • GlobalGap
Working conditions	• UN Guiding Principles on Human Rights • ETI Human Rights Due Diligence Framework • GRI	• ILO • World Bank EHS Guidelines • UFCW • OECD • ICCR
Food safety	• Global Food Safety Initiative (GFSI) • SASB Meat, Dairy and Poultry Standard • BRC • GRI	
Sustainable proteins	• The Good Food Institute (GFI)	

The biggest change in 2019 is the addition of 'sustainable proteins' as a scored factor.[xi] We have also added five new indicators and modified existing indicators to incorporate the latest industry standards and stakeholder feedback. While we have tried to stay consistent with the 2018 pilot Index, many of the significant changes aim to deepen our sector assessment and better integrate performance measures into the Index. For this reason, it is not possible to exactly compare the 2018 and 2019 results, though there are some clear trends. We hope to set a baseline with this year's methodology to see year-on-year movement in future iterations of the Index.

FAIRR conducted company assessments using publicly available information. This includes annual and sustainability reports, company websites and (where available) CDP disclosures.

Figure 10
Company rank components

> **We hope to set a baseline with this year's methodology to see year-on-year movement in future iterations of the Index**

The final company rankings are based on two individual scores:

Risk Factor Score: A simple average of scores across the eight individual risk factors (GHGs; deforestation and biodiversity; water scarcity; water pollution; antibiotics; animal welfare; working conditions; food safety).

Where relevant, company scores on individual risk factors can decrease if policies and programmes are only applicable to certain geographies. Another element that can reduce the risk factor scores is the presence of multiple controversial events, which indicates poor management of the risk. We consider controversies by applying a confidence multiplier of 90% at the risk factor level for a company if there are three or more discrete events within the assessment period. Companies with fewer than three events will not have their scores reduced, but we will include the ⚠ symbol to indicate the presence of a controversy.

On its own, the Risk Factor Score is a useful measure of company performance across the eight risks.

Opportunity Factor Score: This captures the company's performance on the opportunity factor of 'sustainable proteins'.

The Risk + Opportunity score over-weights the Opportunity Factor Score in relation to the Risk Factor Score. This is because growing exposure to alternative non-animal proteins automatically reduces the company's exposure to these risks.

For an in-depth discussion on scoring, see Appendix 2: Methodology and scoring.

xi FAIRR has developed a methodology for assessing how successfully companies are preparing to diversify their protein sources. This is through our collaborative investor engagement on sustainable proteins, which focuses on global food retailers and manufacturers. The Sustainable Proteins factor was adapted from this methodology. For more on the sustainable proteins report and engagement, see fairr.org.

Based on final company scores, companies are assessed in one of the following categories:

HIGH RISK	MEDIUM RISK	LOW RISK	BEST PRACTICE (NEW)
No or limited disclosure and commitments	Basic management of the risk with limited detail	Moderate management of the risk with more detail	Strong management of risk with more detail
	Some disclosure of performance metrics	Moderate levels of disclosure of performance metrics	High levels of disclosure of performance metrics
	Basic performance targets	Moderate performance targets	Strong performance targets
	Limited geographical application	Near global application	Global application
			Improving performance

Company engagement with FAIRR

We invited companies to give feedback on the assessment methodology and to self-report according to the methodology via an online questionnaire.[xii] We also shared individual assessments with all Index companies to give them an opportunity to provide feedback.

The table on the right shows how companies engaged with the Coller FAIRR Protein Producer Index in 2019:

Company	Provided feedback on methodology	Self-reported via online questionnaire	Provided feedback on FAIRR's assessment
Fonterra	✓	✓	✓
Mowi	✓	✓	✓
Bakkafrost	✓		✓
BRF	✓		✓
Grieg Seafood	✓		✓
JBS	✓		✓
Lerøy		✓	✓
Maple Leaf Foods	✓	✓	✓
Mengniu			✓
Tassal	✓		✓
Cranswick			✓
Grupo Nutresa			✓
Hormel		✓	✓
Muyuan Foods			✓
RCL Foods	✓		✓
Tyson			✓

xii Company engagement with FAIRR did not have any bearing on assessment scores.

CASE STUDY: THE DISCLOSURE OF SASB METRICS BY INDEX COMPANIES

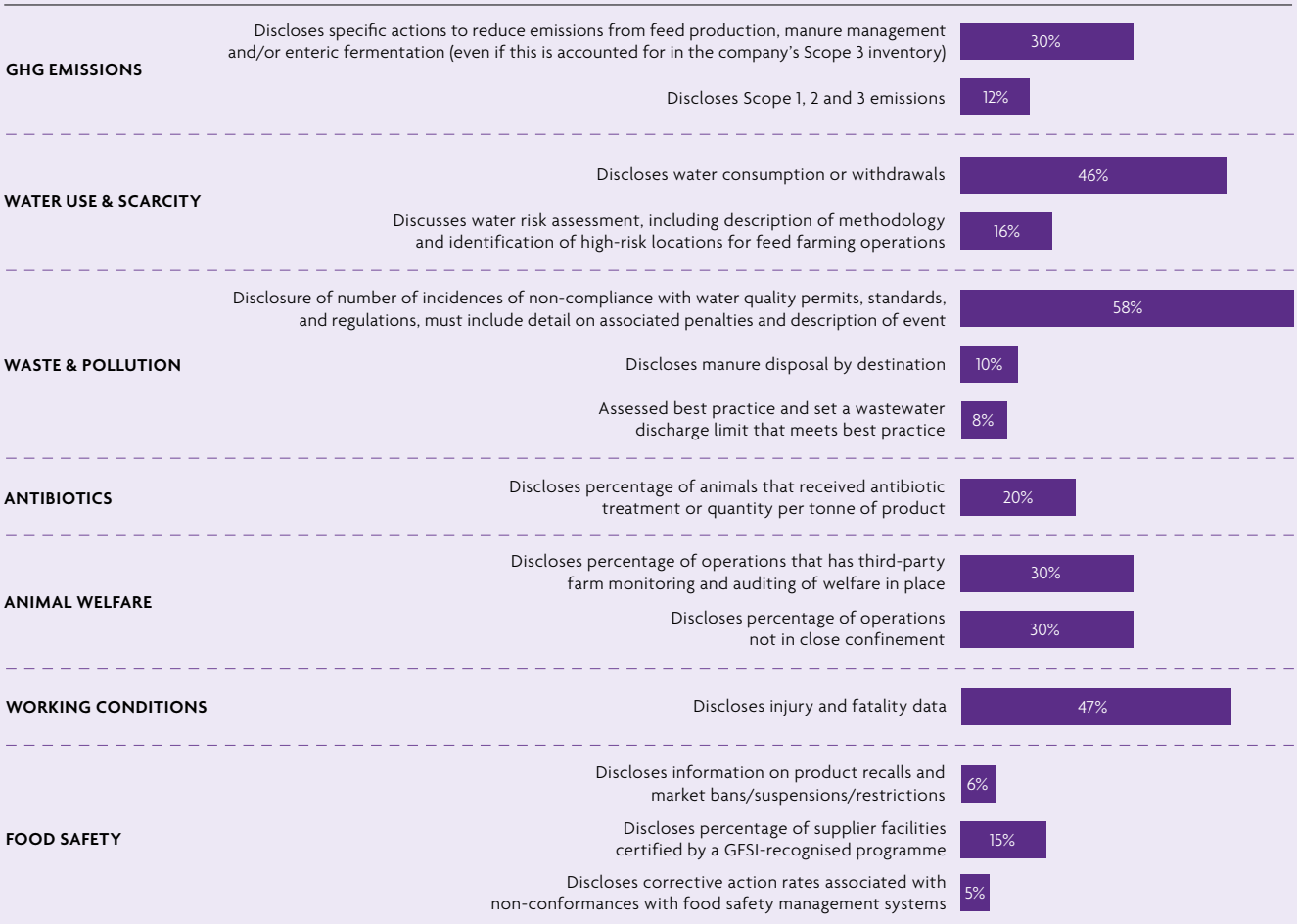
The Sustainability Accounting Standards Board (SASB) is an independent standard-setting board that produces disclosure standards that connect businesses and investors on the financial impacts of sustainability. It identifies sustainability issues that are likely to materially affect the financial condition or operating performance of companies within an industry.

For the food and beverage sector, SASB has developed eight separate standards, including the Meat, Poultry and Dairy Standard.

FAIRR collaborated with SASB to integrate and apply SASB metrics to the 60 companies for the 2019 Index methodology. Twelve of the Index's 30 KPIs are aligned with SASB metrics. Only a small proportion of Index constituents are disclosing these.

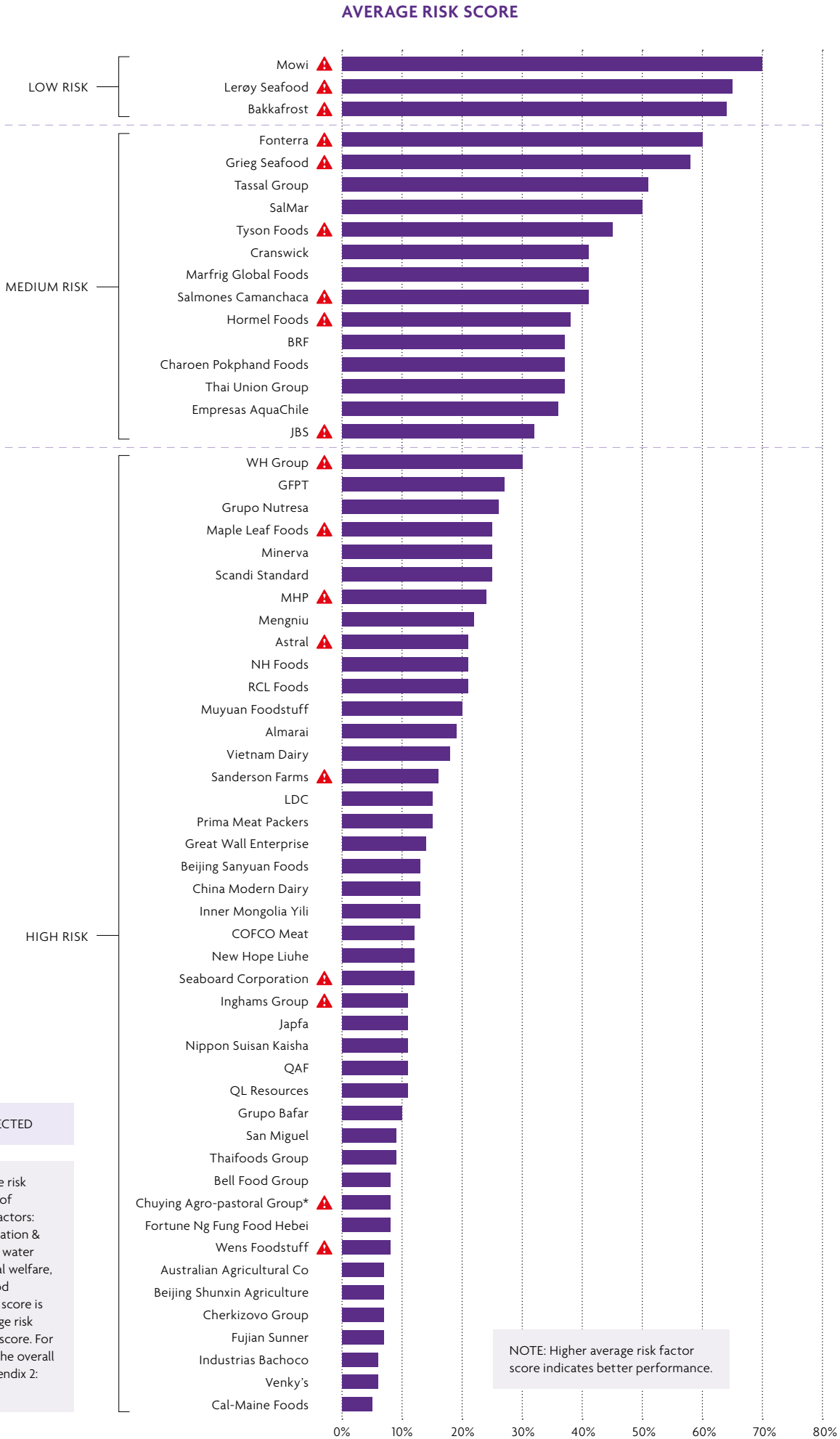
> **"We're encouraged by the increasing alignment between the SASB standard for the meat, poultry and dairy industry and the FAIRR Protein Producer Index. It reflects a growing consensus among the industry and its investors on the key sustainability challenges to preserving and creating value over the long term. This year's findings will serve not only as important signals for investors, but valuable inputs for SASB's ongoing research and standard-setting activities."**
>
> **Bryan Esterly**
> Director of Research – Standards, SASB

Figure 11
Percentage of 60 Index companies disclosing SASB-aligned indicators[xiii]



xiii Each KPI has multiple criteria which are aligned with SASB metrics.

The 2019 Index

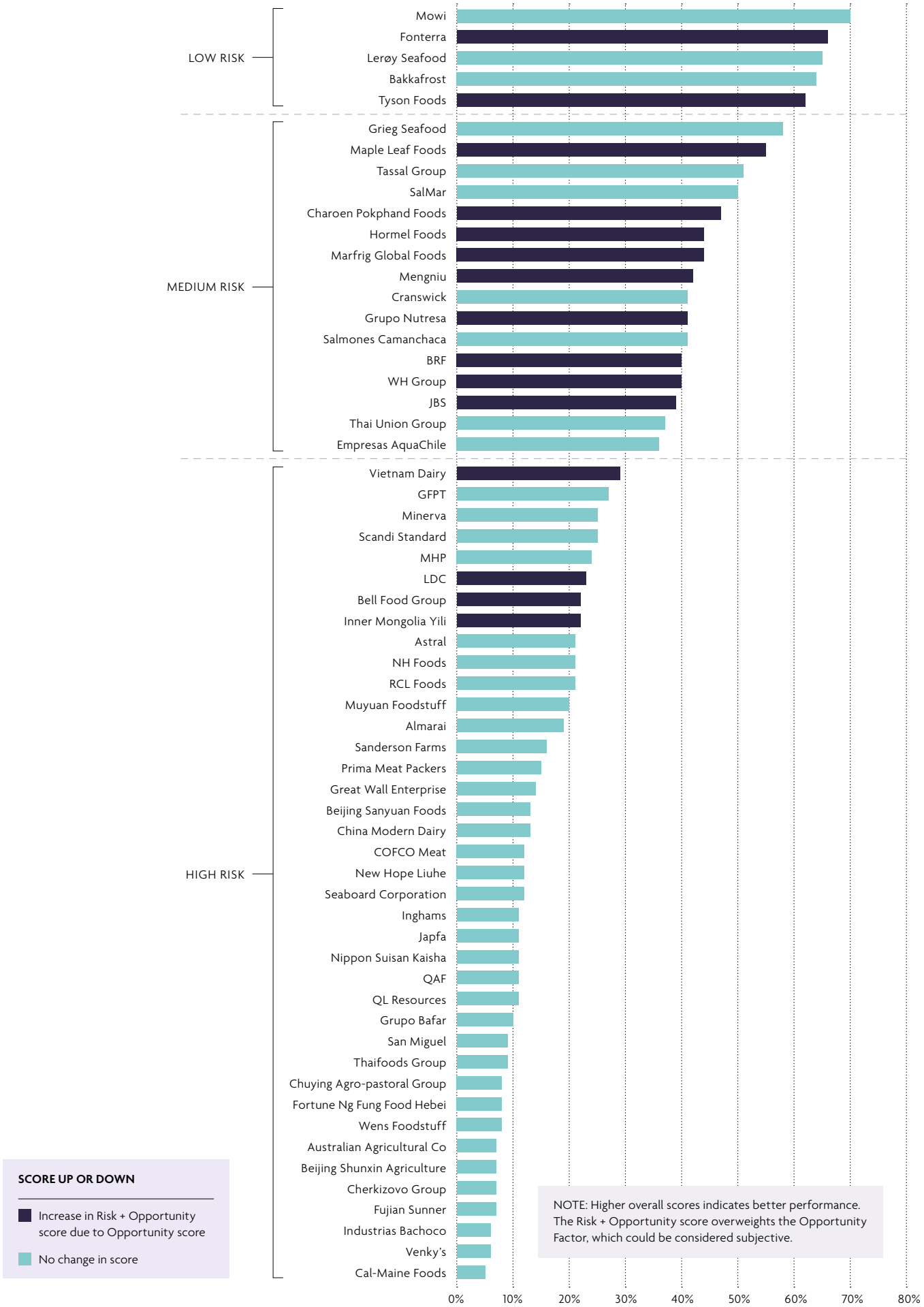


⚠ CONTROVERSIES DETECTED

NOTE: A company's average risk score is the simple average of scores across all eight risk factors: greenhouse gases, deforestation & biodiversity, water scarcity, water pollution, antibiotics, animal welfare, working conditions and food safety. A company's overall score is a combination of the average risk score and the opportunity score. For more information on how the overall score is calculated, see Appendix 2: Methodology and scoring.

*De-listed in August 2019

RISK + OPPORTUNITY SCORE



KEY FINDINGS

The 2019 Index demonstrates that the vast majority of companies have yet to meaningfully address even the most basic sustainability risks. Thirty-nine (of 60) companies, valued at $175 billion and with combined revenues of over $116 billion, are ranked as high risk (worst performers) by the Index.

BEST PERFORMERS

Similar to last year's Index, the five companies categorised as 'low risk' include three European aquaculture companies. Two land-based companies – Fonterra and Tyson – have improved their scores primarily due to their work to manage greenhouse gas emissions and invest in sustainable proteins.

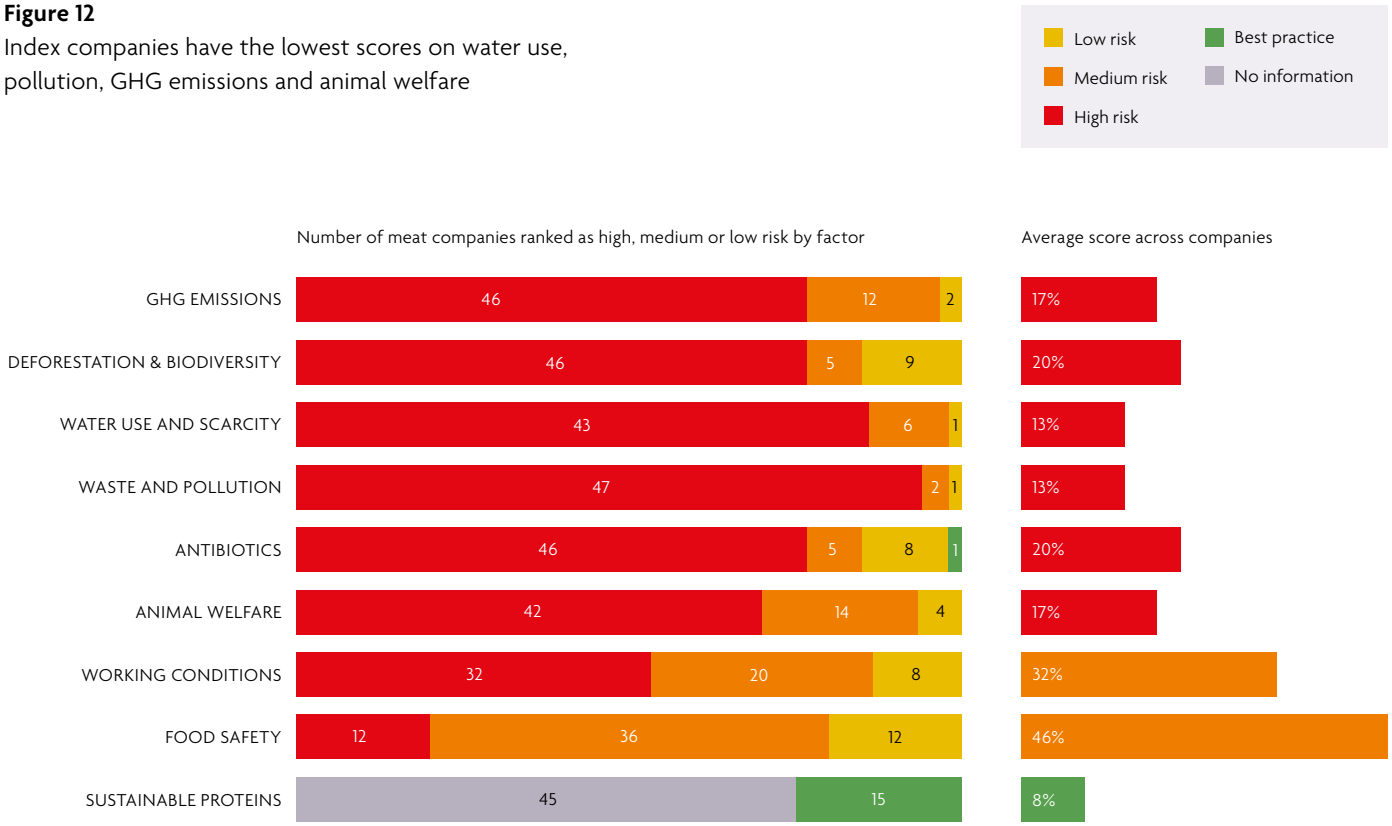
Mowi ASA	Aquaculture
Fonterra Co-operative Group Ltd	Dairy
Lerøy Seafood Group ASA	Aquaculture
Bakkafrost P/F	Aquaculture
Tyson Foods Inc	Meat proteins

WORST PERFORMERS

The bottom five companies in the Index received average scores of 6%, indicating that these companies have very limited management and/or disclosure on any of the nine risk and opportunity factors.

Fujian Sunner Development Co Ltd	Poultry & eggs
Beijing Shunxin Agriculture Co Ltd	Pork
Venky's India Ltd	Poultry & eggs
Industrias Bachoco SAB de CV	Poultry & eggs
Cal-Maine Foods Inc	Poultry & eggs

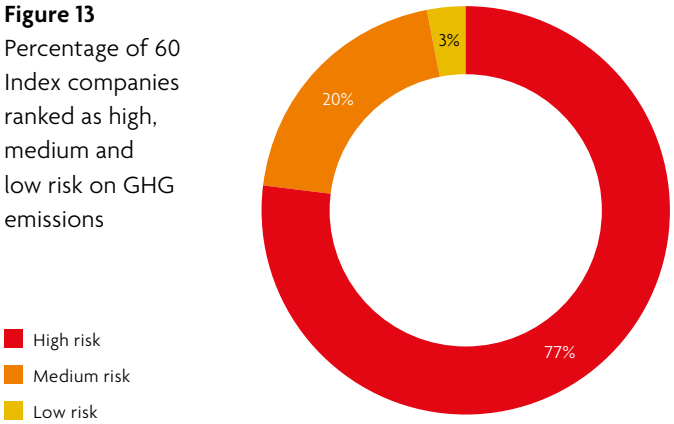
Figure 12
Index companies have the lowest scores on water use, pollution, GHG emissions and animal welfare



GREENHOUSE GAS EMISSIONS

- The 60 companies scored an **average of 17%** on managing greenhouse gas emissions.
- **Forty-six companies** (77%), valued at $222 billion and with revenues of $138 billion, are categorised as 'high risk' – i.e. they have **little to no disclosure** on greenhouse gas emissions targets across their operations and supply chains.
- **Tyson Foods** is the only company with a science-based target for emissions reduction. But it **has yet to disclose some of the biggest sources** of emissions, such as enteric fermentation, feed production and manure management.
- **Seven** companies have disclosed on-farm sources, including feed production, within their emissions inventory
- Companies are reporting losses linked to climate change. **Australian Agricultural Company** (AACo), Australia's biggest beef company, lost over **$100 million** in 2018-19, partially due to extreme flooding, yet it discloses no climate change mitigation or adaptation strategies.

Figure 13
Percentage of 60 Index companies ranked as high, medium and low risk on GHG emissions



- A **holistic strategy** on climate management requires companies to go beyond setting targets: they must complete their emissions inventory to include all significant on-farm sources and demonstrate year-on-year reductions on absolute emissions across all three scopes.

Figure 14
How 22 companies in the Index that report Scope 1, 2 and/or 3 emissions compare on all parameters of climate management.

QUALITY OF INVENTORY
- Complete
- Minor gaps
- Major gaps
- Incomplete

TARGET STRENGTH
- Science-based target
- Target covers >95% emissions in scope
- Target covers 66-95% emissions in scope
- Partial target
- Energy-related target

CHANGE IN ABSOLUTE EMISSIONS
- Large decrease
- Small decrease
- Increase

	QUALITY OF INVENTORY	TARGET STRENGTH	CHANGE IN ABSOLUTE EMISSIONS
Mowi	Complete	Science-based target	Large decrease
Grieg Seafood	Complete	Science-based target	Increase
Lerøy Seafood	Complete	Science-based target	Increase
Marfrig Global Foods	Complete	Science-based target	Increase
WH Group	Complete	Science-based target	Increase
SalMar	Complete	Science-based target	Increase
Bakkafrost	Complete	Energy-related target	Small decrease
Fonterra	Minor gaps	Science-based target	Small decrease
Thai Union Group	Major gaps	Science-based target	Small decrease
NH Foods	Major gaps	Science-based target	Small decrease
JBS	Major gaps	Energy-related target	Small decrease
Charoen Pokphand Foods	Major gaps	Energy-related target	Small decrease
Hormel Foods	Major gaps	Energy-related target	Increase
RCL Foods	Major gaps	Energy-related target	Increase
BRF	Major gaps	Energy-related target	Increase
Tyson Foods	Incomplete	Science-based target	Increase
Cranswick	Incomplete	Science-based target	Small decrease
Maple Leaf Foods	Incomplete	Energy-related target	Increase
Grupo Nutresa	Incomplete	Energy-related target	Small decrease
Almarai	Incomplete	Energy-related target	Small decrease
Tassal Group	Incomplete	Energy-related target	Increase
China Modern Dairy	Incomplete	Energy-related target	Increase

WATER USE AND SCARCITY

- The 50 meat and dairy companies that have critical dependency on freshwater resources scored an **average of 13%** on managing water use.
- **Forty-three companies** (86%), valued at $211 billion and with revenues of $156 billion, are categorised as 'high risk', including 12 producers who provide no discussion on how they manage water use.
- Where companies do address water scarcity, these initiatives are focussed on their direct operations, with companies receiving **average scores of 5% and 9%** on water saving measures in feed and animal farming respectively.
- **12 meat and/or dairy companies** have set specific time-bound water use targets for their facilities, but only two companies, Hormel Foods and Tyson Foods seem to have targets that are 'risk differentiated,' i.e., based on local context.

Figure 15
Water use in livestock production

Water use in feed farming
98% of the total volume of water for animal farming is used for feed production, which makes it highly vulnerable to droughts and other extreme weather events.

Water use in animal farming
Water use in animal farming is primarily for drinking, service water and feed mixing water.

Water use in direct operations
Water is used primarily in slaughtering and processing, for washing livestock, rinsing carcases, cleaning process equiment as well as any processing operations.

WATER POLLUTION IN LIVESTOCK PRODUCTION

- Meat and dairy companies in the Index scored an **average of 13%** on managing water pollution.
- **Forty-seven** companies (94%), valued at $273 billion and with revenues of $260 billion, categorised as 'high risk', including **six** producers which provide **no disclosure** on how they manage pollution linked to fertilizer use and manure.
- **Thirty-three** companies (66%) demonstrate little to no awareness of the need to manage manure sustainably.
- **No company meets SASB's standards** for the sector, which requires disclosure of the amount of manure generated.[41]
- Manure management is the primary driver of community protests and lawsuits. Smithfield Foods, a subsidiary of WH Group, has received **penalties totalling over $550 million** as a result of lawsuits related to hog waste.
- **A single farm** with 140,000 heads of cattle produces more sanitary waste than the **2.3 million** residents of Houston, Texas[42]

DEFORESTATION & BIODIVERSITY

- The 50 meat and dairy companies exposed to deforestation risks in their soy and/or cattle supply chains scored an **average of 8%** on managing these risks.
- **Forty-four** companies (88%), valued at $229 billion and with revenues of $160 billion, are categorised as 'high risk', including **31** which provide no disclosure on deforestation.
- **None** of the 50 meat and dairy companies in the Index have a policy to address or mitigate deforestation that covers all regions in which they source soy and/or cattle.
- The **US-China trade war** is contributing to increased Chinese imports of Brazilian soy, intensifying deforestation rates in the Amazon, already up by **278%** since last year.[43,44]
- **88%** of Asian companies – potentially some of the largest soy buyers from Brazil – have no discussion on deforestation risks. This includes the eight Chinese conglomerates that produce pork.
- All 10 pure aquaculture companies are fully certified or working towards full certification by aquaculture certification schemes, indicating certification has become a core business requirement.

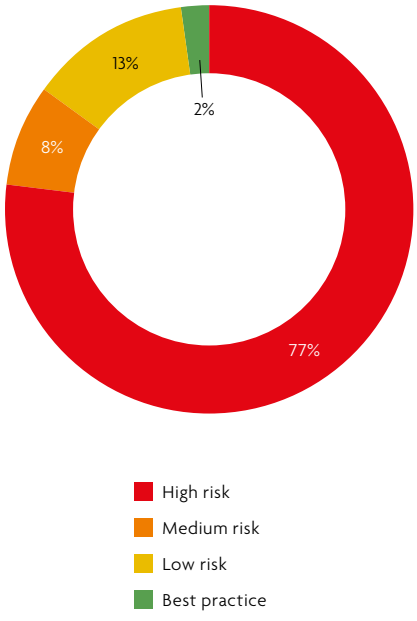
ANIMAL WELFARE

- Meat companies score an average of **22% on welfare commitments** and even lower on third-party auditing and assurance of welfare (14%).
- **Thirty-eight companies** (75%), valued at $217 billion and with revenues of $201 billion, are categorised as 'high risk'.
- Customers such as **McDonald's** and **Kraft Heinz** have developed cage-free commitments, but Cal-Maine, one of the US's largest egg producers does not have a policy to produce cage-free eggs.
- **Only 53% of fish farming** companies discuss the **importance of animal welfare** to the company.
- The discussion remains at a high-level as the discussion tends to **focus on basic metrics such as stocking densities**, housing conditions and reducing mortality rates.
- **Mowi** is the only producer to have some of its operations (in **Scotland**) certified by **RSPCA Assured**.

ANTIBIOTICS

- The 60 companies in the Index scored an **average of 20%** on responding to antibiotic risks
- **Fourty-six companies** (77%), valued at $250 billion and with revenues of $260 billion, are categorised as 'high risk', including **22 who have no policy** on antibiotics use and do not disclose the quantities or types of antibiotics used on their farms.
- **Just four companies** - Bakkafrost, GFPT, Lerøy Seafood, Marfrig Global Foods – have committed to **ending routine use** of antibiotics in farm animals.
- **McDonalds** and **Yum! Brands** have recently committed to reducing antibiotics use in their beef supply chains. But Marfrig is the only beef company that has a policy limiting antibiotics use. McDonald's and Yum! Brands purchase from at least 14 other Index companies, including JBS, Hormel Foods and Tyson Foods.

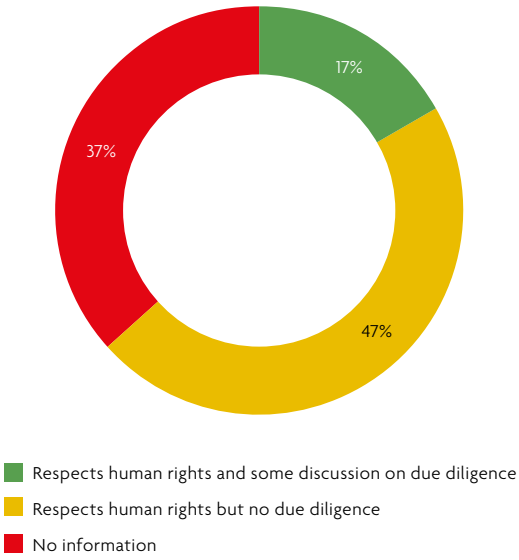
Figure 16
77% of companies are ranked as 'high risk' on antibiotics



WORKING CONDITIONS

- **Fifty companies (83%)**, valued at $264 billion, **do not discuss human rights due diligence** processes to identify, prevent and remedy human rights abuses in business operations.
- **No company** discusses how it is **meeting the UN Guiding Principles of Business and Human Rights**.
- In the US, serious injuries to **meatpacking workers are three times higher than the industrial average**.
- Sixteen companies (**32%**) provide **no disclosure of work-related injury and fatalities**.

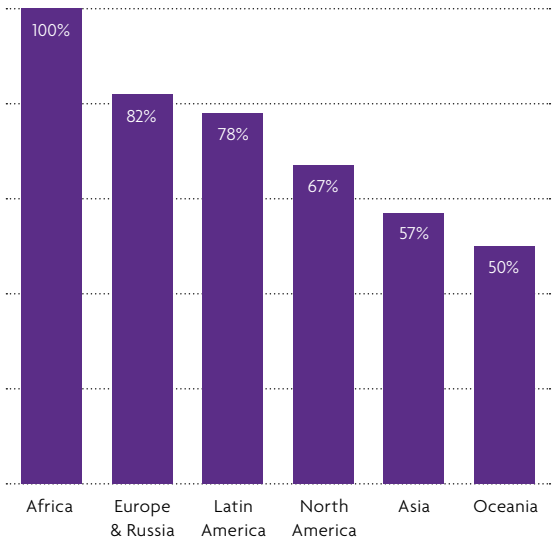
Figure 17
83% of companies do not have a human rights due diligence process



FOOD SAFETY

- **Forty companies (67%), valued at $250 billion, have food safety management certifications recognised by the Global Food Safety Initiative (GFSI)**, which indicates compliance with international food safety standards.
- **82% of companies** headquartered in Europe and Russia have some level of certification, compared to only 57% of Asian companies.
- **Only two of the four Chinese** dairy companies have some operations certified by a GFSI-recognised scheme – **which is significant given the focus on food safety in China**.

Figure 18
The percentage of companies with food safety certification recognised by the GFSI varies across regions



SUSTAINABLE PROTEINS

- Fifteen companies (25%) show evidence of some work to diversify protein products to alternatives. In the last year, eight meat and dairy companies have **introduced plant-based products or announced plans for plant-based ranges**.
- Eleven companies have **announced investments** to grow their alternative protein portfolio. Maple Leaf Foods leads the sector, with £320 million invested in expanding alternative protein production.

1

Meat proteins

The Coller FAIRR Protein Producer Index includes 44 companies that produce beef, pork or poultry (or all three). These 44 companies generate $257 billion in revenues – or 80% of the total 2018 revenues for all Index companies. They are valued at $235 billion in market capitalisation – or 73% of the total market capitalisation of the 60 Index constituents. It is common for poultry producers to also produce pork: 19 of the 44 meat producers produce both.

These companies are highly diverse in terms of their business models, proteins produced and market concentration. Given this diversity, we assess companies that produce multiple proteins across each protein. For example, Tyson Foods produces beef, poultry and pork. We assess it within the beef, poultry and pork sections of the Index.

Overview of performance: meat, dairy and aquaculture companies

Figure 19
Meat proteins have the highest number of companies classified as high risk, and the lowest average risk factor scores

Figure 20
The highest number of meat companies do not disclose information on deforestation-related risks

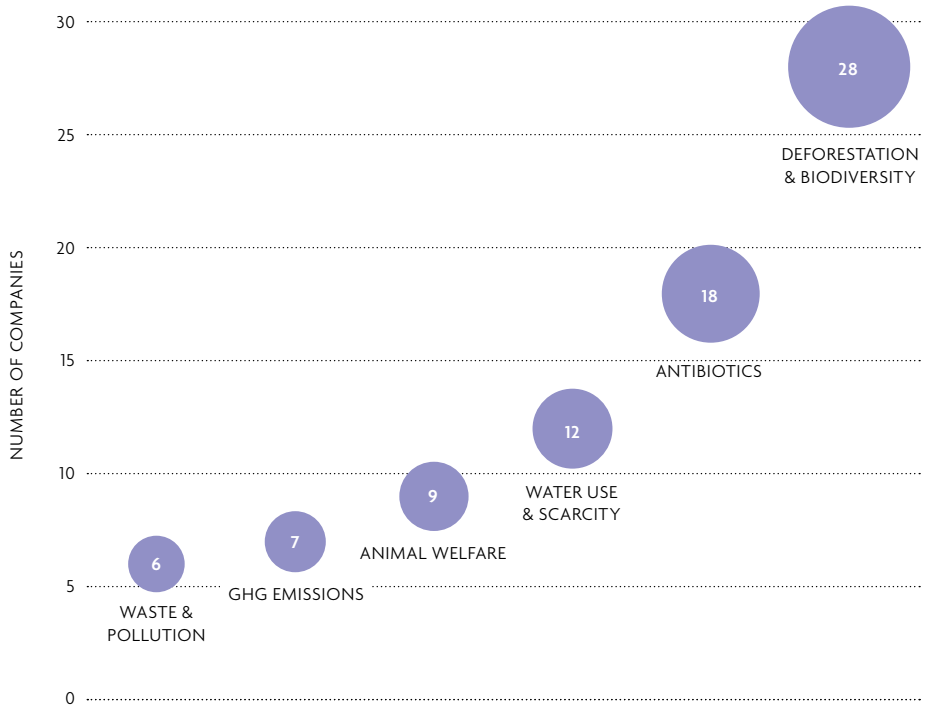
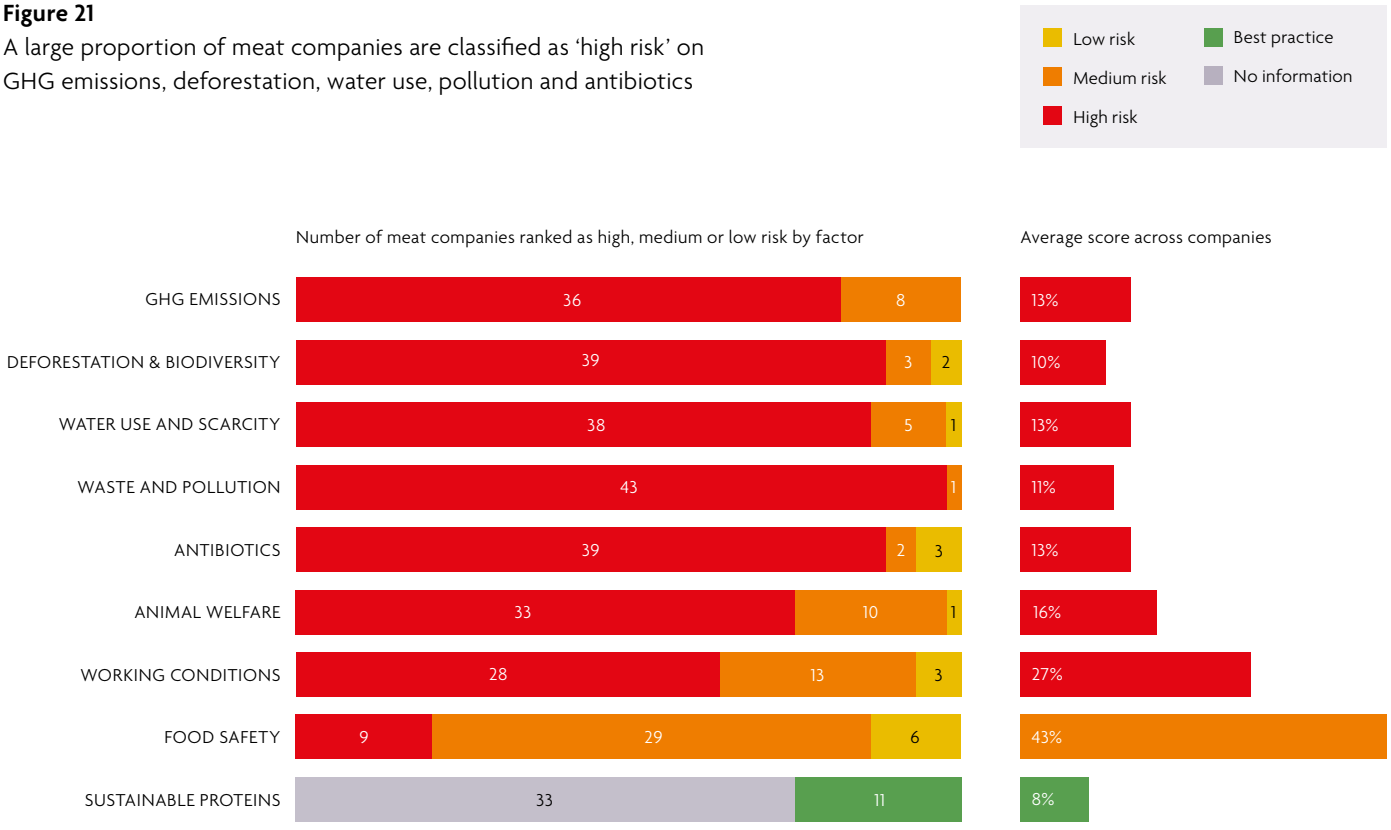


Figure 21
A large proportion of meat companies are classified as 'high risk' on GHG emissions, deforestation, water use, pollution and antibiotics



BEEF CATTLE

Sector context: beef production

In 2017, 350 million heads of cattle around the world produced 73 million tonnes of beef.[45] The US was the largest producer, at 16% of global production volumes, followed by Brazil, China, Argentina and Australia. In terms of annual beef consumption per capita, Argentina, Australia, Brazil, Israel and the US top the rankings, with amounts ranging from 40 to 90 pounds.[46]

Beef production differs between countries, but most large-scale commercialised beef operations are a combination of grass-fed and grain-fed. A common aspect of the modern beef production industry is its vertical segmentation. This contrasts with vertically integrated systems for pork and poultry. Cattle typically change hands several times before they reach abattoirs for slaughter. In the US, for example, 60% of beef calves are placed into 'backgrounding or stocker operations' (or a combination). They are then moved to feedlots for fattening on high-concentrate grain-based diets (primarily corn and soy, but also forage feed such as alfalfa).[47] Similarly, in Brazil, where the cattle are predominantly pasture-raised, cattle can move between indirect suppliers (ranch-to-ranch transfers) throughout all production phases, including breeding, rearing and fattening.[48]

KEY INSIGHTS

- Beef cattle are responsible for the most emissions from livestock. Only one of the 16 companies that produce or sell beef (or both) has a science-based emissions reduction target.
- Most companies producing or selling beef are not addressing their exposure or management of deforestation risks linked to soy or cattle.
- Almost all (98%) of the water footprint associated with animal proteins is linked to feed production. Companies that produce or sell beef are not addressing water risks in their feed supply chains.
- Companies that produce or sell beef are not managing their significant water pollution risks.
- Companies that produce or sell beef demonstrate very poor awareness of antibiotics stewardship.
- Beef companies are vulnerable to food safety risks and are responding with certifications that meet international food safety requirements.

Main ESG risks in beef production

RISK FACTOR	DESCRIPTION	GRAIN-FED	GRASS-FED
GREENHOUSE GASES	Enteric fermentation produces methane (CH_4) through the decomposition and fermentation of plant materials by microbes in the digestive tract of ruminants.[49] Enteric fermentation from cattle is the largest driver of emissions from livestock, at 39% of all emissions associated with the sector.[50]	✓	✓
DEFORESTATION & BIODIVERSITY LOSS	Cattle ranching is the largest driver of deforestation, especially in ecologically sensitive areas like Brazil. The country is the world's biggest exporter of beef. It is set to increase its exports from 20% to 23% of global beef exports by 2028.[51,52]	✓	✓
WATER SCARCITY	Beef cattle is the most water-intensive protein, at six times the water intensity of pulses (on a per gram of protein basis).[53]	✓	✓
WASTE & POLLUTION	Almost 97% of the cattle in the US are 'finished' in feedlots. These typically contain hundreds of thousands of cattle in a small space at any given time. The vast amounts of manure produced by cattle impacts air, soil and water quality through contaminated runoffs and by applying too much manure in surrounding areas.	✓	✓
ANTIBIOTICS	Antibiotics are used extensively in beef feedlots, where most intensively farmed cattle are fattened before slaughtering. In the US, for example, farmers routinely feed cattle Tylosin. This is a medically important drug to prevent diseases like liver abscesses, which occur from grain-fed diets.[54]	✓	✓
WORKING CONDITIONS	In Brazil, the cattle industry has the largest number of slave labour cases in the country. In 2016 and 2017, 280 workers were rescued from the industry at 46 different ranches.[55]	✓	✓

✓ MORE PREVALENT ✓ LESS PREVALENT

All these risks are exacerbated by the sector's highly fragmented nature. This makes it hard for companies to trace and track cattle as they move through the supply chain.

Beef companies assessed in the Index

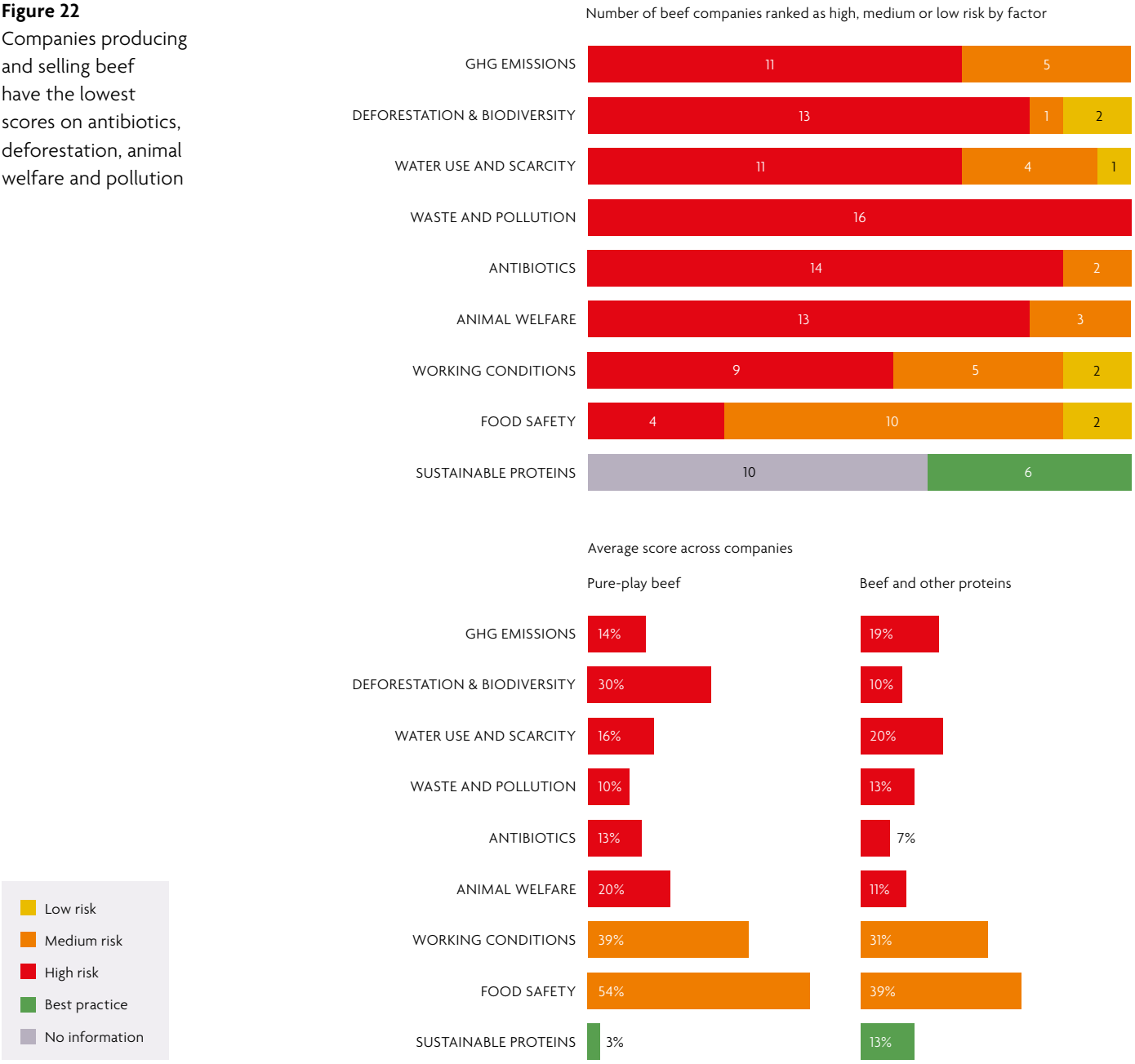
The Index includes 16 companies that produce and sell beef products, including three that are pure-play beef producing companies. These 16 companies contribute a total of $146 billion in revenues (46% of the total 2018 revenues for all 60 Index companies). They have a market capitalisation of $94 billion (29% of the total).

The estimated revenue linked to beef production and sales alone is approximately $66 billion.[xiv]

Companies that produce and sell beef are assessed on all nine factors and 27 KPIs. All land-based protein producers are assessed on 25 KPIs. Beef producers are assessed on two additional KPIs: (a) deforestation/conversion-free commitment; and (b) supplier engagement, monitoring and traceability in cattle supply chains.

xiv We have disaggregated revenues to protein source based primarily on company disclosures. Where these revenues are consolidated for companies that produce and sell multiple proteins, we have assigned revenue proportions based on our understanding of the business.

Figure 22
Companies producing and selling beef have the lowest scores on antibiotics, deforestation, animal welfare and pollution



Discussion of results

> Beef cattle are responsible for the most emissions from livestock. Only one of the 16 companies that produce or sell beef (or both) has a science-based emissions reduction target

Four companies, including one pure-play beef producer, do not have any discussion on emissions targets. Nearly a third (31%) of companies that produce or sell beef disclose limited emissions reduction targets, such as on energy savings or to increase renewable energy. This is even though most emissions in the sector come from non-mechanical sources (feed production, enteric fermentation and manure) rather than from energy use.

Even within five companies that have set targets to reduce Scope 1 + 2 emissions, there is a lack of transparency on what emissions sources are covered by their target. It is not clear whether emissions from non-mechanical sources are included.

Tyson Foods is the only company to have set a science-based target to reduce Scope 3 emissions (from pork, poultry and beef – covering 80% of its Scope 3 emissions inventory) by 30% by 2030. Tyson mainly produces poultry via contract farmers but also buys pork and cattle for processing. However, even in Tyson's case, it's unclear if the target covers the company's full animal protein value chain. The company does not currently collect or calculate GHG emissions from its agricultural commodities. So it is unclear how the company has determined the full value of its inventory.

FAIRR *comment*

Beyond the setting of science-based emissions-reduction targets, the Index methodology assesses two other KPIs: (a) the quality and completeness of a company's GHG inventory; and (b) emissions performance. Company business models are diverse: whether animal agriculture-related emissions are located in Scope 1 or 3 depends on the company. Some companies both own farms and source livestock from farmers (for example, Tyson Foods). This lack of clarity in boundary setting for Scope 1 and 3 emissions makes assessment on these two KPIs unclear. If a company's GHG inventory is unclear or incomplete but it has disclosed decreasing absolute emissions, we have limited the maximum points awarded.

In terms of the quality and completeness of their GHG inventories, only one of the 16 companies has calculated emissions from the production of feed crops. These crops account for 45% of livestock emissions and are typically part of Scope 3 emissions unless the company grows its own feed.[57] Three companies now disclose other agricultural emissions (primarily enteric fermentation and manure management) as part of Scope 1 or Scope 3. While this number remains modest, it is encouraging to see more companies begin to include agriculture-related emissions in their reporting this year. Four companies do not report any GHG inventories.

FAIRR *comment*

In July 2019, Cargill, one of the largest agricultural conglomerates and the largest privately held corporation in the US, set a target to reduce GHG emissions. It pledged to cut emissions in its North American beef supply chain by 30% by 2030 under its initiative 'BeefUp Sustainability'.[58] FAIRR believes this is a positive development. Currently, Tyson is the only meat company with an approved science-based target. This means it will reduce Scope 3 emissions from its animal proteins (which are around 80% of the Scope 3 inventory). It is unclear why Cargill chose not to develop an official science-based target, which is aligned with a 2°C or 1.5°C pathway. Cargill is vulnerable to climate change impacts – the company has extensive supply disruptions due to floods in the US Midwest, including a bomb cyclone that shut down its beef processing facility.[59]

> Most companies producing or selling beef are not addressing their exposure or management of deforestation risks linked to soy or cattle.

Companies selling beef are primarily exposed to deforestation risks in soy during the feedlot phase – that is, when the cattle are fattened on a grain-based diet.

Five of the 16 companies are located in Latin America, where there is a high risk of deforestation and conversion of natural vegetation. Only two companies, JBS and Marfrig, have commitments to avoid deforestation linked to soy, but this is limited to certain regions (such as the Amazon Biome). The other three companies do not discuss how they manage risks associated with soy in their supply chain.

In other regions, only one company – Tyson Foods – provides some limited publicly available discussion on soy used for animal feed. This is used by Tyson's suppliers who grow its beef. It is unclear where Tyson's beef farmers source most of their soy – whether from the US or Brazil. In summary, 11 of the 16 (69%) companies do not discuss deforestation risks in soy supply chains, including two pure-play beef companies.

Companies with beef supply chains are are also exposed to deforestation risks from cattle ranching. This is especially true if they operate in or source from areas such as Brazil, Argentina, Paraguay and (increasingly) Australia.[60]

Three of the six companies that produce or sell beef and are based in these regions have explicit no-deforestation policies. JBS, Marfrig and Minerva have signed the 'Public Livestock Commitment', which commits them to exclude any suppliers that clear the Amazon rainforest after 2009. All three companies provide external assurance of their compliance with this commitment.

However, a common issue is that these companies only address deforestation risks in the Amazon biome, despite potentially sourcing from other high-risk areas such as the Cerrado and Paraguay. Even in the Amazon, despite strong supplier engagement and monitoring systems, these companies remain at risk because of surging beef demand and the highly fragmented nature of the cattle supply chain. In July 2019, an investigation found that JBS was still buying cattle from deforested areas. This is despite a publicly available audit report that states that "99.9% of JBS's cattle purchases meet the company's socio-environmental criteria and the 'Public Livestock Commitment'".[61] Political developments in Brazil are exacerbating this risk: recent data from government sources show that "deforestation of the Brazilian Amazon has surged above three football fields a minute".[62] This is pushing the region towards an unrecoverable tipping point.

Over 60% (10 of 16) of companies that produce or sell beef have no or very limited public discussion of deforestation risks linked to their cattle supply chains. This includes Australian Agricultural Company, Australia's largest beef company, and NH Foods, which produces beef in Uruguay and Australia.

> Almost all (98%) of the water footprint associated with animal proteins is linked to feed production. Companies that produce or sell beef are not addressing water risks in their feed supply chains.

Over 68% of companies do not address water use management in their feed supply chains, including two companies that are pure-play beef producers. This is significant given the dependence of beef companies on feed crops and their exposure to fluctuations in commodity prices. Australian beef producer Australian Agricultural Company faced a 46% increase in the cost of production caused by higher feeding and transport costs after a drought.[63] As extreme weather events increase in frequency with climate change, the margins of beef and other livestock companies will be hit. This is especially true if companies do not develop effective risk mitigation strategies in time.

Five companies provide some discussion on water scarcity risks in their feed supply chains. However, most merely acknowledge the risk or make a reference to responsible water management in their supplier code of conduct. Only one company – Hormel Foods – has established a sustainable agriculture policy that extends to feed grain growers. As part of this policy, feed grain suppliers are expected to adopt water-use efficiency objectives.

> Companies that produce or sell beef are not managing their significant water pollution risks.

Wastewater discharged from slaughterhouses is rich in oxygen-demanding organic matter (such as blood, fat, urine and faeces).[64] These are highly polluting to local water resources when left untreated or when limits are breached. Most companies (12 of the 16) disclose that they did not breach regulatory limits. However, not only does the strength of regulation vary depending on jurisdiction (sometimes even between states within a country), but the enforcement of discharge limits varies too. In 2018, an investigative report by the Environmental Integrity Project found that from January 2016 to June 2018, 74 large meat processing plants based in the US were discharging large amounts of pollution directly into waterways.[65] Most of these plants were owned by Tyson and JBS. In June 2019, one of Tyson's plants discharged 800,000 gallons of wastewater killing thousands of fish and spreading E Coli along a river in Alabama, US.[66]

The US Clean Water Act requires the Environmental Protection Agency (EPA) to set effluent limits. In 2004, the EPA set maximum limits on the monthly discharges and daily discharges of ammonia, total nitrogen, biological oxygen demand and other pollutants.[67] None of the US-based companies has disclosed metrics that indicate the quality level of discharged water, such as nitrogen loading, biological oxygen demand or chemical oxygen demand.

In this year's Index, FAIRR assessed whether companies have conducted an independent assessment and developed an understanding of best practice on water discharge. When local regulation falls short of best practice, companies are expected to set limits that exceed regulation or are aligned with best practice. To identify best practice for the local context, companies should complete a risk assessment for both owned operations and their supply chains. Only one of the 16 companies – Hormel Foods – discusses how it has assessed water discharge risks and is committed to meeting or exceeding the required water discharge quality. However, this limit has not yet been set.

> Companies are also underreporting their water risks from a nutrient management perspective. 75% of companies that produce or sell beef have no discussion on fertiliser use in feed farming – a major source of nutrient pollution.

Similarly, companies provide very limited discussion of manure management. Feedlots, where hundreds of thousands of cattle are housed, produce extensive quantities of manure. One study found that a farm with 140,000 heads of cattle produces more waste than a city with two million residents.[68] The typical approach to manure management is storing it in lagoons and spraying it over fields – which has significant implications for air quality, water quality and human health.[69] Cattle manure and urine contain ammonia, which can cause respiratory illness, and small discharges can kill fish.[70] Pollution from cattle feedlots is seen as a significant source of concern across major beef-producing regions, including the US, Brazil and Argentina.[71,72]

Six companies, including all three pure-play beef companies, provide no discussion on how they manage manure in feedlots. Where there is some discussion of manure, it is not specific to feedlots. The most common approach seems to be storage and application as fertiliser in surrounding farms.

Companies that produce or sell beef demonstrate very poor awareness of antibiotics stewardship.

Supply chain fragmentation makes it difficult for companies to adopt specific antibiotic stewardship targets for beef. However, this is shifting. McDonald's and Yum! Brands have recently committed to reducing antibiotics use in their beef supply chains. This level of commitment is not being reflected in their supplier base, though. Marfrig is the only company that has a policy limiting antibiotics use for its Brazilian business. (The policy does not seem to cover Marfrig's US operations, including its recent acquisition of National Beef). Over 50% of companies that produce or sell beef have no policy on antibiotics use.

Beef companies are vulnerable to food safety risks and are responding with certifications that meet international food safety requirements.

Since March 2018, 18 food recall events in the US have involved beef products. These include major recalls from JBS due to E Coli contamination.[73] Most companies (63%) in the Index that produce or sell beef disclose some level of certification by schemes recognised by the Global Food Safety Initiative (GFSI). These are a good indication of standards that meet international food safety requirements.[74]

In August 2019, Tyson Foods petitioned the US government to reduce the number of government inspectors at its beef plant in Kansas, USA, instead relying on its employees to check carcasses for disease and contamination. This has raised concerns from food safety advocates that untrained employees may miss signs of drugs and contamination, bypassing essential safeguards. This follows similar proposals in the pork and poultry industry, and is an opportunity for investors to engage companies to better understand their advocacy on this issue.[75]

BEST PRACTICE

Marfrig Foods, an integrated beef producer, performs the best among pure play beef producers.

Compared to peers, the company has a relatively complete emissions inventory that includes non-mechanical sources such as enteric fermentation and feed production (though it has yet to include its recently acquired US beef business). The company has said they are currently evaluating setting science-based targets.

One of the biggest risks for companies operating in Brazil is deforestation, and the company has a strong programme to minimise deforestation risks linked to soy and cattle ranching in the Amazon biome. They source certified soy from Uruguay, and their cattle sourcing from direct suppliers in the Amazon has a comprehensive monitoring and assurance system.

On the health side, the company has a strong antibiotics policy that prohibits the routine use of antibiotics. They also disclose that 20 of their production units are certified by schemes recognised by the GFSI.

In August 2019, they announced a partnership with Archer Daniels Midland Co to produce and market their own brand of plant protein alternatives, indicating that they are monitoring and reacting to consumer trends.

FAIRR *view*

Marfrig Transition Bond

In July 2019, Marfrig announced a $500 million transition bond, whose proceeds will be used to finance purchases of cattle that come from non-deforestation sources in the Amazon.[76]

From our perspective, Marfrig will use the bond proceeds to finance what it is already doing relatively well from a sustainability standpoint. For Marfrig to encourage a shift (or transition) to greener operations, the company could instead have focused on:

- incentivising their indirect suppliers to develop better farming practices and improvements to traceability monitoring
- designing a plan for sustainable operations in regions other than the Amazon Biome
- improving their water footprint across the supply chain
- providing data on manure management in their own facilities and across the full cycle of cattle production

See Appendix 6 for our full analysis of Marfrig's transition bond.

Figure 23
Overall score of companies producing/selling beef products

THE FULL COMPANY BENCHMARK IS AVAILABLE FOR FAIRR INVESTOR MEMBERS.
SEE INDEX.FAIRR.ORG FOR THE FULL DATA SET.

POULTRY AND EGGS

Sector context: chicken production

In 2017, 76 billion heads of poultry produced 123 million tonnes of chicken meat.[77] The US was the largest producer of chicken, at 17% of global production volumes, followed by Brazil, China, Russia and India. In terms of annual chicken consumption, Israel, the US, Malaysia, Australia, Peru and Brazil top the rankings, with amounts ranging from 88 to 145 pounds per capita.[78] While turkey is also significantly produced and consumed around the world, chicken by far is the most consumed poultry meat.

Industrially produced chickens are 'broilers': they are raised specifically for meat. Almost all the chicken in the US today comes from broiler production, and this system of production dominates chicken production worldwide. Intensively raised chickens have been bred specifically to grow faster on less feed: "A typical broiler today reaches the desired 5–6 pounds of live weight in just about 42 days; it grows twice as fast, twice as large, on half the feed than a broiler did about 70 years ago."[79] While this makes production more efficient, there are growing welfare concerns that are increasingly material for companies that produce chicken and eggs (see feature box).

One of the primary reasons for the rapid growth of the chicken industry is its success with combining various stages of production into vertically integrated firms. Companies typically own or control every stage of production, starting with feed milling, breeding, hatching and slaughter (the breeding stock is provided by external companies). As integrated producers, these companies use 'contract growers' – farmers working under contract – to raise the birds in closed, indoor barns.[80]

The chicken industry is highly consolidated, with a few players enjoying large market shares. The global poultry meat breeding stock, for example, is supplied by just three companies: Aviagen Broiler Breeders, Cobb-Vantress and Hubbard.[81] In the US, 60% of chicken production is controlled by four companies: Tyson Foods, Pilgrim's (JBS subsidiary), Perdue (privately owned) and Sanderson Farms. The top 10 companies control 80% of the market.[82] This dominance has allowed these companies considerable clout. A recent lawsuit alleges that the biggest poultry companies conspired to fix prices between 2008 and 2016, resulting in a 50% price increase for broiler chickens.[83]

The modern broiler chicken

Carys E. Bennett et al., "*The broiler chicken as a signal of a human reconfigured biosphere*"[84]

Broilers from a 1957 breed are between one-fourth and one-fifth of the body weight of broilers from a twenty-first century breed. The modern broiler is a distinctive new morphotype with a relatively wide body shape, a low centre of gravity and multiple osteo-pathologies. If left to live to maturity, broilers are unlikely to survive. In one study, increasing their slaughter age from five weeks to nine weeks resulted in a sevenfold increase in mortality rate: the rapid growth of leg and breast muscle tissue leads to a relative decrease in the size of other organs such as the heart and lungs, which restricts their function and thus longevity. Changes in the centre of gravity of the body, reduced pelvic limb muscle mass and increased pectoral muscle mass cause poor locomotion and frequent lameness. Unlike most other neobiota, this new broiler morphotype is shaped by, and unable to live without, intensive human intervention.

Sector context: egg production

In 2017, 11 billion hens produced 120 million tonnes of eggs. China dominates egg production, at over 30% of global production volumes, followed by the US, India, Mexico, Brazil and Japan.[85]

Like chicken production, commercial egg production has seen a rapid transformation focused on improving productivity and feed efficiency. Each laying hen produces 289 eggs on average, which has reduced their life span considerably.[86] Egg production is dominated by conventional cage systems – popularly known as 'battery cages' – though this is changing in some markets due to regulation and consumer concerns.

Unlike the dairy supply chain, most commercial egg companies do not typically process hens for meat once they stop laying eggs. Hens have been bred to lay eggs, and their meat is seen as 'tough' after a lifetime of laying eggs.[87] While this is hard to confirm, companies typically cull these birds, after which they are sent to landfills or to renderers for use as pet food.

KEY INSIGHTS

- Nearly 70% of companies that produce or sell poultry products have no emissions targets or targets that are very limited in scope.
- Most companies that produce or sell chickens are not disclosing information on deforestation risks linked to soy supply chains.
- Companies mainly manage chicken litter by applying it to farmland as fertiliser, which has significant water impairment issues.
- Just over 40% of companies that produce or sell poultry products do not have a policy on antibiotics use.
- Poultry companies achieve an average score of 20% on welfare commitments. There is a lack of third-party auditing on company commitments on welfare.

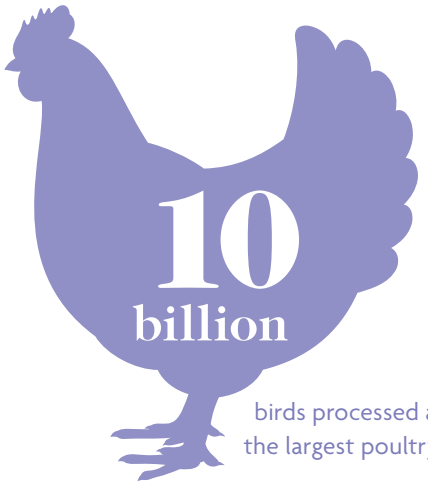
Main ESG risks in poultry production

RISK FACTOR	DESCRIPTION
GREENHOUSE GASES 	Nearly 78% and 69% of GHG emissions from the poultry and egg sectors are linked to feed production.[88] This is driven by the application of fertilisers and land use change from the production of feed such as soybean. According to the FAO, eggs have higher manure emissions. This is because layer hens have a greater proportion of their manure managed in anaerobic conditions, which leads to higher methane emissions.
DEFORESTATION & BIODIVERSITY LOSS 	Soy for animal feed is the leading cause of deforestation in ecologically sensitive areas in Brazil, including in the Amazon and the Cerrado. Soy meal makes up more than 35% of the content of concentrates fed to broiler chickens.[89] In 2017, 90% of the soy from Brazil became animal feed, 50% of which was used as chicken feed.[90]
WASTE & POLLUTION 	Like other meat proteins, extensive use of nitrogen to grow feed such as corn and manure from intensive poultry and egg operations pollute local waterways. These operations typically house hundreds of thousands of birds at any given time. Poultry litter contains phosphorous, which can fuel algal blooms. There are multiple community issues in the areas with a high concentration of poultry farms due to poor regulation of millions of tonnes of chicken litter.[91, 92, 93]
ANTIBIOTICS 	Antibiotics are used routinely in poultry operations to increase feed efficiency and prevent and treat intestinal diseases.[94] Studies show that antibiotics categorised as 'highest priority critically important' by the WHO – fluoroquinolones, third-generation cephalosporins, macrolides and polymyxins – are approved for use in poultry in the largest poultry-producing countries. The exceptions to this are fluoroquinolones in the US and cephalosporins in the EU.
WORKING CONDITIONS 	The US poultry industry is increasingly the subject of campaigns by organisations such as Oxfam for poor working conditions. Companies are accused of focusing on increasing productivity at the expense of worker health, safety and welfare.[95] One of the most controversial issues is increasing line speeds, from the current 140 birds per minute to 175 birds per minute, which was approved by the United States Department of Agriculture (USDA) after intense lobbying from the industry.[96] Industry consolidation has also led to concerns about the extent of control that integrated firms possess over farmers who serve as contract growers. This can lead to poor wages, no benefits, increased physical and mental stress and poor animal welfare outcomes.[97] Similarly, a report has found that slave labour is 'endemic' in Brazil's poultry industry.[98]
ANIMAL WELFARE 	As more and more large customers are making commitments to transition to cage-free eggs, there is pressure for producers to operate at standards that meet such commitments. In 2015, McDonald's made a commitment to transition by 2025. Walmart followed suit soon after. Many others now have commitments, including Kraft Heinz, Kroger, Denny's, Nestlé, Unilever and General Mill. The introduction of laws that ban caged production will cost companies with caged-bird operations in the short term (it is estimated that the conversion of such facilities costs $40 per bird).[115]

Poultry companies assessed in the Index

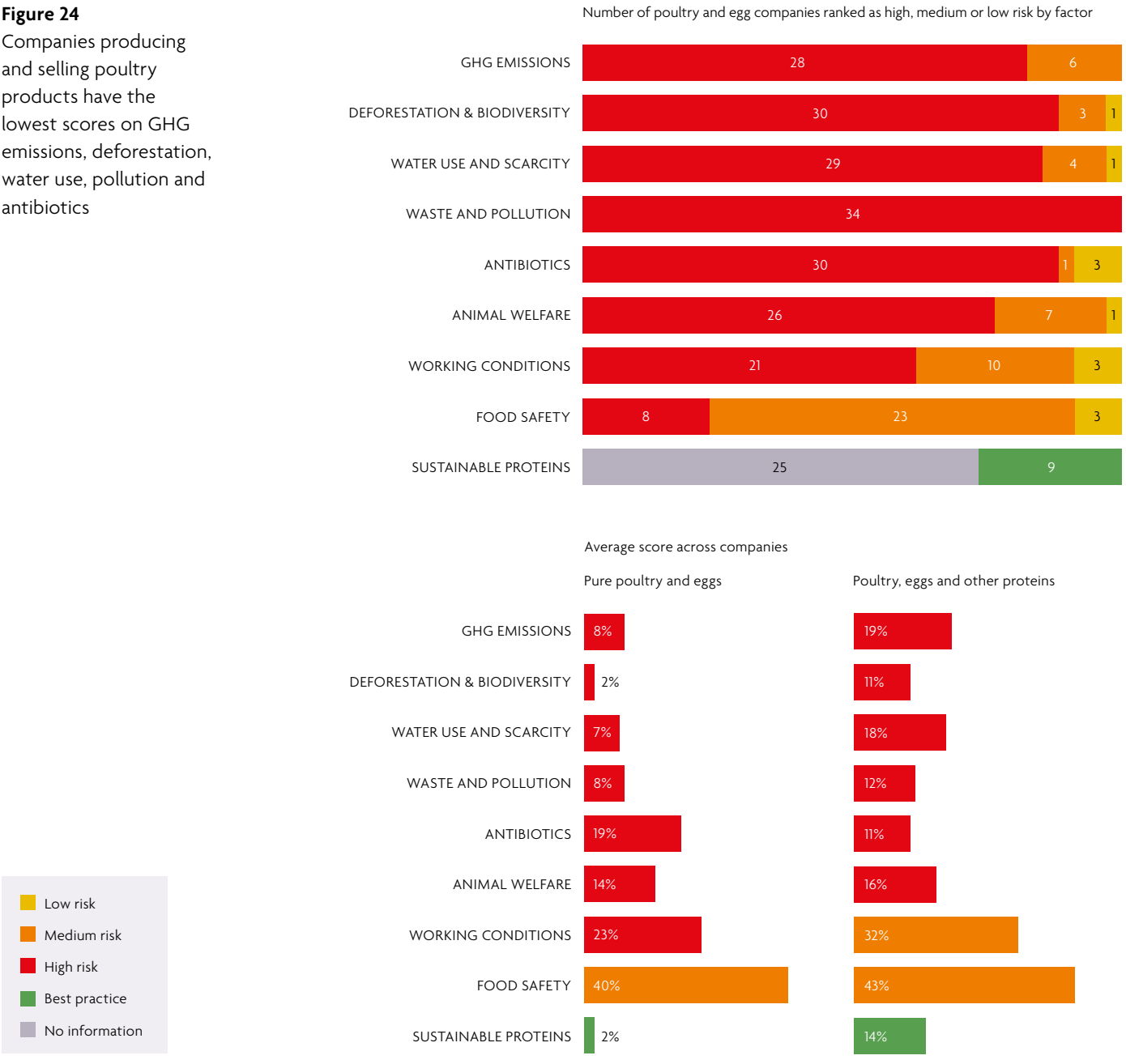
The Index includes 34 companies that produce and sell poultry products (including eggs). This includes 13 pure-play poultry-producing companies. These 34 companies contribute a total of $209 billion in revenues (65% of the total 2018 revenues for all 60 Index companies). They have a market capitalisation of $188 billion (58% of the total). The estimated revenue linked to poultry production and sales alone is approximately $76 billion.

Poultry-producing companies are assessed on all nine factors and 25 KPIs. These 25 KPIs are universally applied to other land-based protein producers in the Index.



birds processed annually by the largest poultry companies[99]

Figure 24
Companies producing and selling poultry products have the lowest scores on GHG emissions, deforestation, water use, pollution and antibiotics



Discussion of results

Nearly 70% of companies that produce or sell poultry products have no emissions targets or targets that are very limited in scope.

Ten companies (30%), including six pure-play poultry producers, do not have any discussion on emissions targets. An additional 13 companies disclose limited emissions-reduction targets, such as on energy savings or to increase renewable energy. This is even though the largest sources of emissions in the sector come from non-mechanical sources (primarily feed production).

Only six companies have calculated emissions from animal agriculture (whether in Scope 1 or 3). None of these companies has calculated emissions from feed production.

Most companies that produce or sell chicken are not disclosing information on deforestation risks linked to soy supply chains.

Soy is one of the primary ingredients purchased by poultry companies for chicken feed. The US, Brazil and Argentina are the biggest soybean producers globally, making up 79% of global production.[100] The risk of deforestation and biodiversity loss in Brazil and Argentina, which produce 46% of global soybeans, is very high. It is estimated that over two-thirds of deforestation in the Amazon, Cerrado and Chaco regions in these countries is driven by beef and soy expansion.[101]

The vast majority – 24 of the 34 companies, including 11 pure-play poultry producers – do not disclose how they manage deforestation or conversion risks that they may be exposed to in soy supply chains. Only three poultry companies have commitments to avoid deforestation linked to soy but these appear to be limited in geographic scope. For example, BRF, a major Brazilian poultry and pork producer, has a commitment on soy only for the Amazon biome. Yet they also seem to source soy from the Cerrado savannah. No company has full traceability of its entire soy supply chain in all geographies, though three companies discuss traceability systems.

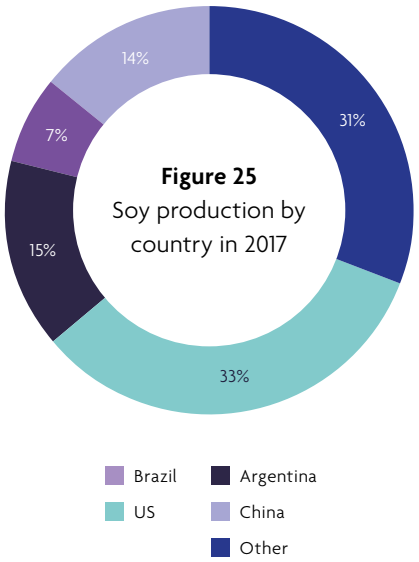


Figure 25
Soy production by country in 2017

Companies mainly manage chicken litter by applying it to farmland as fertiliser, which has significant water impairment issues.

About two-thirds of companies (22 of 34) – including 12 from Asia – that produce or sell poultry do not discuss water use risks in feed supply chains. Droughts and floods have a significant impact on feed prices and volatility. In the US, poultry firms such as Sanderson Farms, Pilgrim's Pride and Cal-Maine Foods have seen a significant jump in feed costs linked to extreme weather events.[102] None of these companies discuss water management linked to its feed production.

Poultry farms typically generate dry waste (a mixture of faeces, feathers, sawdust, bedding and dead chickens). This is compared to wet waste generated by cattle and pork operations. In major producing regions, including in the US, this waste is stored in large uncovered piles for days. After that, it may be applied as fertiliser or burned for energy.[103] This approach leads to significant community health issues. The application of large quantities of fertiliser from multiple farms in the same area can be detrimental to the local environment. In 2018, MHP, Ukraine's largest poultry company, was subject to community complaints on its waste management practices. These complaints were sent to the World Bank and the European Bank for Reconstruction and Development, triggering an investigation.[104] The two banks are providing financing for the company's construction of Europe's largest poultry farm.

Some 15 companies provide no discussion on how they manage pollution risks linked to chicken litter. Three companies make a high-level reference to waste management in their supplier code of conduct. Only 13 companies provide a discussion on their approach to managing manure. The dominant method is to convert manure to fertiliser, though it is unclear if this manure is treated first. We note that this is not necessarily the most sustainable method to dispose of large quantities of manure. Applying it on local farms has been linked to significant water impairment issues.

Some companies are investing in treatment or manure-to-energy conversion systems (or both). This is most prevalent in Asia: five of the thirteen companies that produce or sell poultry in Asia reference such investments.

Only one company (MHP) has a community engagement plan, despite growing resistance from local communities to large industrial farms. Even MHP's stakeholder engagement plan is in response to a 63-page detailed complaint to their financiers.[105]

> Just over 40% of companies that produce or sell poultry products do not have a policy on antibiotics use.

Thirteen companies, including four that are pure-play poultry producers, do not discuss how they manage the risks associated with antibiotics' overuse in their poultry supply chains. Three companies show some awareness of the risk of antimicrobial resistance but have not set policies to avoid use of antibiotics.

Only one company raises chickens without antibiotics. The stance of other companies is vague: some restrict antibiotics' use, others restrict the use of critically important antibiotics. Some, meanwhile, have different policies for different species or subsidiaries. Best practice in antibiotics use would be to have a policy to avoid routine use of antibiotics and to limit use to diagnosed cases where antibiotics is administered by a veterinarian.

The use of antibiotics in livestock is expected to double by 2030 in Brazil, Russia, India, China and South Africa. It is therefore critical to engage companies operating in these regions to adopt stewardship policies.[106] This year's Index shows a modest improvement in the number of companies from these regions responding to this issue compared with last year's results: 11 companies that produce or sell poultry products show evidence of some type of policy on antibiotics, with one Thai poultry producer (GFPT) stating it uses no antibiotics.

In terms of performance, only five companies disclose a reduction in the quantity of antibiotics used in the reporting period.

> Poultry companies achieve an average score of 20% on welfare commitments. There is a lack of third-party auditing on company commitments on welfare.

Nine companies (26% of the total of 34) that produce or sell poultry products have no discussion on animal welfare. All these companies are based in Asia, Africa or Mexico, and supply domestic markets. This indicates that welfare issues have yet to become important to consumers in those markets.

The average score of companies on the strength of their welfare policy is 20%. The Index's methodology assesses whether companies provide, at a minimum, a statement in support of the 'five freedoms'. This is considered basic management of welfare. The Index also looks for commitments on seven specific issues: (a) avoiding confinement; (b) avoiding routine mutilation; (c) humane slaughter; (d) providing environmental enrichments; (e) avoiding long-distance transportation; (f) its position on breeding and genetics; and (g) training employees on welfare issues. Nearly 60% do not have commitments to avoid close confinement or to move towards cage-free production. This is significant given market and regulatory risks. Confinement is also closely linked with antibiotics' overuse, as the risk of disease is higher in intensive production systems.

Further, these companies perform poorly in terms of implementation. They score an average of 14% on confinement standards and on auditing and assurance. None of the companies is audited by an animal welfare organisation of higher welfare assurance, such as RSPCA Assured Outdoor. Only one company – Australia-based Ingham's – is audited by RSPCA Assured Indoor. Other companies that are externally audited only use farm assurance schemes, such as Red Tractor or Professional Animal Auditor Certification Organisation (PAACO), which only have basic welfare provisions.

Only one of the 34 companies (Swedish-based Scandi Standard) has invested in a product line that uses a slow-growing breed. Another company (UK-based Cranswick) purchases a portion of its poultry from farmers that sell slower-growing breeds.

> In the US, poultry and eggs remain the major source of food poisoning.[107] The country's largest egg producer, Cal-Maine Foods, has no discussion on food safety risks or certifications.

The majority of companies (22 of 34 or 65%) in the Index that produce or sell poultry disclose some level of certification by schemes recognised by the Global Food Safety Initiative (GFSI). This includes six companies based in Asia, including one based in China, which shows growing global recognition of GFSI's adoption. Only two pure poultry companies have no disclosure on food safety certification – Cal-Maine Foods in the US and Venky's in India.

Ten companies that produce and/or sell poultry products disclosed the number of recalls linked to their operations in the reporting year. Cal-Maine Foods announced a voluntary recall in April 2018 due to potential salmonella contamination.[108] The company does not discuss recalls in its annual reporting.

Regulatory risk related to close confinement of animals

Cal-Maine, the largest producer of eggs in the US, is the country's only egg company without a blanket cage-free policy: only one of its brands is cage-free. In 2018, it sold over one billion eggs, or about 20% of US egg consumption. Its flock size is over 36 million layer hens.[109]

Tighter regulations on confinement may increase short-term capital costs for companies

The EU passed legislation to ban barren battery cages back in 1990. However, enriched cages are still widely used.[110] Now, regulators in other countries are beginning to catch up. In May 2019, the state of Washington passed a law that requires eggs sold in the state to come from cage-free hens by 2023.[111] Washington is not the first state to pass such a law: California, Massachusetts and Rhode Island have all enacted similar legislation.

However, not all states will move in the same direction. The US Supreme Court denied 13 states permission to sue Massachusetts to overturn the law.[112] Iowa, the top egg-producing state in the US, subsequently enacted a law to protect conventional caged-chicken production systems.[113]

Market risk: customers with cage-free commitments

The pressure to move towards cage-free production is also coming from the market. More and more large customers are making commitments to transition to cage-free eggs. In 2015, McDonald's made a commitment to transition by 2025. Walmart followed suit soon after. Many others now have commitments, including Kraft Heinz, Kroger, Denny's, Nestlé, Unilever and General Mills. These commitments were made as the result of a successful campaign run by four organisations: the Humane League, Mercy For Animals, the Humane Society of the United States' Farm Animal Protection Campaign and Compassion in World Farming USA.[114] Even US Presidential candidates have announced support for animal welfare plans, indicating growing consumer support.

Implications for investors

The introduction of laws that ban caged production will cost companies with caged-bird operations in the short term (it is estimated that the conversion of such facilities costs $40 per bird[115]). However, it will give privileged market access to companies that already produce cage-free eggs. This example also shows the growing need for companies and investors to take advocacy campaigns seriously.

BEST PRACTICE

Cranswick: UK-based Cranswick is ranked as low risk on four risk factors. It does not permit the routine use of antibiotics, has restricted the use of CIAs since 2017 and discloses a 50% decrease in use in 2009. It has commitments on all welfare-related issues, and procures 40% of its poultry meat from suppliers that grow slower-growing breeds. Cranswick provides detailed discussion on the measures it takes to ensure fair and safe working conditions, including how employees are involved in health and safety committees. The vast majority of its sites have received an A rating under the British Retail Consortium's food safety certification.

CASE STUDY: SCIENCE-BASED TARGETS

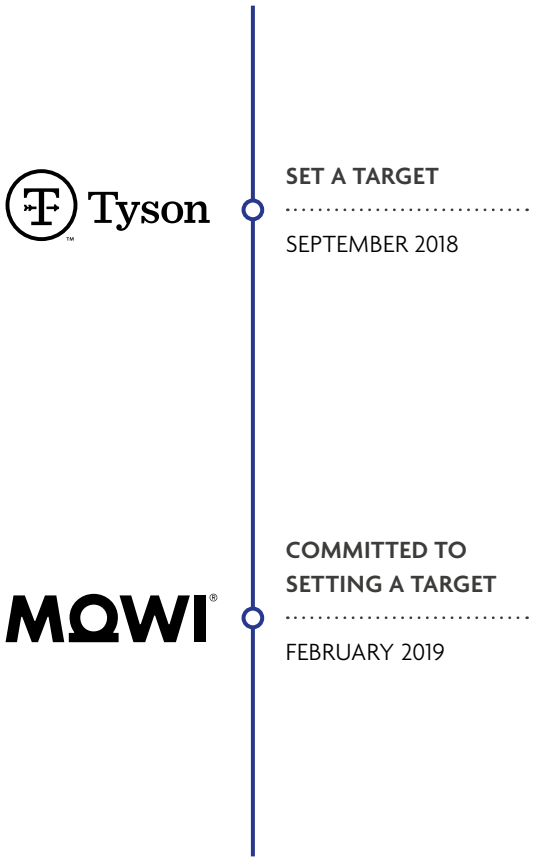
A GHG emissions-reduction target is considered 'science based' if it is in line with what the latest climate science says is necessary to meet the goals of the Paris Agreement: to limit global warming to well below 2°C above pre-industrial levels and pursue efforts to limit warming to 1.5°C.[116]

In 2019, FAIRR collaborated with the Science Based Targets initiative (SBTi) to integrate science-based targets into the GHG emissions risk factor. Companies that have set science-based targets are recognised as best practice in the Index. The principal advantages of setting a science-based target are: (a) companies have to set targets aligned with a minimum 2°C pathway; and (b) companies have to set targets to reduce their Scope 3 emissions if these emissions are over 40% of total value chain emissions. This latter criteria is applicable to animal protein producers because feed production, enteric fermentation and manure storage account for 94% of livestock emissions.[117] Nearly 600 companies globally have science-based targets, the biggest cohort being from the food and beverage processing sector – customers to the companies in the Index.

> **"SBTs [science-based targets] are a quantitative measure of corporate climate leadership and are now being used by investors as a key forward-looking indictor to define 'Paris alignment'. In parallel, benchmark administrators, such as FAIRR, are developing a wide range of indices aimed at capturing climate considerations more specifically. The incorporation of SBTs into benchmarks is an important step to create additional incentives and mainstream the practise of companies setting SBTs."**
>
> **Science Based Targets initiative**

Only two Index constituents have science-based targets

Only one Index company, Tyson Foods – an integrated poultry, beef and pork producer – has set a science-based target. It commits to reduce absolute Scope 1 and 2 GHG emissions by 30% by 2030 from a 2016 base year. It also pledges to reduce Scope 3 emissions from production of poultry, pork and beef (covering 80% of its Scope 3 inventory) by 30% per ton of finished meat by 2030 from a 2016 base year. Another Index company, Mowi – the world's largest salmon company – has committed to setting a science-based target.



Going beyond 2°C

The Intergovernmental Panel on Climate Change's (IPCC's) 'Special Report on Global Warming of 1.5°C' clearly highlighted that much more needs to be done to prevent the worst impacts of climate change and secure a thriving, sustainable economy. In response, the SBTi developed a new suite of resources and raised minimum ambition to well below 2°C. It will also increase transparency by publishing the temperature alignment (2°C, well below 2°C or 1.5°C) of all new and existing targets on its website in October 2019.

Figure 26
Overall score of companies producing/selling poultry and egg products

THE FULL COMPANY BENCHMARK IS AVAILABLE FOR FAIRR INVESTOR MEMBERS.
SEE INDEX.FAIRR.ORG FOR THE FULL DATA SET.

PORK

Sector context: pork production

In 2017, 2.2 billion heads of pig produced 175 million tonnes of pork.[118] China is the world's largest producer, at 46% of global production volumes, followed by the US, Germany, Spain, Brazil and Vietnam. These six countries account for 70% of the world's pork production. In terms of annual pork consumption, Vietnam, China, Korea, US and Switzerland top the rankings, with amounts ranging from 60 to 77 pounds per capita.[119]

At least half of the world's pigs are raised in intensive-farming systems. In the US, the figure is close to 97%.[120] Like the poultry industry, the pig sector tends to be concentrated and vertically integrated: just four companies control 66% of production in the US.[121] Companies in this sector have either full vertical integration, raising most of the hogs they process, or act as integrators, using independent growers or contractors to grow their pigs. The world's largest pork producer, Smithfield Foods, finishes 81% of its hogs on contract farms. However, it also controls every part of that process, including genetics, breeding and feed processing.[122] Seaboard, the second largest pork producer in the US, also controls genetic and commercial breeding, farrowing, nursery and finishing. The company also raises 89% of the hogs it processes.[123]

This system of farming is now standard in other major pork-producing markets, most notably China. In 2018, the number of swine in large-scale farms surpassed that of small-scale farms for the first time, driven by regulatory policy.[124] The decimation caused by African Swine Fever (ASF) to the country's pig sector is expected to accelerate this trend.[125]

Like cattle and poultry, today's pigs are bred for maximum productive and reproductive efficiency. Sows (female pigs) produce 25 piglets a year, some as much as 30, up from 14 piglets three decades ago.[126] This focused breeding is leading to concerns about increased sow mortality, which in the US has risen to 10.2% on farms with more than 125 pigs.[127] Some farms are seeing sow deaths of up to 50% due to a condition known as prolapse. This causes the animal's rectum, vagina or uterus to collapse.

KEY INSIGHTS

- Over 50% of companies that produce or sell pork products (or both) have no emissions targets or targets that are limited in scope.
- Most pork producers, including those from China, are not addressing deforestation risks in their soy supply chains.
- Nearly 27% of companies that produce or sell pork have no discussion on manure management.
- Over 40% of companies that produce or sell pork, including three pure-play pork producers, have no discussion on antibiotics use.
- Only 38% of companies that produce or sell pork have eliminated, or have a target to eliminate, gestation crates for pregnant sows.
- More than half (58%) of companies that produce or sell pork have operations certified by programmes recognised by the Global Food Safety Initiative.

Main ESG risks in pork production

RISK FACTOR	DESCRIPTION
GREENHOUSE GASES 	Feed production and manure storage/processing contribute 60% and 27% of the emissions respectively from global pig supply chains.[128] Like chicken, this is driven by the application of fertilisers and land use change from the production of feed such as soybean. Intensive pork production is also vulnerable to growing climate change impacts on feed sources such as corn and soybean. Feed costs account for between 55% and 80% of the total cost of raising a pig. So any volatility in feed can have an impact on the bottom line.[129]
DEFORESTATION & BIODIVERSITY LOSS 	Soy for animal feed is the leading cause of deforestation in ecologically sensitive areas in Brazil, including in the Amazon and the Cerrado. Soy makes up around 20% of the content fed to pigs.[130] In 2017, 90% of the soy from Brazil became animal feed, 25% of which was used as pig feed.[131] Rising pork demand from China is a leading driver of this risk. Since 1990, China's per capita consumption of pork has doubled from 15 to 30 kg per year.[132] Almost half of China's soy imports come from Brazil (an increase of 2,000% since 2000) and the US–China trade war is expected to increase this reliance. Some estimates show that Brazilian production of soybeans could increase by 39% to meet Chinese demand, potentially causing extensive deforestation.[133]
WASTE & POLLUTION 	Like other meat proteins, extensive use of nitrogen to grow feed such as corn, and manure from intensive pork operations pollute local waterways and contaminate groundwater. In the US, 'hog lagoons' are a common way to store pig waste from massive industrial farms. There are around 4,000 of these lagoons in North Carolina, which has the largest concentration of hog farms in the country.[134] Manure from these lagoons is typically sprayed onto nearby farms to keep it from overflowing, creating odour and health issues. Studies have found higher incidences of hospitalisations and deaths within communities living next to hog farms.[135] Another risk is the breach of lagoons during storms and hurricanes. This is expected to increase with climate change. In 2018, Hurricane Florence caused 132 of the state's lagoons to become "compromised or close to being compromised by structural damage, inundation, or overtopping."[136] Just two lagoons that failed completely caused seven million gallons of untreated swine waste to mix with floodwaters.[137]
ANTIBIOTICS 	Pork production is one of the largest global consumers of antibiotics. On average it uses 172 mg of antimicrobials per kg of animal produced. This is nearly four times the amount used in cattle.[138] In the US, nearly one-third of all medically important antibiotics are sold for pig production, primarily for disease prevention.[139] In China, the world's largest producer of pork, one study found that the total amount of antibiotics in swine farming was 48.4 million kg in 2013, with fluoroquinolones and β-lactams (classified by the WHO as critically important to human health) contributing more than half.[140] The Chinese government has recently launched a pilot programme to eliminate the use of antibiotics in livestock feed by 2020.[141]
WORKING CONDITIONS 	Multiple studies have been carried out in the US in Iowa, Pennyslvania and North Carolina, where there is a high concentration of pork production. These have found that farm workers and communities close to pig farms were in some instances six times more likely to carry the multidrug-resistant *Staphylococcus aureus* (MRSA) compared to the general population.[142, 143]
FOOD SAFETY 	In the US, research has shown that 71% of pork products in supermarkets carried drug-resistant bacteria. Supermarket samples of pork in Brazil, Spain and Thailand have also been found to have resistant bacteria[144,145] Increasingly, meat eaters are falling sick to these strains. In 2018, an outbreak linked to pork products in the US caused 178 known infections with 29 people needing hospital treatment.[146] New rules by the current government will delegate more control over food safety oversight to plant owners, with no plans to test for salmonella or E Coli.[147] The rules will also potentially remove any caps from slaughter line speeds. Currently, these are limited to 1,106 hogs per hour.[148] Advocacy groups have documented instances of faecal contamination and diseased carcasses being allowed to pass through because of faster line speeds. African Swine Fever (ASF) is a deadly infectious disease that affects pigs. In August 2018, an outbreak of the disease was reported in China. To date, almost five million pigs in Asia have died either directly from the disease or because they have been culled to halt the spread of the disease.[149] However, some projections estimate that the number will be much higher at 150-200 million to be culled or to die from the disease.[150] Although ASF does not affect humans nor any other animal species, it has the potential to spread very rapidly and have devastating socio-economic and public health impacts.[151] This highlights the importance of putting in place stringent food safety management systems. It also shows the need to develop full value chain traceability to manage any potential outbreak effectively.

Pork companies assessed in the Index

The Index includes 26 companies that produce and sell pork products, including seven that are pure-play pork producing companies. These 26 companies contribute a total of $207 billion in revenues (65% of the total 2018 revenues for all 60 Index companies). They have a market capitalisation of $184 billion (57% of the total). The estimated revenue linked to pork production and sales alone is approximately $67 billion.

Pork-producing companies are assessed on all nine factors and 25 KPIs. These KPIs are universally applied to other land-based protein producers in the Index.

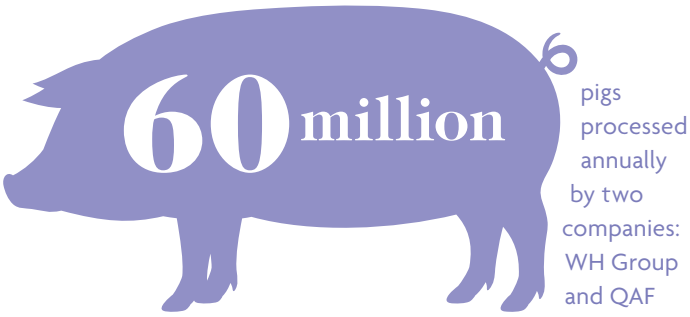
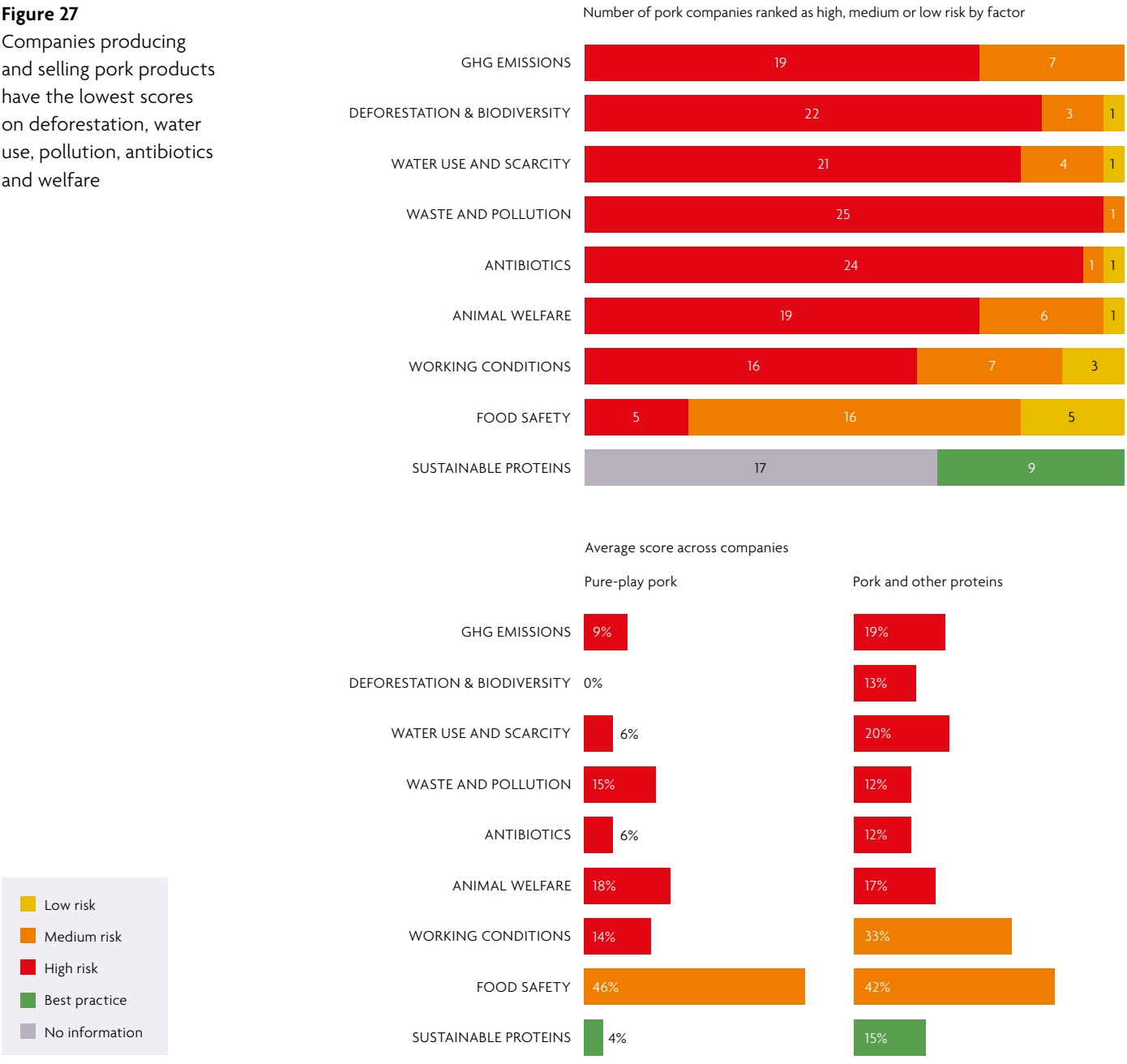


Figure 27
Companies producing and selling pork products have the lowest scores on deforestation, water use, pollution, antibiotics and welfare



Discussion of results

Over 50% of companies that produce or sell pork products (or both) have no emissions targets or targets that are limited in scope.

Two of the seven pure-play pork producers – QAF and Seaboard – make no reference to any emissions targets. However, they do have some discussion on waste-to-energy projects.

Eleven more companies disclose limited emissions-reduction targets, such as on energy savings or to increase renewable energy. This is even though the largest sources of emissions in the sector are non-mechanical (primarily manure management and feed production). WH Group's subsidiary Smithfield Foods is the only pure-play pork producer with Scope 1, 2 and 3 targets. However, the company's reporting on emissions from hog production and feed management is inconsistent, making it unclear if these targets covers all emissions in scope.

Most pork producers, including those from China, are not addressing deforestation risks in their soy supply chains.

Nearly 80% of companies provide no or very limited discussion of deforestation risks linked to their soy supply chains. Most of these companies show evidence of sourcing soy for feed, which means they are exposed to risks. Of the 15 companies based in Asia that produce or sell pork, only one company (CPF) has a deforestation target. None of the Chinese companies that sell pork makes any reference to deforestation, despite being cited as a critical driver of forest degradation in Brazil. Similarly, none of the seven pure-play global pork producers discusses deforestation risks linked to soy.

Nearly 27% of companies that produce or sell pork have no discussion on manure management.

This includes European and North American producers such as Cranswick, Tyson and Maple Leaf. While 14 companies that produce or sell pork have a manure management policy, the predominant method seems to be for use as fertiliser. This can lead to soil and water quality issues from over-application. Seven companies also reference investing in systems to convert manure or wastewater into biogas. This year, WH Group's US subsidiary Smithfield Foods has developed an extensive section on how it manages manure. This is primarily in response to community nuisance litigation that has seen punitive damages of $500 million levelled against the company. Smithfield Foods has recently disclosed plans to cover its manure lagoons. It has also completed construction of a manure-to-energy project, which it plans to extend to most of its facilities within the next ten years.[152]

Over 40% of companies that produce or sell pork, including three pure-play pork producers, have no discussion on antibiotics use.

Most companies demonstrate only basic awareness of, or policies on, antibiotic use. Essentially, this is a commitment to avoid their use to promote hog growth. Only Charoen Pokphand, based in Thailand, and Cranswick, based in the UK, have a comprehensive policy to avoid routine use of medically important antibiotics.

Only 38% of companies that produce or sell pork have eliminated, or have a target to eliminate, gestation crates for pregnant sows.

A common practice in pork production is to confine gestating sows in individual crates. This practice has been linked to several welfare problems, such as urinary tract infections, weakened bones, overgrown hooves and lameness. In recent years, there has been some movement by the industry, encouraged by retailers, regulators and customers, to phase out the use of gestation crates and move towards group housing of sows. However, only ten companies (38%) that produce or sell pork state that they have eliminated, or have a target to eliminate, gestation crates.

More than half (58%) of companies that produce or sell pork have operations certified by programmes recognised by the Global Food Safety Initiative

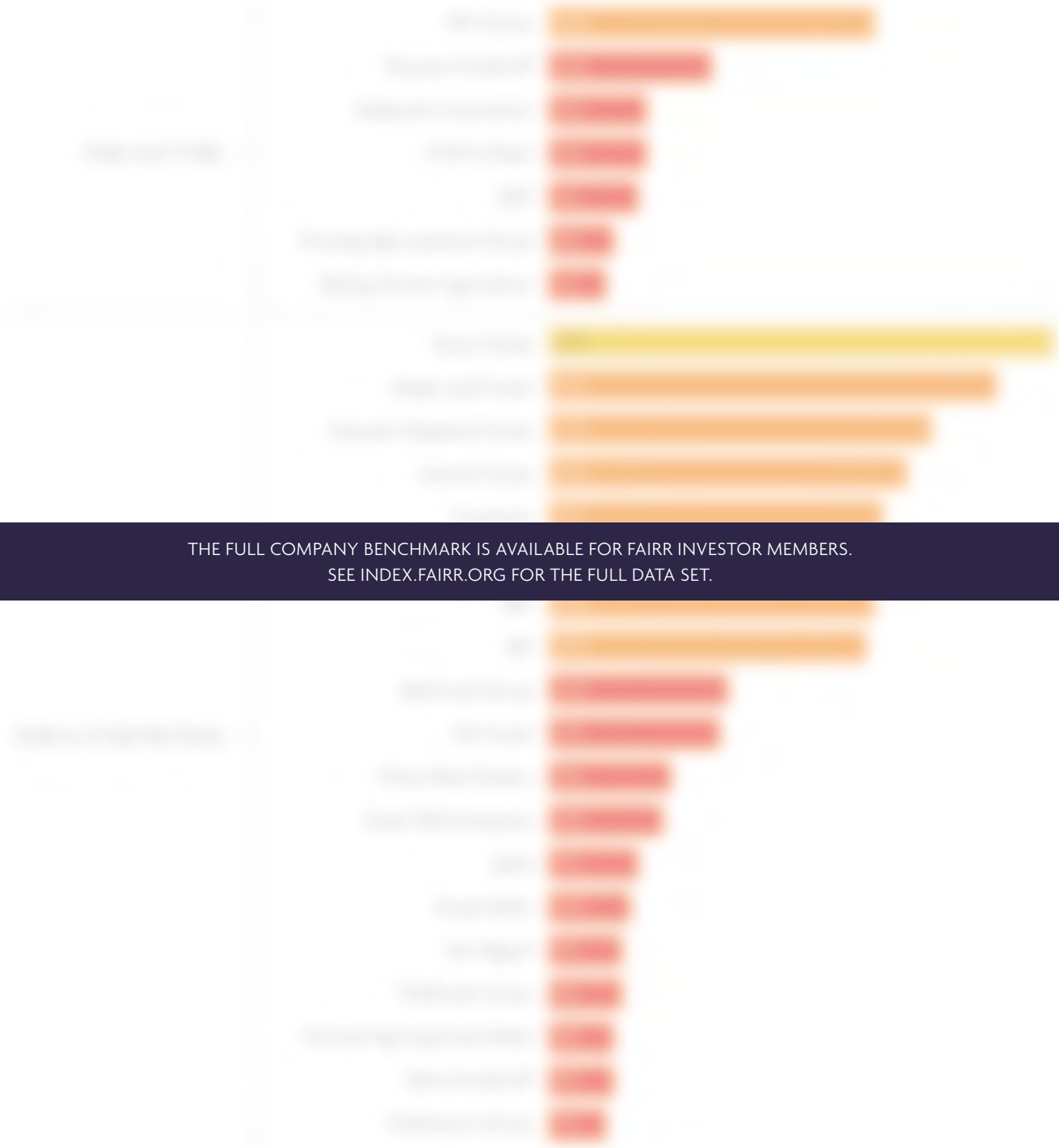
It is encouraging that 15 of the 26 companies (58%) disclose some level of certification by schemes recognised by the GFSI. This is a good indication of standards that meet international food safety requirements. However, only three companies (including one Chinese company) are fully certified by a GFSI-recognised scheme. This means that many companies have inconsistent food safety standards across different facilities and locations.

BEST PRACTICE

Hormel: Relative to its peers, Hormel has taken a proactive approach to managing its water risks. The company has worked with a third-party consultant to complete a risk assessment of its owned operations and top ten suppliers by spend in 2017. The company disclosed that three of its manufacturing facilities are located in high-risk areas. The company also published its Sustainable Agriculture Policy which lays out its expectation on water efficiency, soil management and nutrient management for direct suppliers, contract animal producers and feed grain growers.

While this is a strong policy, we have not yet seen any updates on its implementation. The company has said they plan to seek self-certifications of compliance with the requirements for their largest direct suppliers and complete site-specific reviews with their high-risk suppliers. We encourage the company to report on their progress with suppliers this year.

Figure 28
Overall score of companies producing/selling pork products



THE FULL COMPANY BENCHMARK IS AVAILABLE FOR FAIRR INVESTOR MEMBERS.
SEE INDEX.FAIRR.ORG FOR THE FULL DATA SET.

Amazon fires and cattle ranching

In late August, there was significant media and policy attention driven by devastating forest fires in the Amazon. The fires have been linked to growing disregard for the Forest Code, which has led to reports that the fires were set by cattle ranchers and illegal miners cutting and burning forests. The number of forest fires in Brazil were 80% higher than last year, according to Brazil's space research center.

Brazil is the world's largest exporter of beef, providing close to 20% of the total global exports, and nearly 40% of the country's cattle herd is in the Amazon region. While most of the consumption is domestic, rising demand from Asia – especially China and Hong Kong – is adding pressure on the ecosystem.

Despite no-deforestation commitments and strong monitoring programmes from Brazilian meatpackers such as JBS and Marfrig, the highly segmented nature of the cattle industry makes it hard for beef companies to have full visibility into whether their cattle are purchased from deforested areas.

The fires have resulted in the possibility of regulatory action, especially from European countries. Finland has called on the EU to consider banning Brazilian beef imports, and both Ireland and France have threatened to block the trade deal between the two regions without action from the Brazilian government.

Sources: Butler, R. (2019), Mongabay; Macintosh, E. (2019), CNN; Ingraham, C. (2019), Washington Post

Climate change and the livestock sector

In November 2018, a report issued by 13 federal agencies in the US warned that damage form climate change could cost the country as much as 10% of its economy.[153]

The livestock sector is particularly vulnerable to these impacts. The two IPCC reports, 'Special Report on Global Warming of 1.5°C' and 'Climate Change and Land' detail the multiple ways in which climate change will directly impact animal agriculture. These include through changes in feed/forage quantity and quality, poor animal health outcomes (for example, persistent heat stress and higher incidence of disease), lower productivity (such as reduced milk yields and reproductive efficiency), higher mortality and reduced water availability.[154]

One study is stark in its pronouncement. Warming of 2°C is expected to result in a decline in livestock of 7–10%, with associated economic losses of between $9.7 and $12.6 billion.[155]

For the aquaculture sector, a warming climate will increase the risk of diseases, parasites, low oxygen levels and harmful algal blooms.[156] Intense storms and rising sea levels also threaten cages and other infrastructure and equipment in offshore systems.

Table 8
Physical risks and financial costs of climate change

Company	Proteins	Headquarters	Physical risk	Financial costs
JBS	Beef and poultry	Brazil	Acute: increased severity of extreme weather events such as cyclones and floods.	The company has faced water scarcity in recent years, mainly in Brazil. This is due to the lack of a steady rainy season attributed to, among other things, climate change. Water scarcity had negatively influenced the availability of energy to the company's production units and led to higher electricity prices. In addition, JBS had to partially discontinue some operations in Brazil due to lack of water access.
Marfrig	Beef	Brazil	Chronic: rising mean temperatures.	Estimated financial implications from this risk include increased costs due to the impacts on availability and price of cattle and beef. These can vary significantly due to unpredictable factors such as weather and climate impacts.
Mowi	Aquaculture	Norway	Chronic: changes in precipitation patterns and extreme variability in weather patterns.	In the unlikely event that the production at a large facility is disrupted for 6–12 months, this may potentially cost up to NOK 100–200 million, depending on the size and average production capacity of the plant.
RCL Foods	Poultry	South Africa	Chronic: changes in precipitation patterns and extreme variability in weather patterns.	In South Africa, rainfall over the past few years has been significantly below the long-term average. Dam levels have fallen materially, and severe irrigation restrictions have been imposed. A one-week shut down of country-wide processing operations could result in loss of profits of approximately R10 million, based on current operating profit in the company's consumer division.
BRF	Poultry and Pork	Brazil	Chronic: changes in precipitation patterns and extreme variability in weather patterns.	BRF's commodities area estimated that impacts in the grain market, and subsequent price variation, could entail gains or losses around R$ 800 million per year.

Source: Company CDP Climate Change Reports, 201

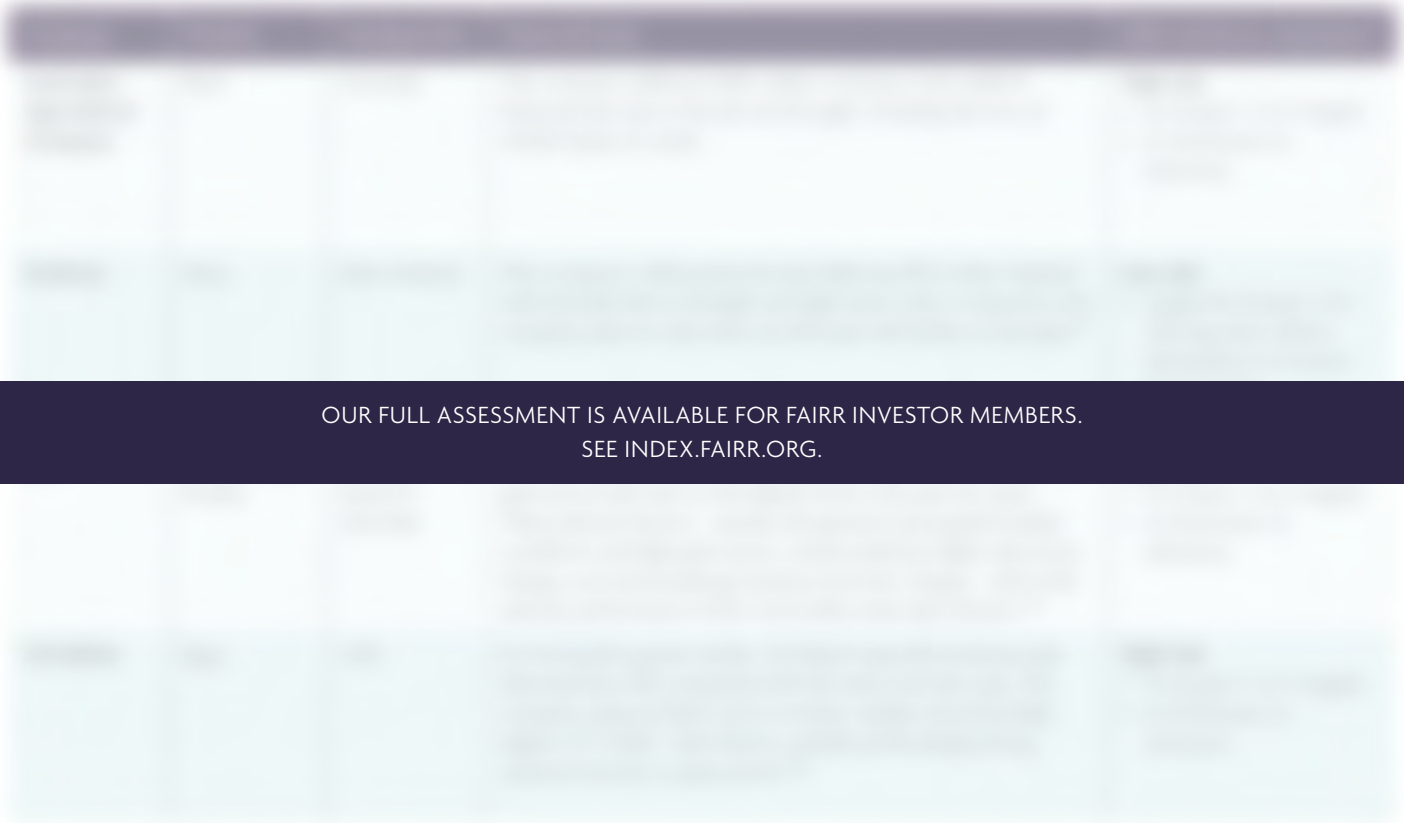
Protein Producer Index Report

We are seeing these risks play out now. In the US, record flooding in Nebraska has cost the livestock industry in the state over $400 million, after farmers lost hundreds of thousands of cattle and pigs.[157] Corn and soybean farms that are primary suppliers of animal feed have been devastated by floods and drought. There have been record planting delays this year, with planting progress falling well below the five-year average.[158] In addition, floods have slowed barge traffic on waterways such as the Mississippi River, reducing supplies of commodities and fertilisers, which has had a ripple effect across the sector.[159] These issues have created a 'corn crisis', which has resulted in sell-offs of meat companies including Tyson and Pilgrim's Pride.[160]

In Australia, over 500,000 livestock were killed by floods in 2019, after a long period of drought.[161] The country's central bank warned that the country's gross domestic product was cut by 0.15% due to extreme weather events, with agriculture being the most impacted sector.[162]

Climate change impacts will create a vicious cycle, exacerbating the very issues that contribute to the sector's risks. The IPCC reports that higher temperatures will increase methane production.[163] Rising carbon emissions are linked to fewer nutrients and proteins in grasses that are fed to pasture-raised beef. This might in turn result in farmers dumping more fertilisers, leading to higher GHG emissions.[164] Similarly, analysts are expecting farmers to increase fertiliser use in response to recent planting delays for corn and soy.[165]

Table 9
Index companies and impacts from climate change



Protein Producer Index Report 55

ENGAGEMENT QUESTIONS FOR INVESTORS – MEAT AND DAIRY COMPANIES

OUR ENGAGEMENT QUESTIONS ARE AVAILABLE FOR FAIRR INVESTOR MEMBERS.
SEE INDEX.FAIRR.ORG FOR RESOURCES.

OUR ENGAGEMENT QUESTIONS ARE AVAILABLE FOR FAIRR INVESTOR MEMBERS.
SEE INDEX.FAIRR.ORG FOR RESOURCES.

2

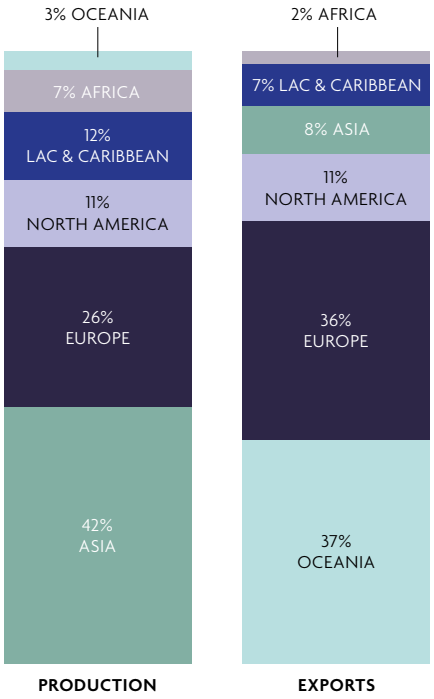
Dairy

Sector context: dairy production

The global dairy market is estimated to be worth $530 billion.[xv] Milk production occurs worldwide and the WWF estimates that there are over 290 million dairy cows producing 706 million tonnes of milk today.[169] India, the US and China are the top-producing countries in the world. Most of this milk is produced for domestic consumption. Europe and Oceania are the largest exporters of dairy products globally, accounting for only 3% of production but 37% of exports in 2018.[170] The main dairy products produced and traded are milk powders (skim and whole milk), butter and cheese. Most of the world's largest dairy companies by sales are cooperatives or privately held (or both). Fonterra is a cooperative whose farmers are shareholders and whose investors can buy shares in the Fonterra Shareholders' Fund.[171] Three of the world's top 15 global dairy companies by sales are constituents of this Index.

Like beef production, two of the most common business models adopted by dairy producers are grain-fed (in concentrated animal feeding operations) and grass-fed.

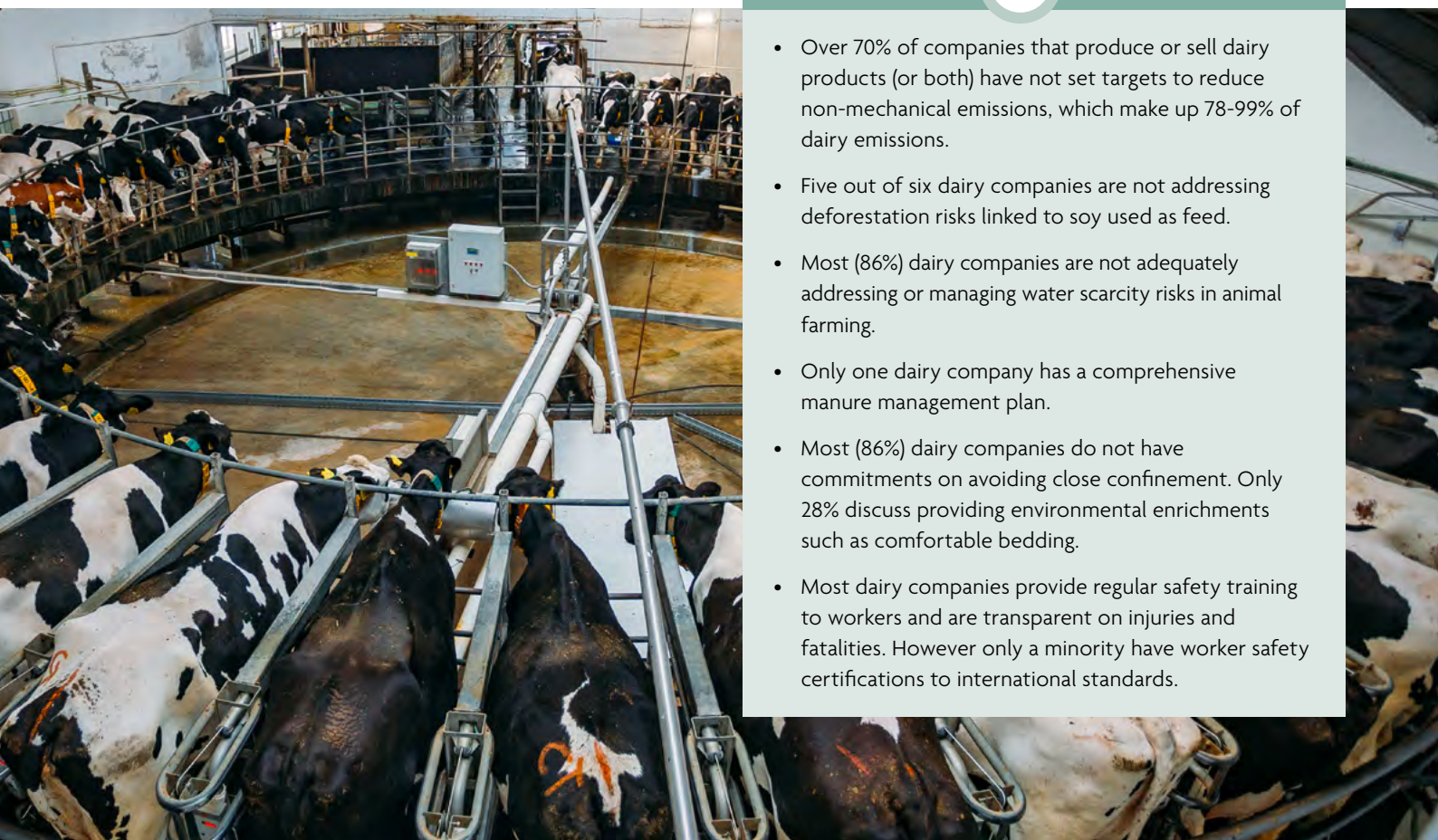
Figure 29
Dairy production and export volume by region in 2018



xv FAIRR estimation using OECD data on volume and price.

KEY INSIGHTS

- Over 70% of companies that produce or sell dairy products (or both) have not set targets to reduce non-mechanical emissions, which make up 78-99% of dairy emissions.
- Five out of six dairy companies are not addressing deforestation risks linked to soy used as feed.
- Most (86%) dairy companies are not adequately addressing or managing water scarcity risks in animal farming.
- Only one dairy company has a comprehensive manure management plan.
- Most (86%) dairy companies do not have commitments on avoiding close confinement. Only 28% discuss providing environmental enrichments such as comfortable bedding.
- Most dairy companies provide regular safety training to workers and are transparent on injuries and fatalities. However only a minority have worker safety certifications to international standards.



Main ESG risks in dairy production

Given the similarities between beef and dairy production, the main ESG risks faced by the dairy industry are similar. In many parts of the world, the two sub-sectors have strong links with each other. Male dairy calves cannot produce milk and are not considered suitable for beef production, so are sold to veal farms.[172]

RISK FACTOR	DESCRIPTION	GRAIN-FED	GRASS-FED
GREENHOUSE GASES	Enteric fermentation produces methane (CH_4) through the decomposition and fermentation of plant materials by microbes in the digestive tract of ruminants.[173] Enteric fermentation from cattle is the largest driver of emissions from livestock at 39% of all emissions associated with the sector.[174] The FAO estimates that while dairy farming has become more efficient, absolute emissions increased by 18% between 2005 and 2015.[175]	✓	✓
DEFORESTATION & BIODIVERSITY LOSS	In certain regions, such as South America, the dairy industry is directly linked to the conversion of primary land to ranches.[176] The dairy industry is also linked to deforestation through the purchasing of soy as cattle feed.	✓	✓
WATER SCARCITY	Water is one of the most important resources on a dairy farm. It is critical for drinking, washing, cleaning and feed processing. Livestock drinking accounts for a third of blue water[xvi] consumption in farms.[177]	✓	✓
WASTE & POLLUTION	A farm with 4,000 dairy cows produces around 37.5 million gallons of manure and wastewater per year.[178] Nitrate pollution in groundwater sources caused by dairy farms is an increasing risk in dairy-producing regions. This has led to lawsuits and community protests.	✓	✓
ANTIBIOTICS	A common treatment for mastitis in dairy cows (inflammation of the mammary gland and udder tissue due to bacterial infection) is to administer antibiotics preventatively during the 'dry' period in between lactations.[179] This has been linked to antimicrobial resistance in faecal bacteria in dairy cows in the US, which can ultimately transfer to humans.[180]	✓	✓
WORKING CONDITIONS	Dairy farming is associated with higher rates of work-related injuries compared to other industrial sectors. Fatalities tend to be associated with heavy equipment use. njuries and fatalities associated with manure-handling systems and livestock handling occur on modern farms.[181]	✓	✓

✓ MORE PREVALENT ✓ LESS PREVALENT

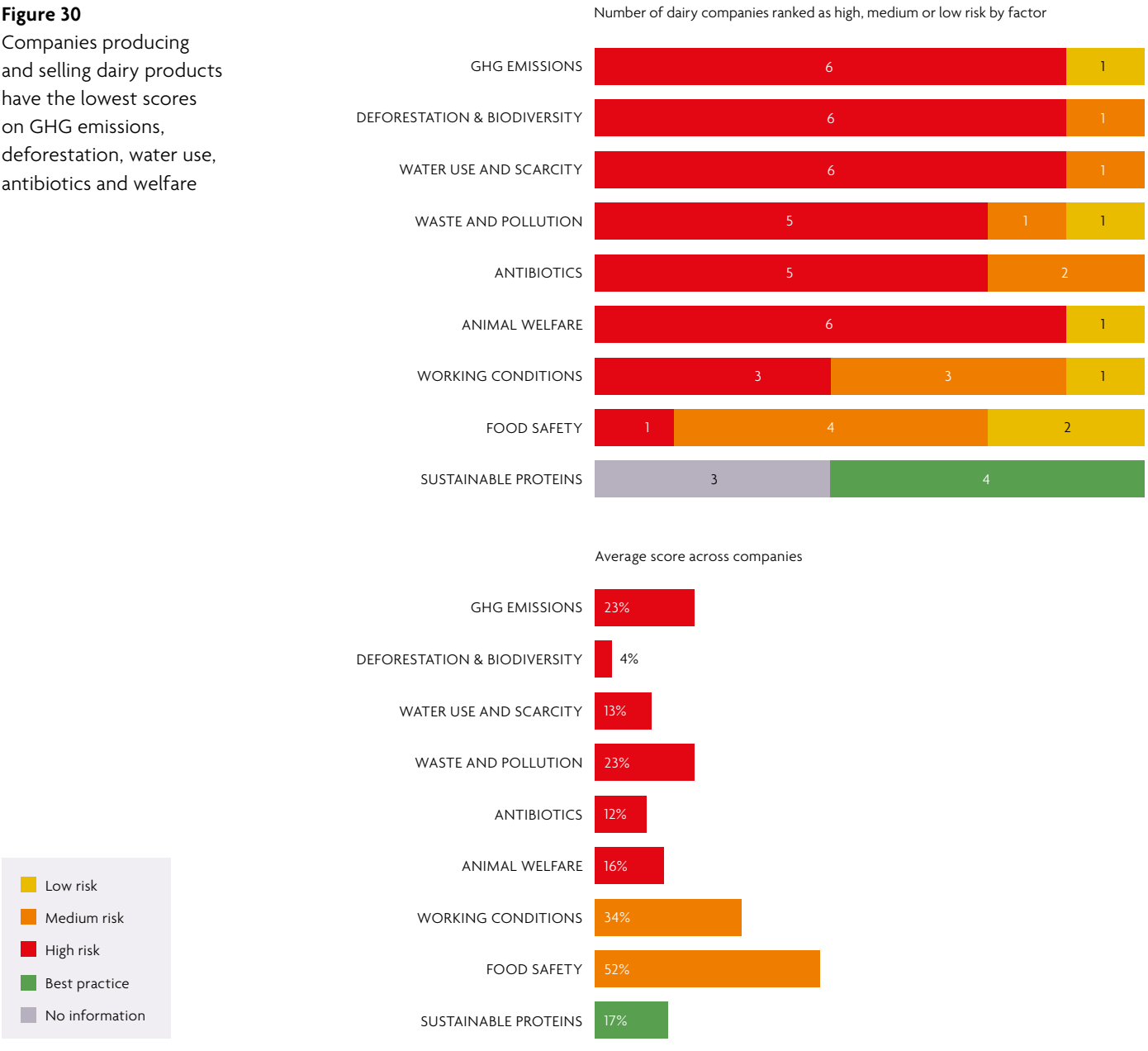
xvi Blue water is potable water which has been treated to a standard suitable for human consumption. Other types of water are green water (rainwater that falls on land and does not runoff) and grey water (water which has been used but may still be suitable for additional uses).

Dairy companies assessed in the Index

The Index includes seven companies that produce and sell dairy products, including six that are pure-play dairy-producing companies. The estimated revenue linked to dairy production and sales alone is approximately $45 billion (14% of the total 2018 revenues for all 60 Index companies). The seven companies have a market capitalisation of $70 billion (22% of the total).

Dairy-producing companies are assessed on all nine factors and 27 KPIs. All land-based protein producers are assessed on 25 KPIs. Dairy producers are assessed on two additional KPIs: (a) deforestation/conversion-free commitment; and (b) supplier engagement, monitoring and traceability in cattle supply chains.

Figure 30
Companies producing and selling dairy products have the lowest scores on GHG emissions, deforestation, water use, antibiotics and welfare



Discussion of results

Over 70% of companies that produce or sell dairy products (or both) have not set targets to reduce non-mechanical emissions, which make up 78-99% of dairy emissions

The FAO estimates that the global dairy sector contributes around 4% of total global anthropogenic GHG emissions. On-farm activities contribute most significantly to overall GHG emissions. This varies by region: on-farm emissions contribute 78–83% of emissions in industrialised countries compared with 90–99% of emissions in developing countries.[182] We found that six of the seven dairy companies in the Index operate in developing countries in Asia. One company, Fonterra, operates in New Zealand. Fonterra is the only company that has calculated and disclosed agricultural emissions from enteric fermentation and manure. Four other companies disclose total emissions, with no supporting information such as emissions sources.

Five of the seven dairy companies have only set emissions-reduction targets focused on energy savings or increasing the share of renewable energy, rather than for on-farm emissions.

Five out of six dairy companies are not addressing deforestation risks linked to soy used as feed

There is a lack of transparency on the types of commodities purchased as feed ingredients. Even the three companies that do disclose feed do not discuss deforestation or conversion risks associated with these commodities. There is also a general lack of clarity on the extent to which companies raise cows on pastures or in confined operations. This impacts how much feed is purchased and therefore the level of exposure to deforestation risks.

Most (86%) dairy companies are not adequately addressing or managing water scarcity risks in animal farming

Dairy companies are highly dependent on water. This dependence is projected to increase with global warming. Livestock consumption of water is expected to increase by two to three times, making it critical for companies to have strong scarcity risk management plans in place.[183]

The Index assesses whether companies address water scarcity risks across the supply chain: in feed-growing, on animal farms and in processing facilities. Only one company, Almarai, which operates confined dairy operations in Saudi Arabia, provides some discussion on water use in feed farming. This is likely due to increased scrutiny of the company's feed-growing operations, cultivated outside the country, including in water-scarce regions such as California and Argentina.[184]

Similarly, only one company, Fonterra, discusses water consumption or withdrawal in animal farming in New Zealand. On the other hand, all companies disclose water use metrics for their processing facilities, and two companies have a time-bound target. This indicates that the focus of companies remains on factories, and has not extended to their agricultural supply chains.

Only one dairy company has a comprehensive manure management plan

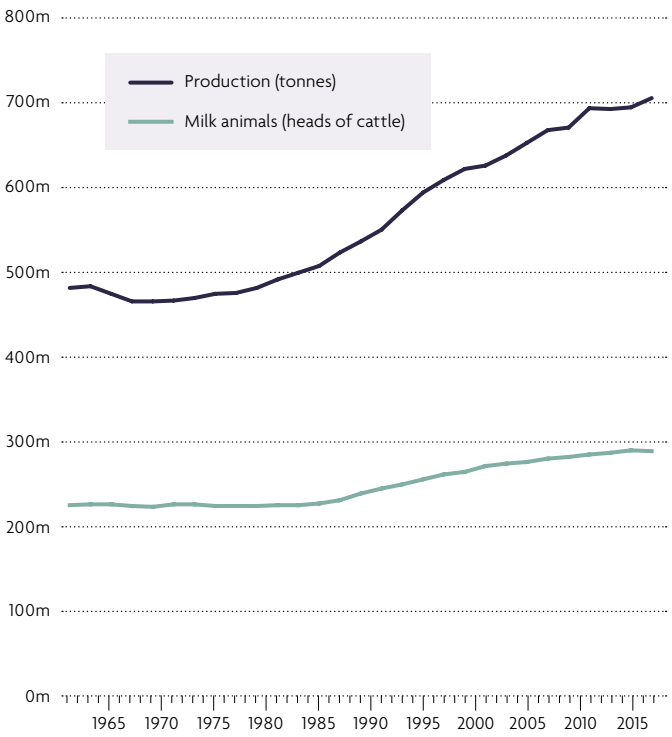
Dairy companies score an average of 26% on the management of waste and pollution risks. Like the water use risk factor, we assess how a company manages pollution risks across its value chain: nutrient pollution in feed crop farming, manure-related pollution in animal farming and wastewater in processing facilities.

Only one company, Almarai, provides any discussion on nutrient pollution risks associated with the farming of feed crops. Despite the millions of tonnes of manure produced, 30% of dairy companies do not provide any discussion on manure. Fonterra is the only dairy company with a comprehensive manure management plan, which covers areas such as nutrient budgets, nitrogen reports and effluent management. These plans and requirements are laid out in the company's Farmers' Handbook.[185] It discloses that 95% of its suppliers have submitted nutrient budgets and have received a nitrogen report this year.

Most (86%) dairy companies do not have commitments on avoiding close confinement. Only 28% discuss providing environmental enrichments such as comfortable bedding.

As shown in Figure 30, global milk production (in tonnes) has increased by 60% more than the heads of dairy cattle since the 1960s. This is mainly due to the intensification of milk production and the increasing amount of milk produced by each cow. The Holstein-Friesian dairy cow is the most common type of dairy cow in the UK, Europe, USA[186] and Oceania.[187,188] The Holstein cow has been bred to produce very high yields of milk.[189] The intensification of milk production and growth in yield is associated with various welfare impacts, one being the inability to exhibit natural behaviours in confined housing. Six of the seven dairy companies primarily house cattle in confined systems, whereas 85% of Fonterra's cows are free from confinement.

Figure 31
Global milk production has increased 60% more than the heads of dairy cattle since the 1960s[190]



Most dairy companies provide regular safety training to workers and are transparent on injuries and fatalities. However, only a minority have worker safety certifications to international standards

Six of the seven dairy companies disclose injury and fatality data in multiple years. All describe preventative and protective measures in place to ensure worker safety. However, only three companies (43%) have worker safety certifications, meaning that most are not certified to international standards.

THE DAIRY MARKET IN CHINA

The Chinese dairy market was worth around $50 billion in 2017. The four Chinese dairy companies in the Index contributed nearly half these revenues. For the Chinese Communist Party (CCP), milk is a key strategic economic area. The country's thirteenth five-year plan is to shift dairy production from small-scale herds to industrial factory farms – and to keep its population of 1.4 billion drinking milk. The government has even published guidelines recommending people consume three times as much dairy as they consume currently.[191]

A growing domestic industry will have consequences for China and the world, including on climate emissions, water use and quality, deforestation rates from feed, and antibiotics overuse. Currently only one of the four Chinese dairy companies in the Index has a target to reduce emissions (beyond energy savings). None of the Chinese companies are addressing deforestation or biodiversity. None of the Chinese companies are addressing water scarcity and quality risks in feed supply chains. There is only minimal discussion on manure management. None of the four companies has an antibiotics policy.

In 2008, the sector suffered perhaps one of the largest food safety scandals in Chinese history. Milk had been adulterated with the toxic industrial compound melamine. This is typically used in the production of dinnerware, adhesives and coatings. An estimated 300,000 babies became sick. This scandal not only damaged the reputation of Chinese exports but also devastated domestic demand and trust in the dairy industry.[192]

Only two of the four Chinese dairy companies have disclosed they have some level of certification by schemes recognised by the Global Food Safety Initiative (GFSI). These are a good indication of standards that meet international food safety requirements. None of the companies discuss their product recall process, but three of them disclose that they did not experience a recall event this reporting year.

BEST PRACTICE

Fonterra outranks all other dairy companies in the Index on every risk factor. It has set a goal to achieve 'climate-neutral growth' for on-farm emissions in New Zealand by 2030, primarily through cow productivity and a reduction in supplementary feed. It has also disclosed a near-complete GHG inventory (only supplementary feed has not yet been calculated). It avoids the prophylactic use of CIAs, has commitments on most welfare-related issues and is audited by the Royal New Zealand Society for the Prevention of Cruelty to Animals. Fonterra is one of only ten Index companies that discusses its human rights due diligence process. It also has a long-standing agreement with the International Union of Food (IUF). Nearly all (90%) of its sites are certified by a GFSI-recognised scheme.

Figure 32
Overall score of companies producing/selling dairy products

THE FULL COMPANY BENCHMARK IS AVAILABLE FOR FAIRR INVESTOR MEMBERS.
SEE INDEX.FAIRR.ORG FOR THE FULL DATA SET.

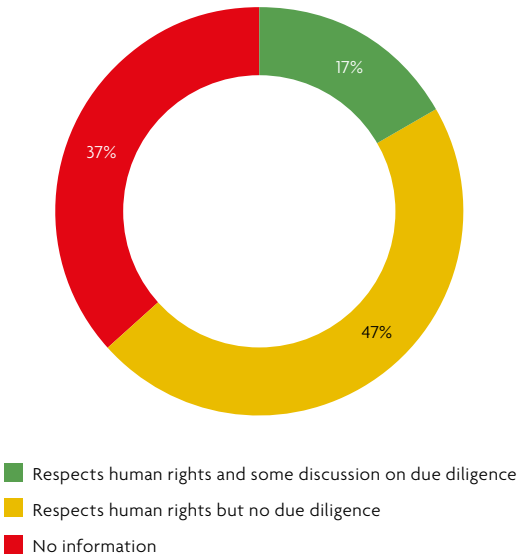
The majority of companies do not discuss the human rights due diligence process they have in place

83% of companies – 50 companies worth $264 billion in market capitalisation – do not discuss the human rights due diligence process they undertake to identify, prevent, address and remedy human rights abuses in business operations

In 2019, the Index included an indicator on human rights policy and due diligence. We assess whether companies – at a minimum – have a dedicated policy that recognise their responsibility to respect human rights. In alignment with the UN Guiding Principles on Business and Human Rights, this KPI also assesses the due diligence process that companies have in place to assess and act upon human rights risks. Since the publication of the UN Guiding Principles of Business and Human Rights, companies across sectors have been working towards conducting human rights due diligence in their operations and supply chain. The livestock and fish sectors are unique in their complete lack of discussion on this issue.

All Index companies are assessed on this KPI regardless of protein and/or region, given that one of the foundational principles of the UN Guiding Principles is that it is relevant regardless of geographic location: "the responsibility to respect human rights is a global standard of expected conduct for all business enterprises wherever they operate" and regardless of domestic regulations: "it exists independently of States' abilities and/or willingness to fulfil their own human rights obligations". While 63% of companies provide some discussion on respecting human rights, 83% of companies provide no discussion on how they conduct human rights due diligence to identify, prevent, mitigate and account for how human rights impacts are addressed.

Figure 33
83% of companies – valued at $264 billion – do not discuss human rights due diligence



3

Aquaculture

Sector context: aquaculture production

In 2017, the global aquaculture industry produced 80,135,760 tonnes of fish and shellfish, with a value of $237 billion. China is by far the world's top producer, accounting for nearly 60% of global production by value, followed by India, Indonesia, Chile, Vietnam and Norway.[193] In 2015, fish accounted for about 17% of all animal proteins consumed. At around the same time, aquaculture surpassed fisheries as the main reported source of seafood.

Aquaculture is a diverse industry that includes the farming of hundreds of species of fish, crustaceans, molluscs and other aquatic animals. Many of these species are specific to certain parts of the world.

In terms of global volume, the most important cultured seafood species in 2017 included carp, miscellaneous freshwater fish and tilapia. The most important species by value differ somewhat from those that are the most harvested. In addition to carp and miscellaneous freshwater fish (which rank highly because of their high volume), shrimp, freshwater crustaceans and salmonids derive the highest economic value.[194]

Like other animal proteins, aquaculture production uses different farming environments depending on the maturity of the animal.

1. **Hatchery:** In this stage, the focus is on developing the fry (recently hatched young fish). Given their vulnerability at early stages of life, strong technical competence is essential to achieve good survival rates. Vertically integrated aquaculture companies may own their own hatcheries, whereas others will purchase fry from external hatcheries.[195]
2. **Nursery:** Fish and shellfish are transferred to a nursery once they reach an appropriate size.[196]
3. **Grow-out:** The final and longest farm phase, where fish and shellfish are transferred to a farm to reach their full size.[197]

Table 11
Duration of production phases for farmed salmon and shrimp[198]

Species	Hatchery	Nursery	Grow-out
Salmon	3–4 months	6–12 months	12–24 months
Shrimp	1 month	2 months	3 months

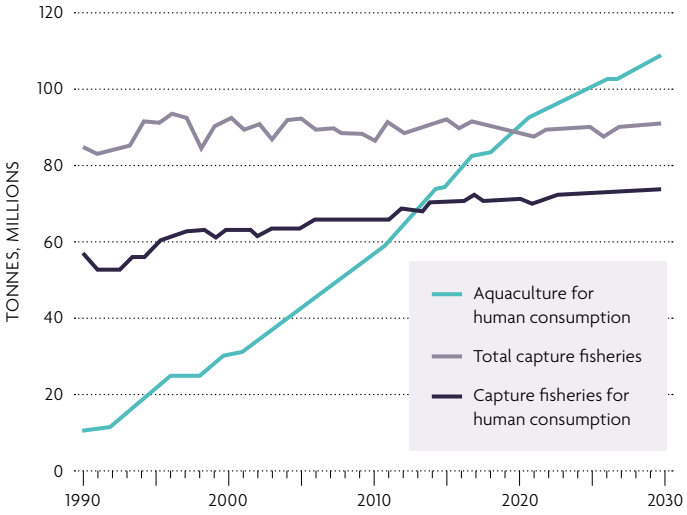


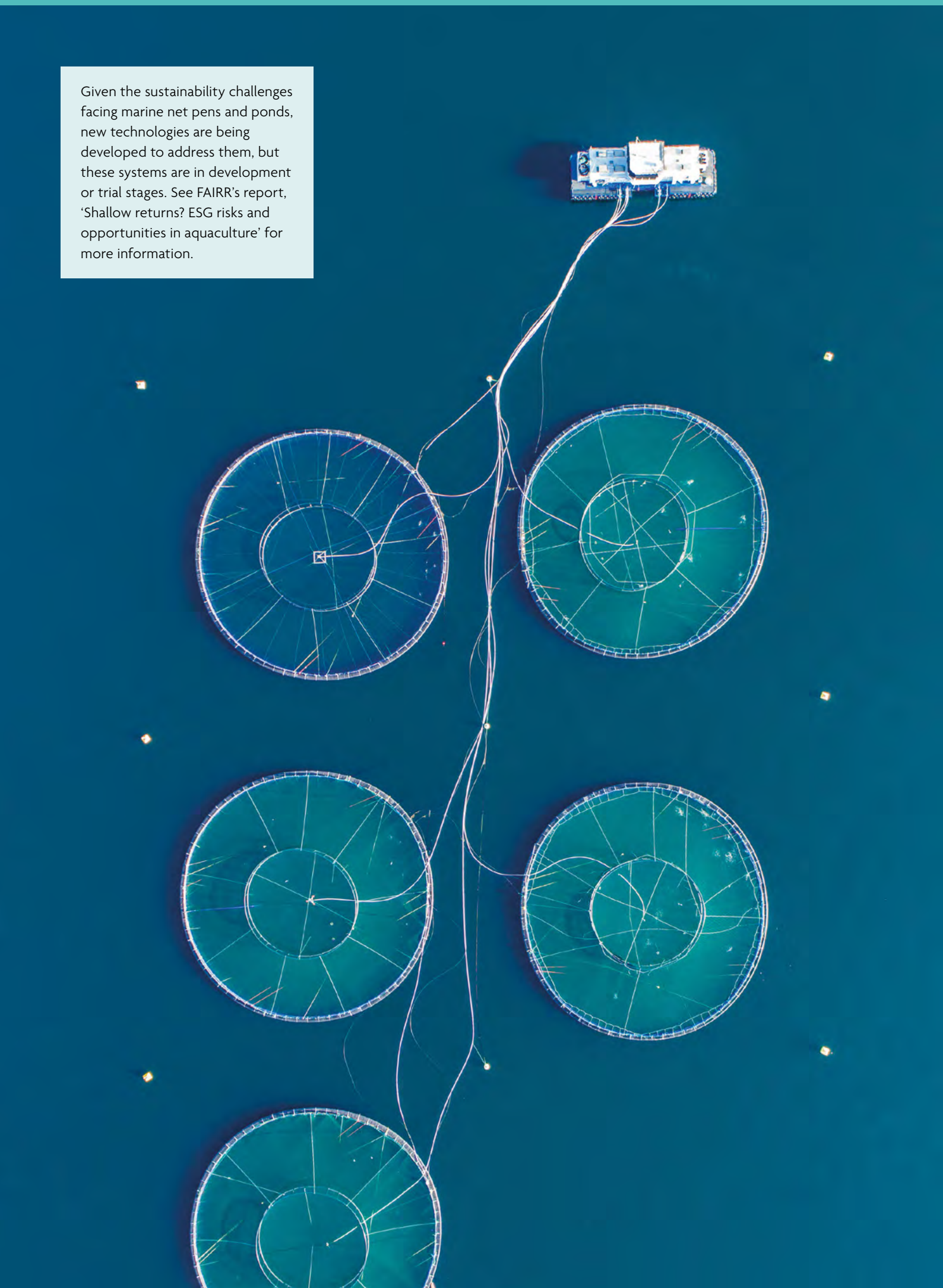
Figure 34
Global capture fisheries and aquaculture production, 1990–2030

Traditionally, most seafood is cultured in ponds or marine net pens. These systems, particularly marine net pens, are characterised by their open nature. There is no boundary between the farm and wider ecosystem. This means that farm outputs, such as faecal waste, unconsumed feed and medicines are discharged directly into the surrounding environment. If effluents build up beyond the environment's natural carrying capacity, this can damage the local ecosystem. The vast majority of salmon aquaculture is produced in marine net pens.

KEY INSIGHTS

- On average, fish feed accounts for around 87% of GHG emissions in Atlantic salmon production. However, none of the companies has a Scope 3 emissions-reduction target.
- Salmon and shrimp production rely on wild fish stocks, yet companies producing aquaculture and other proteins are not discussing environmental impacts of feed production. European salmon producers acknowledge the importance of this issue and are disclosing plans to address it.
- Most companies are in the process of certifying their operations and five of fifteen companies are fully certified to at least one scheme, but 60% of Asian multiple protein producers do not disclose any information on this issue.
- There is a strong regional trend in performance on disease management. Asian producers score the lowest, European producers score the highest.
- None of the Asian aquaculture companies, both pure-play and multiple protein producers, discloses information on quantity of antibiotics used.

Given the sustainability challenges facing marine net pens and ponds, new technologies are being developed to address them, but these systems are in development or trial stages. See FAIRR's report, 'Shallow returns? ESG risks and opportunities in aquaculture' for more information.



Main ESG risks in aquaculture

RISK FACTOR	DESCRIPTION	SALMON	SHRIMP
GHG EMISSIONS 	GHG emissions vary widely by species produced. Life-cycle analysis conducted in 2019 suggests farmed Atlantic salmon production is more GHG-intensive than chicken production.[199] Shrimp and prawn production is more emission-intensive than beef production from dairy herds.[200]	✓	✓
DEFORESTATION & BIODIVERSITY LOSS 	Farming of carnivorous species, such as salmon and shrimp, requires the use of fishmeal and fish oil in feed. These ingredients are sourced from wild-caught fish, linking the expansion of aquaculture to depletion of wild fish stocks. Fishmeal and fish oil prices are volatile and production is sensitive to climate risk. Feed producers are innovating to find alternative ingredients, but some of these have other sustainability impacts. For example, replacing fishmeal and fish oil with soy can increase GHG emissions and deforestation risk.	✓	✓
DISEASE MANAGEMENT	Like in other protein production systems, disease presents a risk to aquaculture companies. The pure-play aquaculture companies disclose much more information on disease management practices than multiple protein producers.	✓	✓
ANTIBIOTICS 	Use of antibiotics varies widely in aquaculture. Norway has drastically reduced antibiotic use in salmon production, whereas in Chile it remains high due to prevalence of *Piscirickettsia salmonis* infection in the region.[201] Data is not readily available for Asian countries, but literature notes their use as 'widespread'.[202] In 2019, the US refused 26 entry lines of shrimp from India due to the presence of banned antibiotics.[203]	✓	✓

✓ MORE PREVALENT ✓ LESS PREVALENT

Aquaculture companies in the Index

Fifteen companies in the Index produce aquaculture products. These companies contribute a total of $56 billion in revenues (18% of the total 2018 revenues for all 60 Index companies). They have a market capitalisation of $48 billion (15% of the total). However, ten of these are pure aquaculture players and five of these companies produce other proteins. For the five that produce other proteins, aquaculture represents a smaller proportion of their revenues. The estimated revenue generated by these five companies from aquaculture is $2.5 billion (or 10% of the total revenues generated by these five companies).

The ten pure aquaculture companies are assessed on seven factors and 19 KPIs. The companies that produce aquaculture and other proteins are assessed on all nine factors and 30 KPIs, including five aquaculture-specific KPIs (see Table 12).

Table 12
Aquaculture-specific KPIs

Deforestation and biodiversity	Aquatic animal welfare
1. Aquaculture certification	1. Aquatic animal welfare
2. Feed ingredients and conversion	
3. Disease management	
4. Ecosystem impacts	

Figure 35
Companies producing or selling aquaculture and other proteins have lower scores than companies that produce aquaculture only

Discussion of results

> On average, fish feed accounts for around 87% of GHG emissions in Atlantic salmon production.[204] However, none of the companies has a Scope 3 emissions-reduction target

In terms of the quality and completeness of the GHG inventory, only five of the fifteen aquaculture companies have calculated and disclosed complete GHG inventories (that is, inventories that include emissions from fish feed production). However, none has set a Scope 3 emissions-reduction target. Only one company, Mowi, is in the process of setting one. This is significant, given that most GHG emissions (almost 90%) in salmon aquaculture come from Scope 3.

Most companies disclose increasing absolute emissions. Only four state that their emissions have decreased from the previous reporting period.

> Salmon and shrimp production rely on wild fish stocks, yet companies producing aquaculture and other proteins are not discussing environmental impacts of feed production. European salmon producers acknowledge the importance of this issue and are disclosing plans to address it.

Salmon and shrimp are carnivorous fish: they consume other fish in their natural diets. This means that fish feed, or aquafeed, for these species must contain fishmeal or fish oil. These ingredients are made from fish captured in the wild, putting pressure on wild fish stocks.

Nearly one fifth of global capture fisheries production is used for fishmeal and fish oil production. Of this proportion, 69% of fishmeal and 75% of fish oil production is used in farmed fish feed.[205] The proportion of fishmeal and fish oil (FMFO) in salmon and shrimp feed has declined over recent years. However, increased demand for seafood means that FMFO demand will also increase.[206]

Eight pure-play aquaculture companies disclose the components of feed by percentage: Bakkafrost, Grieg Seafood, Lerøy Seafood, Mowi, Salmar, Salmones Camanchaca, Tassal and Thai Union. The proportion of marine products used in fish feed ranges from 10-44%. However, six of these companies state that these are sourced from suppliers certified by the Marine Stewardship Council or the Global Standard for Responsible Supply (IFFO RS).

Multiple protein producers do not perform as well as pure-play seafood producers on this issue. This is likely because fishmeal and fish oil availability presents a greater business risk to pure-play aquaculture producers than companies with a more diverse range of products.

FAIRR *comment*

Farmed fish products are often perceived as relatively sustainable compared to other animal proteins. However, new research suggests that farmed salmon has a higher climate impact than poultry[207] – and farmed shrimp is higher than beef from dairy herds (though significantly lower than beef from beef herds).[208] It is therefore concerning that many companies are not taking action on their Scope 3 GHG emissions, and four report increasing absolute emissions.

Most of the companies do not provide detail on why emissions have increased. However, for salmon farmers, most emissions come from feed production. The increased use of plant-based ingredients such as soy and corn to replace marine ingredients alleviates pressure on ocean resources. However, it is more GHG-intensive. This may be a contributing factor to rising GHG emissions at some companies. Producers must balance and prioritise environmental impacts when innovating to find sustainable feed sources. When discussing carbon reductions, Bakkafrost, for example, states that it aims to work with stakeholders on sustainable and efficient feed production.

Producers should also consider the impact of adopting new production systems on GHG emissions. Salmon producers are looking at recirculating aquaculture systems (RAS) technology to expand production. This could allow them to overcome regulatory limits on the number of licenses that can be issued to producers (to prevent overcrowding and pollution in coastal zones).[209] Despite the benefits of RAS, energy use in these systems can be three to five times higher than in marine net pen farming.[210] If these facilities are powered by fossil fuels, the consequent GHG emissions may be much higher than conventional net pen farms.

> Most companies are in the process of certifying their operations and five of 15 companies are fully certified to at least one scheme, but Asian multiple protein producers do not disclose any information on this issue

Aquaculture's complexity makes certification the most globally accepted way for producers to communicate transparency and strong sustainability standards in their operations – both to other supply chain actors and consumers.

The Index assesses whether aquaculture companies are certified to one of the three major schemes: Aquaculture Stewardship Council (ASC), GLOBALG.A.P. or Best Aquaculture Practices (BAP). The schemes' underlying requirements differ, but all assess whether farms and supply chains are performing on environmental impacts, fish health, feed sustainability escapee management and traceability. ASC certification is generally regarded as the most stringent in terms of environmental protection.[211] In response to consumer demand, multiple US and European retailers are starting to require farmed seafood to carry a credible certification.

All 10 pure play aquaculture companies are fully certified or working towards full certification by one of these schemes, indicating certification has become a core business requirement. The only companies without any discussion on certification are three Asian multiple protein companies with aquaculture segments: Great Wall Enterprises, NH Foods and QL Resources.

> There is a strong regional trend in performance on disease management. Asian producers score the lowest, whereas European producers score the highest

The pure-play aquaculture companies disclose more information on disease-management practices than multiple protein producers. Two companies, all European aquaculture companies, received full marks for this indicator. They demonstrated targets to reduce mortality rates, disclosure on frequency of disease outbreaks and non-medicinal approaches to manage and prevent them.

Sea-lice infestation is the main health issue affecting salmon farms, present in all top three salmon-producing countries. In Norway, costs of managing sea lice are estimated at 9% of revenues.[212] A DNB Markets report indicates that management costs are rising and predicted to remain 'stable and high'.[213] In Chile, the industry is fighting *Piscirickettsia salmonis* infection. A vaccination has not yet been commercialised for this disease. Chile therefore needs to use more antibiotics compared to Scottish and Norwegian production.

There is definite room for improvement among the Asian producers. However, in some cases it may be that on-the-ground practices are simply not reflected in corporate reporting. Nissui, for example, does not disclose enough information on relatively basic measures such as mortality rates or number of disease outbreaks. However, it does report that it has developed an automated system that captures data on fish size, which is used to inform fish health monitoring. The company is developing advanced technology to improve operational efficiency and fish health outcomes. So it seems likely that it is making a concerted effort to record and manage disease outbreaks.

> None of the Asian aquaculture companies, both pure-play and multiple protein producers, discloses information on quantity of antibiotics used

In aquaculture, like terrestrial farming systems, antibiotics overuse is widespread in certain regions. The Norwegian aquaculture sector has almost eliminated antibiotic use by vaccinating fish. However, hotspots of antibiotic use in aquaculture, such as Chilean salmon and Asian shrimp production, represent some of the highest antimicrobial use in food production. A 2015 study estimated that chicken production used 148 mg/PCU (population correction unit) of antibiotics, while pig production averaged 172 mg/PCU. In comparison, Chilean salmon production is estimated to use up to 1,400 mg/PCU.[214]

Antibiotics may be more likely to enter the surrounding environment on fish farms than on terrestrial animal farms. Given the difficulty in administering medication to individual fish, medicines are usually given to an entire population of fish, even if only a small subset are affected. Often, unhealthy fish do not consume the medicine due to reduced appetite. Uneaten feed containing antibiotics can therefore enter the aquatic environment. This can exacerbate the development of antibiotic-resistant bacteria.[215]

Data on the use of antibiotics in aquaculture is not readily available for Asian countries, but literature notes that their use is 'widespread'.[216] It is therefore urgent that Asian aquaculture producers begin to report on antibiotics use. A 2017 study on shrimp production from China found that 52% of tested samples contained antimicrobial residues. In 10% of these samples, the residues exceeded legal limits.[217]

The emerging issue of fish welfare

In the 2019 Index, we introduced a dedicated indicator on aquatic animal welfare. The findings show that welfare considerations among fish-producing companies are, in general, in their infancy. The average score across all 15 companies is 23%. There is a key difference between pure-play companies and those that produce other proteins. The average score for pure-play companies is 33% compared to just 5% for companies producing other proteins. The current discussion tends to focus on basic metrics such as stocking densities, housing conditions and reducing mortality rates. Stocking density is a useful proxy for other welfare outcomes such as body condition, increased susceptibility to disease and stress-levels. However, scientists are developing a better understanding of fish welfare that goes beyond basic metrics.

There are geographic differences in risk management. Nearly all the companies that ranked as low or medium risk on this KPI are salmon producers in the Nordics. Mowi and Grieg Seafood top the list. Mowi is the only producer to have some of its operations (in Scotland) certified by RSPCA Assured ('Mowi Annual Report 2018').

Grieg Seafood goes beyond its key producing species and makes welfare considerations for cleaner fish ('Grieg Seafood Annual Report 2018'). These fish are commonly used as a biological control measure to treat sea lice infestations.

However, none of the companies assessed provides a discussion demonstrating consideration of natural behaviour. The conditions in a fish farm are vastly different from the natural habitat of each species, particularly for salmon.[218] FAIRR's 2019 report on the risks in the aquaculture sector noted that leading food retailers such as Tesco, Sainsbury's and Waitrose, which are more exposed to reputational risks than Index producers, have already implemented fish welfare policies ('Shallow returns? ESG risks and opportunities in aquaculture', FAIRR 2019). This presents an emerging market risk for Index producers who will have to demonstrate higher welfare standards to maintain such customers.

BEST PRACTICE

Antibiotics

Bakkafrost is the best-performing aquaculture company on antibiotics, reporting that it has not used any antibiotics in salmon production since 2004. Lerøy Seafood has committed to only using antibiotics when necessary to protect fish welfare. It reports on quantities of antibiotics used and has shown a downward trend: no antibiotics were used in 2017 and 2018 throughout the Group's operations.

Disease prevention

Mowi, **Grieg Seafood** and **SalMar** all report use of sea lice skirts to prevent sea lice infestation. Skirts are sheets of material attached to the top portion of a net pen structure. The material forms a barrier around the top of the farm. As sea lice larvae are generally found close to the surface of farms, the skirt prevents sea lice within the upper part of the water from entering a salmon farm. Mowi also reports use of deep lights to attract salmon to the bottom of the pen, increasing the distance between fish and sea lice at the surface. These examples are considered best practices as they minimise impact on the fish and wider environment. Many other non-medicinal treatments, such as thermal delousing and use of cleaner fish, come with negative welfare and sustainability impacts.[219]

Human rights

Thai aquaculture producers **Charoen Pokphand Foods** and **Thai Union** demonstrated the best scores on human rights reporting. Both companies have due diligence processes and whistleblowing mechanisms in place. Both have reported on remediation measures when instances of slavery have been found. Thai Union names external partners it is working with to improve its human rights performance.

This strong performance is most likely in response to the widely reported cases of slavery in Thai seafood supply chains in 2014. Since 2015, several cases of slavery and forced labour have also been reported in fishery operations in Southeast Asia, which supply fishmeal for aquaculture operators.[220] Numerous industry initiatives have focused on improving seafood supply chains to eradicate forced labour. However, a 2018 report by Human Rights Watch concluded that despite the noteworthy efforts made since 2014, forced labour in Thailand remains deeply engrained in the seafood industry.[221] Overall, the lack of transparency in Asian seafood operations makes it difficult to assess risk exposure and whether the situation is improving. In January 2019, Thailand became the first country in Asia to ratify the International Labour Organization's Working in Fishing Convention, signalling government pressure to act on this issue.[222]

Figure 33
Overall score of companies producing/selling aquaculture products

THE FULL COMPANY BENCHMARK IS AVAILABLE FOR FAIRR INVESTOR MEMBERS.
SEE INDEX.FAIRR.ORG FOR THE FULL DATA SET.

ENGAGEMENT QUESTIONS FOR INVESTORS

OUR ENGAGEMENT QUESTIONS ARE AVAILABLE FOR FAIRR INVESTOR MEMBERS.
SEE INDEX.FAIRR.ORG FOR RESOURCES.

4

Sustainable proteins

Sector context: sustainable proteins

The 60 global companies included in the Index are some of the world's largest producers and sellers of meat, fish and dairy. Their growth ambitions are predicated on increasing global consumption of animal proteins, particularly driven by emerging markets. Yet the most advanced scientific consensus – including through the IPCC – is that even current levels of consumption of animal proteins pose a profound threat to human and planetary health.

This threat is compounded by the sector's vulnerability to climate change impacts. These will lead to rising operational costs linked to lower water and feed availability, lower productivity of animals, increased incidence of diseases and damage to infrastructure from extreme weather events. For companies in the livestock and fish sectors, diversifying to portfolios that include both animal and alternative protein sources presents the biggest opportunity to mitigate risks while preparing for market and technological disruptions.

> **"Balanced diets, featuring plant-based foods, such as those based on coarse grains, legumes, fruits and vegetables, nuts and seeds, and animal-sourced food produced in resilient, sustainable and low-GHG emission systems, present major opportunities for adaptation and mitigation while generating significant co-benefits in terms of human health (high confidence). By 2050, dietary changes could free several Mkm2 (medium confidence) of land and provide a technical mitigation potential of 0.7 to 8.0 GtCO2e yr-1, relative to business as usual projections (high confidence)."**
>
> **IPCC Report**
> 'Climate Change and Land', August 2019

KEY INSIGHTS

- For the first time, 15 of 60 companies (25%) show evidence of some work to increase their access to alternative protein sources.
- In 2019, eleven companies announced investments to grow their alternative protein portfolio.
- Meat companies are beginning to make bold statements on protein diversification.

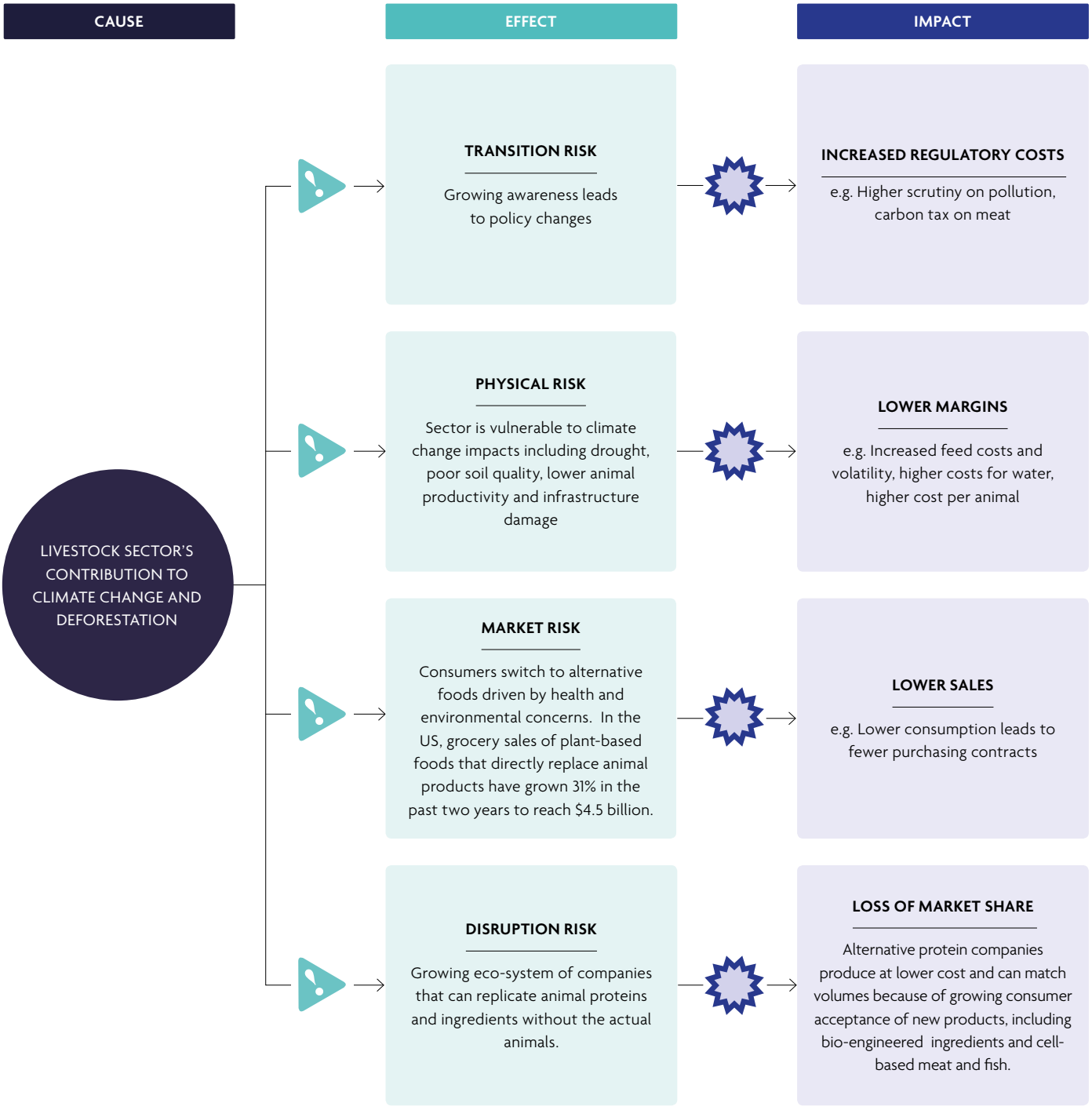
FAIRR sustainable proteins engagement

Since 2016, FAIRR has facilitated a collaborative investor engagement to encourage the world's largest food retailers and manufacturers to develop a global, evidence-based approach to diversify protein sources away from an over-reliance on animal proteins. As part of this process, we have developed an evaluation framework designed to track companies' approach to mitigating supply-chain risks in animal protein commodities. The framework also tracks their approach to expanding alternative protein portfolios through product development and consumer engagement. The methodology for the Opportunity Factor is based on this framework but is adapted to producers rather than consumer facing companies.

Read more about FAIRR's Sustainable Proteins in our report, 'Appetite for Disruption'.

By 2050, dietary changes could contribute 23–45% of the total mitigation potential from changes in production and consumption of food.[224]

Figure 37
Climate change makes the livestock and fish sectors vulnerable to transition, physical, market and disruption risks



Our pilot Index in 2018 included a qualitative analysis to understand how companies in this sector were preparing for a protein shift. In 2019, we built on this with the introduction of an Opportunity Factor. This quantifies a company's exposure to alternative proteins.

Our methodology for the Opportunity Factor seeks to understand if protein producers have:

1. **Products on the market:** We assess the extent to which the company has an alternative product offering.
2. **Expansion plans:** We evaluate whether the company has plans to expand its offering, for example through internal R&D or via venture investments or acquisitions.
3. **Motivation:** We seek to understand how a company is communicating its strategy in this space. This includes whether it recognises protein diversification as a material business issue.
4. **Tracking and reporting:** We assess whether a company has set targets and metrics to grow this part of its business.

All 60 companies are evaluated on the Opportunity Factor. An Opportunity Factor Score is integrated into the overall score and ranking. Read more about our scoring methodology in Appendix 2: Methodology and scoring.

Discussion of results

For the first time, 15 of 60 companies (25%) show evidence of some work to increase their access to alternative protein sources

These companies derived $209 billion in revenues in 2018 (65% of the total 2018 revenues for all 60 Index companies). They represent $156 billion in market capitalisation (48% of the total). The meat sector has responded to growing consumer demand for alternative proteins with a rush of product launches and investments. This includes announcements from Brazilian giants such as JBS and Marfrig, as well as investments from companies such as MapleLeaf, Tyson and Bell Food Group. Ten meat and dairy companies have announced plans to introduce plant-based ranges.

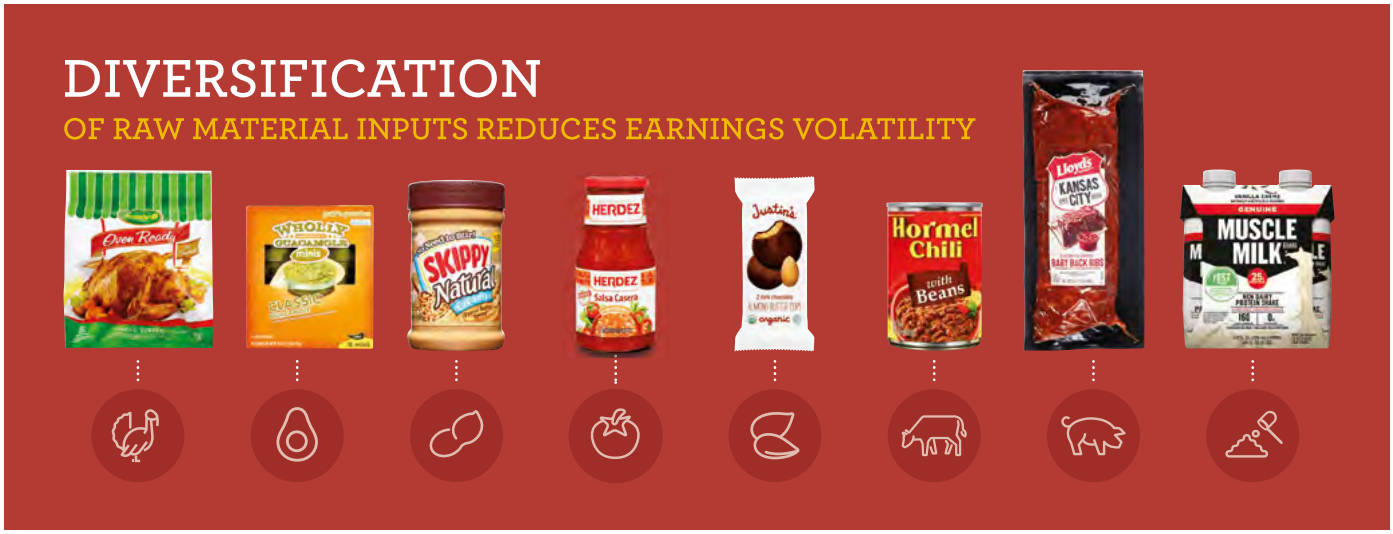
In 2019, eleven companies announced investments to grow their alternative protein portfolio

These investments included venture investments in bio-engineered ingredient manufacturers and plant and cell-based meat companies. They also included investment in facilities and research to manufacture plant-based protein ranges.

Meat companies are beginning to make bold statements on protein diversification

In August 2019, the CEO of Maple Leaf, Canada's largest hog processor, described the plant-based sector as a $25 billion dollar opportunity. Michael McCain predicted that plant-based protein would reach 10–15% of the meat market by 2029.[223] Both Maple Leaf and Tyson have rebranded themselves as 'protein' companies, and Tyson's Chief Sustainability Officer's title has changed to Alternative Proteins & Chief Sustainability Officer. In its annual reporting to investors, Hormel makes an explicit reference to its plant-based portfolio. It describes it as a way to "find balance through diversifying areas such as our raw material inputs" to minimise sales and earnings volatility.

Figure 38
Excerpt from Hormel Foods Annual Report 2019, page 7



BEST PRACTICE

Maple Leaf leads the sector on plans to diversify protein sources

In 2017, the company acquired two plant-based companies. A year later, the company launched its own wholly owned subsidiary, GreenLeaf Foods. The company is investing $310 million in a dedicated plant-based facility in Indiana, the largest plant-based processing facility in North America.

Maple Leaf has invested an additional $26 million in two existing facilities to scale up production. In its annual report to investors, the company makes an explicit link between protein diversification and sustainability: "our strategy to broaden our portfolio into plant-based proteins... is important to consumers and to a sustainable food system."

Companies are diversifying into sustainable proteins

VENTURE/DIRECT INVESTMENTS	NEW PRODUCT LAUNCHES	COLLABORATION/INNOVATION
Bell Food Group: investing €2 million in Mosa Meat, a cell-based beef company.	**BRF**: planned launch of plant-based products.	**Fonterra**: working with various research institutions and start-ups for the development of plant and fermentation-based nutrition.
Tyson Foods: Tyson Ventures (TV) made investments in start-ups such as Memphis Meats and Future Meat Technologies.	**Marfig**: partnering with Archer Daniels Midland (ADM) to develop and sell plant-based protein products in Brazil.	**CPF**: 30% of new product development will have a health focus, including a vegetarian line
Fonterra: Purchased stake in Motif Ingredients, a US-based food ingredients company that develops and commercialises bio-engineered animal and food ingredients.	**JBS**: unveiled first plant-based burger.	
	Maple Leaf: launched dedicated plant-based subsidiary, and has invested $310 million in a facility to produce plant-based proteins.	
	Tyson Foods: unveiled new alternative protein and blended products under brand 'Raised & Rooted'.	
	Smithfield Foods: launched new range of products under brand 'Pure Farmland'	
	Grupo Nutresa: introduced two plant-based products under brand Pietran	
	Hormel Foods: introduced blend burgers under Applegate Farms	

Table 14
Company activity on alternative proteins

Appendices

APPENDIX 1: FULL LIST OF COMPANIES

COMPANY NAME	DESCRIPTION [xvii]
Almarai Co JSC	Almarai is the Middle East's leading food manufacturer and distributor, and the world's largest vertically integrated dairy company. Around 61% of revenues are derived from dairy, 13% from fresh poultry products, and the rest from juice, bakery and infant nutrition. The company owns over 190,000 dairy cows in farms in Saudi Arabia and Jordan.
Astral Foods Ltd	Astral is a leading South African integrated poultry producer. It has operations based in Gauteng (Festive brand), Mpumalanga (Goldi brand), Kwazulu-Natal (Mountain Valley brand) and the Western Cape (County Fair brand). It is a leading low cost producer of feed pre-mixes, complete feed, hatching eggs, day-old chicks, broiler and distributor and producers of a variety of fresh, frozen and value added chicken products in Southern Africa.
Australian Agricultural Co Ltd	The Australian Agricultural Company is Australia's largest integrated cattle and beef producer. It specialises in both grass-fed and grain-fed beef production.
Bakkafrost P/F	Bakkafrost, based in the Faroe Islands, is a vertically integrated salmon farming company with full control and responsibility over all aspects of production. Its primary sales are to the EU (44%), Eastern Europe (21%), US (18%) and Asia (17%).
Beijing Sanyuan Foods Co Ltd	Beijing Sanyuan Foods produces, processes and sells dairy products, beverages, foods, cold foods and drinks, and ice creams in China.
Beijing Shunxin Agriculture Co Ltd	Beijing Shunxin Agriculture is a Chinese company principally engaged in the production, processing and distribution of distilled liquor and meat (hogs). It integrates hog breeding, raising, slaughtering, meat processing and cold chain distribution. With a complete industrial chain of meat processing and an annual slaughter capacity of three million hogs, Shunxin has the largest single-factory slaughter volume in China.
Bell Food Group AG	The Bell Food group consists of four companies: Bell, Eisberg, Hilcona and Hügli. Its products range includes meat, poultry, charcuterie, seafood and ultra-fresh, fresh and non-perishable convenience products such as salads, sandwiches, ready-made meals, pasta, sauces and spices. It's business area consists of Bell Switzerland, Bell Germany and Bell International divisions, and the Convenience business area with Eisberg, Hilcona and Hügli divisions.
BRF SA	BRF SA is one of the largest producers of fresh and frozen protein foods in the world, employing over 13,000 integrated producers to grow its animals. BRF has invested in shares of COFCO Meat (an operation valued at $20 million), which maintains 47 pig farms, two slaughter plants and two processed meat plants in China. As a result, BRF now holds 1.99% of the capital of the state-owned company, China's leader in agribusiness.
Cal-Maine Foods Inc	Cal-Maine Foods is the largest fully integrated producer and marketer of shell eggs in the US. In fiscal 2017, it sold approximately 1,031 million dozen shell eggs – 20% of US shell egg consumption.
Charoen Pokphand Foods PCL	Charoen Pokphand Foods is one of the world's leading listed agro-industrial and food conglomerates that operates vertically integrated businesses. The company is present in 16 countries and exports products from Thailand to over 30 countries. It operates in both the livestock (swine, broilers, layers and ducks) and aquaculture (shrimp and fish) businesses. It is involved in manufacturing animal feed; animal breeding and animal farming; meat processing; manufacturing semi-cooked and fully cooked meat; food products and ready-meal products; and the meat and food retail and restaurant businesses.
Cherkizovo Group PJSC	Cherkizovo Group is Russia's largest vertically integrated meat and feed producer. It is one of the top three companies serving Russia's chicken, pork and processed meat markets, and is the country's largest feed manufacturer.
China Mengniu Dairy Co Ltd	China Mengniu Dairy and its subsidiaries manufacture and distribute quality dairy products in China. It is one of the leading dairy product manufacturers in China, with MENGNIU as its core brand. Danone Group, which owns a 9.9% stake in Mengniu, is Mengniu's second largest strategic shareholder. Inner Mongolia Mengniu Danone Dairy Co Ltd ('Mengniu Danone') is a joint-equity company held 80% by Mengniu and 20% by Danone.
China Modern Dairy Holdings Ltd	China Modern Dairy is the largest dairy farming company and the largest raw milk producer in China. It is primarily engaged in two business segments: (a) dairy farming, which is 70% of its business; and (b) liquid milk products under its own brands. Modern Dairy is a long-term partner of Mengniu and is its largest raw milk supplier. In 2017, Mengniu announced the acquisition of additional shares of China Modern Dairy – Mengniu and its concert party own 61.3% of the company's issued share capital.

[xvii] Company descriptions are based on financial reports where available and/or Bloomberg and Reuters.

COMPANY NAME	DESCRIPTION
Chuying Agro-Pastoral Group Co Ltd	Chuying Agro-Pastoral is a China-based vertically integrated company, principally engaged in the breeding and distribution of livestock and poultry. The company primarily provides live pig products, including commodity piglets, boars and commodity hogs, as well as poultry products, including hatching eggs, chicks and meat chicken. It is also engaged in the distribution of grain, vegetables, frozen products and cooked food, as well as providing internet, banking and other services.
COFCO Meat Holdings Ltd	COFCO Meat is the pork producing unit of China's largest state food conglomerate, COFCO. The company's activities include feed processing, hog breeding, hog slaughtering and segmentation, meat product processing, product sale, and meat imports. COFCO Meat also operates and manages slaughterhouses throughout China. BRF has a minority stake in COFCO Meat.
Cranswick PLC	Cranswick is a British-based producer of fresh pork (32%) and poultry (11%), as well as convenience and gourmet products, including beef. Around three-quarters of its revenues come from retail customers, primarily through their own-label products.
Empresas AquaChile SA	AquaChile is a Chilean company that farms and processes salmon, sea trout and tilapia eggs. It has a presence in the whole production chain of the aquaculture industry. It operates in over 180 geographical locations and 63 farms in Chile and Costa Rica, as well as having sales offices in the US. Nearly 50% of sales come from Atlantic salmon. It also manufactures fish feed.
Fonterra Co-operative Group Ltd	Fonterra is New Zealand's biggest company and the world's largest processor of dairy products. It is a co-operative, owned and supplied by around 10,700 farmer shareholders in New Zealand. The co-operative collects around 18 billion litres of milk each season in New Zealand, 1.5 billion litres in Australia and 500 million litres in Chile. It also has access to 600 to 800 million litres in Europe, and produces safe, secure and high-quality milk from its farms in China.
Fortune Ng Fung Food (Hebei) Co Ltd	Fortune Ng Fung Food is a China-based company, principally engaged in livestock breeding and slaughtering, and food processing businesses. Its principal products include live cattle, beef, mutton, meat (pork) products, dairy products, fast food, and beverages.
Fujian Sunner Development Co Ltd	Fujian Sunner is engaged in breeding, slaughtering, processing and selling chicken, primarily in China. It offers frozen chicken products for fast food and food manufacturing industries, meat wholesale markets and other markets.

COMPANY NAME	DESCRIPTION
GFPT PCL	GFPT is a fully vertically integrated producer and distributor of frozen chicken meat, processed chicken, and animal and aquatic feed for Thai and overseas markets. Almost 45% of its revenues are from fresh poultry sales and 30% from chicken farms and sales of day-old chicks.
Great Wall Enterprises Co Ltd	Great Wall Enterprises Co engages food, restaurant and livestock businesses in China. It operates feed plants, chicken slaughter houses, poultry processing plants, breeding and hatchery farms, pig farms, and a lab farm for animal nutrition research and development.
Grieg Seafood ASA	Grieg Seafood is one of the world's leading fish farming companies, specialising in Atlantic salmon. The group is present in Norway, British Columbia (Canada) and in Shetland (UK). Over 54% of its sales are to the EU.
Grupo Bafar SAB de CV	Grupo Bafar SAB de CV is a Mexico-based holding company principally engaged, through its subsidiaries, in the food industry. The company operates through seven business divisions: consumption products division, which is engaged in the supply of meat, processed meats and dairy products; retail, which operates the CarneMart and BIF stores; manufacturing; logistics, active in the storage and distribution of the products; cattle trade, engaged in the breeding of cattle and which supplies BIF stores with meat; poultry division, responsible for the production and sale of poultry and eggs; and exports.
Grupo Nutresa SA	Grupo Nutresa is the leader in processed foods in Colombia (61.1% market share) and a large player in Latin America. It is a highly diversified food business, with eight business units: cold cuts (21% of sales), biscuits, chocolates, Tresmontes Lucchetti, coffee, retail food, ice cream and pasta. Between 30% and 50% of Grupo Nutresa's sourced products for the retail and cold cuts segments are animal proteins.
Hormel Foods Corp	Hormel operates through the following segments: grocery products, refrigerated foods, Jennie-O Turkey Store, specialty foods, and international & other. Its business is involved in processing, marketing and selling branded and unbranded pork, beef, chicken and turkey products for retail, foodservice and fresh product customers.
Industrias Bachoco SAB de CV	Bachoco is a vertically integrated company with operations in Mexico and the US with its headquarters located in Celaya, Guanajuato, Mexico. Its main business lines are chicken, table eggs, balanced feed, swine and others, including further process products of turkey and beef.
Inghams Group Ltd	Inghams is Australia and New Zealand's largest vertically integrated poultry producer. It is also a large stockfeed producer, supplying to the poultry, pig, dairy and equine industries.

COMPANY NAME	DESCRIPTION
Inner Mongolia Yili Industrial Group Co Ltd	Yili is China's largest dairy producer. It has large-scale and concentrated-breeding pastures that contribute to 100% of its total milk source.
Japfa Ltd	Japfa is a Singapore-based company that specialises in producing quality dairy, protein staples (poultry, beef, swine and aquaculture) and packaged food. Its business is vertically integrated from animal feed production and breeding to commercial farming and food processing. It is one of the two largest producers of poultry in Indonesia, and has a similar vertically integrated business model for poultry operations in Vietnam, Myanmar and India, as well as swine operations in Vietnam.
JBS SA	JBS is the world's second-largest food company, with an extensive product portfolio focusing mainly on fresh and frozen beef, pork and poultry, as well as prepared and processed foodstuffs.
LDC SA	LDC is a France-based holding company engaged in food processing. The group provides poultry products, as well as a range of delicatessen food. Its poultry division is engaged in poultry breeding, pig and cattle farming and egg production.
Lerøy Seafood Group ASA	Lerøy Seafood's core business, based in Norway, is producing salmon and trout, catches of whitefish, processing, product development, marketing, selling and distributing seafood.
Maple Leaf Foods Inc	Maple Leaf Foods is a Canadian packaged meats producer. Its portfolio includes prepared meats, ready-to-cook and ready-to-serve meals, valued-added fresh pork and poultry and plant protein products.
Marfrig Global Foods SA	Marfrig is one of the largest global animal protein companies, involved in producing, processing, manufacturing, selling and distributing animal protein (cattle, sheep and poultry) and various food products such as breaded, ready-made food, fish, frozen vegetables and desserts. It recently announced the acquisition of National Beef, making it the world's second-largest beef producer.
MHP SE	MHP SE is a vertically integrated company that has a market share of around 55% of the Ukrainian poultry market. Chicken meat is one of the main ingredients in its processed meat products – accounting for over 50% of its composition, the rest being beef or pork. The company also produces and sells feed grains for its own operations, as well as to third parties.
Minerva SA	Minerva Foods is one of the South American leaders in the production and sale of fresh beef and its by-products, as well as live cattle exports, and it also maintains operations in the meat processing segment.
Mowi ASA	Mowi ASA is one of the biggest seafood companies in the world, operating in 25 countries, and it is the world's largest producer of Atlantic salmon, supplying one fifth of the global demand for farm-raised Atlantic salmon.

COMPANY NAME	DESCRIPTION
Muyuan Foodstuff Co Ltd	Muyuan Foodstuff breeds pigs in China: boars, commodity pigs and other pigs. It also produces animal feed products.
New Hope Liuhe Co Ltd	New Hope Liuhe is a leading enterprise in agricultural industrialisation in China and an affiliate of New Hope Group. New Hope Liuhe has grown its operations into animal feed, livestock breeding and raising (chicken and pigs), meat processing and financial investments. The company operates nationally across China and in 20 other countries and regions including Vietnam, the Philippines, Bangladesh, Indonesia, Cambodia, Sri Lanka, Singapore and Egypt.
NH Foods Ltd	The NH Foods Group is a vertically integrated company that raises cattle, hogs and poultry. It maintains 122 farms in Japan and 26 overseas (Australia and Middle East). The fresh meats business accounts for more than 50% of its sales. The company also has a marine and dairy products division.
Nippon Suisan Kaisha Ltd	Nippon Suisan Kaisha provides various seafood products in Japan and internationally. The company engages in the aquaculture and provision of salmon, yellowtail and bluefin tuna, as well as pollock roe products.
Prima Meat Packers Ltd	Prima Meat Packers is a Japan-based company, principally engaged in the production and sale of meat products and processed products. The company operates in three business segments. The meat products segment is engaged in the rearing of pigs, the processing and sale of meat, as well as related logistics business.
QAF Ltd	QAF's Australian primary production business is through the Rivalea Group. Rivalea is Australia's largest pork producer and one of Australia's leading vertically integrated pork companies with a sizeable investment in pig farming, pork processing and feed milling. QAF also has a bakery business segment.
QL Resources Bhd	Malaysia-based QL is among Asia's largest egg producers and surimi manufacturers. The group has three principal activities: integrated livestock farming (poultry and egg), marine products manufacturing (deep-sea fishing, fishmeal and aquaculture) and palm oil activities. It operates in Malaysia, Indonesia, Vietnam and China.
RCL Foods Ltd/ South Africa	RCL is a leading African food producer based in South Africa. Its consumer division produces a wide range of quality culinary, pet food and beverage products through its five business units: chicken, grocery, pies, beverages and speciality. It also has an animal feed business. Two-fifths of its chickens are supplied by contract growers, but it owns over 180 chicken hatcheries and farms.

COMPANY NAME	DESCRIPTION
SalMar ASA	SalMar is one of the world's leading producers of Atlantic salmon and is integrated from broodstock, roe and smolt to value-added products (VAP) and sales. SalMar has significant farming operations in both central and northern Norway, as well as in Scotland through 50% ownership in Scottish Sea Farms and 34% in Arnarlax. SalMar also operates a comprehensive harvesting and VAP facility in central Norway at the company's headquarters at InnovaMar on Frøya and on Vikenco at Aukra.
Salmones Camanchaca	Camanchaca is engaged in industrial fishing in northern and southern Chile as well as farming Atlantic salmon, mussels and abalone. It operates along over 6,000 kilometres of coastline and exports to more than 50 countries.
San Miguel Food and Beverage Inc	San Miguel is one of the leading food companies in the Philippines. Its products and services span across the entire value chain – from animal feeds, fresh chicken and fresh meats to processed meats, dairy, spreads, oils, biscuits, coffee and jelly snacks. The company operates a vertically integrated business model in its meats business, ranging from plantations, breeding and contract growing to processing and marketing of chicken and hogs. The Purefoods-Hormel Company Inc, a joint venture with Hormel USA, produces and markets processed meats that account for nearly two-thirds of the processed meats market.
Sanderson Farms Inc	Sanderson Farms is the third-largest poultry producer in the US, processing over 4.2 billion pounds of meat in fiscal 2017. It is a fully vertically integrated poultry processing company engaged in producing, processing, marketing and distributing fresh and frozen chicken products.
Scandi Standard AB	Scandi Standard is the leading producer of chicken-based food products in the Nordic region and Ireland. The company is also involved in rearing, producing and hatching day-old chicks; processing slaughterhouse byproducts for use in pet food; and packing and selling eggs.
Seaboard Corporation	As an integrated food company, Seaboard Foods is the third-largest US hog producer and fourth-leading pork processor. It produces and sells fresh, frozen and processed pork products to further processors, food service operators, grocery stores, retail outlets and other distributors in the US. Internationally, Seaboard Foods sells to distributors in China, Japan, Mexico and other foreign markets. Seaboard has a 50% non-controlling voting interest in Butterball, one of the largest vertically integrated producers, processors and marketers of branded and non-branded turkey products in the US. The corporation also has an integrated agricultural commodity trading and milling division focused on soybeans, wheat and other commodities.

COMPANY NAME	DESCRIPTION
Tassal Group Ltd	Tassal Group is engaged in hatching, farming, processing, selling and marketing of Atlantic salmon. The company is an integrated salmon grower and salmon and seafood processor, seller and marketer.
Thai Union Group PCL	Thai Union is a global seafood leader, which has 10 different brands, it has 12 production facilities in 10 countries across North America, Europe, Africa and Asia. They have a range of products including shelf-stable, chilled and frozen foods,
Thaifoods Group PCL	Thaifoods Group is an integrated food production company. It business comprises poultry, egg, swine and animal feed in Thailand and Vietnam. Its poultry business involves chicken breeding, chicken meat production and sales, and sale of day-old chicks, live chickens and processed chicken. Its swine business involves pig breeding, sale of live pigs and pork meat. The feed business involves the manufacture and sale of feed for animals, mainly chickens and pigs.
Tyson Foods Inc	Tyson Foods is one of the world's largest food companies. It operates in four reportable segments: beef, pork, chicken and prepared foods. 'Other' primarily incudes its foreign chicken production operations in China and India, third-party merger and integration costs and corporate overhead related to Tyson New Ventures, LLC. It operates a fully vertically integrated chicken production process. Its integrated operations consist of breeding stock, contract growers, feed production, processing, further processing, marketing and transportation of chicken and related products, including animal and pet food ingredients. It also processes live fed cattle and hogs and fabricates dressed beef and pork carcasses into primal and sub-primal meat cuts, case-ready beef and pork and fully cooked meats.
Venky's India Ltd	VH Group is the largest fully integrated poultry group in Asia. Its activities include specific pathogen-free eggs; chicken and eggs processing; broiler and layer breeding; genetic research and poultry diseases diagnostics; poultry vaccines and feed supplements; vaccine production; bio-security products; poultry feed and equipment; nutritional health products; and soya bean extracts.
Vietnam Dairy Products JSC	Vinamilk processes, manufactures, and distributes milk cake, soya milk, fresh milk, refreshment drinks, bottled milk, powdered milk, nutritious powder and other milk products. It is the largest dairy company in Vietnam.

COMPANY NAME	DESCRIPTION
Wens Foodstuff Group Co. Ltd	Wens Foodstuff Group Co., Ltd. operates as a livestock and poultry farming company in China. The company engages in the breeding and distribution of chickens and pigs, cows, meat ducks, deep sea fish, meat goats, and meat pigeons; and food processing, farming implement manufacturing, veterinary drug making, and fresh meat logistics activities. It also supplies eggs, raw milk and dairy products, and fresh and processed meat products. The company was formerly known as Guangdong Wens Foodstuff Group Co., Ltd. and changed its name to Wens Foodstuff Group Co., Ltd. in August 2018. The company was founded in 1983 and is based in Yunfu, China.
WH Group Ltd	WH Group is the largest pork company in the world, with number one positions in China, the US and key markets in Europe. It integrates hog production, hog slaughtering and the processing and distribution of packaged meats and fresh pork. It is a majority shareholder in Henan Shuanghui Investment & Development, China's largest meat processing business. It also owns Smithfield Foods in the US.

APPENDIX 2: METHODOLOGY AND SCORING

The Index has nine factors and 30 key performance indicators (KPIs). Each KPI has a maximum score of five points. Where applicable, the KPI scores have a geographic multiplier (70–100%) depending on the universality of the company's performance, policies, targets or discussion.

All KPIs within an individual risk factor are weighted equally. An individual risk factor score is a simple average of scores across individual KPIs.

How we factor controversies into our assessments

The Index methodology is designed to assess how livestock and aquaculture companies manage and report on material environmental, social and governance (ESG) risks (and opportunities). We acknowledge that disclosure on its own is not entirely reflective of whether companies manage ESG risks and, if they do, whether their management systems are effective. To provide a more comprehensive view, we have started to integrate limited performance-based indicators where available and relevant: for example, on emissions performance, aquaculture feed conversion ratios and antibiotics usage.

Controversies are an additional way to assess performance. Multiple controversies within a specific company, whether regulatory breaches or violations of the company's own policy, indicate the presence of systemic enterprise-wide risks.

Controversies can harm a company's reputation, result in the loss of consumers or contracts, and increase costs due to product loss or damage. All of these can impact fund returns.

We consider controversies by applying a confidence multiplier of 90% *at the risk factor level* for a company if there are three or more discrete events within the assessment period. Companies with fewer than three events will not have their scores reduced, but we will include the symbol to indicate the presence of a controversy.

Eligible controversies are defined based on the specific risk factor and the credibility of the source. The primary sources of information are news articles published between 1 June 2018 and 30 July 2019.

It is important to note that our process is not meant to be a comprehensive review of all company controversies. We also acknowledge the limitation of controversy screening, which can impact high-profile companies even if the same issues are pervasive across the sector. External ratings use more complex methodologies that categorise events based on their severity, but these can also be subjective. Our approach is deliberately simple to ensure that the methodology factors in multiple occurrences of specific events at the very least. This will indicate the presence of systemic problems and present the biggest risks for investors.

Table 15
Risk factors and controversy types

Risk factor	Events
Deforestation & biodiversity	• Breach of company deforestation policy • Documentation/investigation of illegal deforestation • Escape event for aquaculture companies • Disease/sea lice event for aquaculture companies
Water pollution	• Lawsuit against the company on environmental issues • Report or research detailing multiple pollution or wastewater-related violations • Regulatory fine due to environmental breach
Animal welfare	• Documentation/investigation of animal abuse
Antibiotics	• Use of banned antibiotics • Documentation/investigation of widespread/routine use of medically important antibiotics • Documentation/investigation or fines linked to antibiotic residues in the final product
Working conditions	• Documentation/investigation of human rights abuses, poor wages, child labour, gender discrimination • Report of unsafe working conditions, injuries and/or fatalities
Food safety	• Food safety incident or recall

How we calculate the final company score

To calculate the final company score, we use both the **Risk Factor Score** and the **Opportunity Score**.

Risk Factor Score: Scores on the individual risk factors are derived after the application of the geographic and confidence multipliers. Since all risk factors are weighted equally, the company's Risk Factor Score is a simple average of scores across all eight risk factors: GHG emissions, deforestation and biodiversity, water use and scarcity, waste and pollution, antibiotics, animal welfare, working conditions, and food safety. The Risk Factor Score is then converted to a percentage (out of 100).

Opportunity Factor Score: The Index has one opportunity factor: sustainable proteins. Like individual risk factor scores, the Opportunity Factor Score (based on one KPI) has a maximum of five points and is converted to a percentage (out of 100).

We acknowledge that overweighting the Opportunity Factor score introduces subjectivity into the company rankings. This is why we provide rankings based on both Risk and Risk and Opportunity, so investors can use the information accordingly. We will continue to refine this methodology as more companies increase their exposure to alternative proteins.

We chose a co-efficient of 50% for two reasons:

1. Increasing exposure to alternative proteins automatically reduces the company's exposure to six of the eight risks covered by the Index: GHG emissions, antibiotics, deforestation and biodiversity, water use and scarcity, waste and pollution, and animal welfare.
2. The IPCC report 'Climate change and Land' has estimated that dietary changes could contribute 23–45% of the total mitigation potential from changes to production and consumption of food.[225]

The scoring formula ensures that the company's final score only benefits from the addition of the Opportunity Factor Score. Companies that score zero on sustainable proteins do not benefit from the opportunity factor. Equally, their overall score is not impacted by the lack of progress in this area.

A company's overall score is calculated using the formula below. S is the overall score, x is the Risk Factor Score and y is the Opportunity Factor score.

$$S = \underbrace{x}_{\text{RISK + OPPORTUNITY SCORE}} + \underbrace{((0.50)(y)}_{\text{RISK FACTOR SCORE}} \underbrace{(1-x))}_{\text{OPPORTUNITY FACTOR SCORE}}$$

An illustrative example is in the table below.

Table 26
Example of calculating a company's score

Factor	Raw factor score	No. of controversies	Confidence factor	Factor score	
GHG emissions	20%	0	100%	20%	
Deforestation and biodiversity	50%	2	100%	50%	
Water use and scarcity	40%	0	100%	40%	
Waste and pollution	30%	4	90%	27%	
Antibiotics	50%	0	100%	50%	
Animal welfare	50%	2	100%	50%	
Working conditions	80%	4	90%	72%	
Food safety	70%	5	90%	63%	
Risk Factor Score				47%	*x*
Deficit between 100% and average risk score				53%	
Sustainable proteins	20%	N/A	N/A	20%	*y*
Weighted opportunity score				5%	
Overall score				52%	*S*

Limitations

The nine factors and 30 indicators reflect the sector's material impacts. However, these are not an exhaustive list.

A key risk for the industry is growing awareness of the causal link between high meat consumption and non-communicable diseases such as cancer, diabetes and obesity. However, the Index does not consider health and nutrition issues as part of its current risk framework, beyond an assessment of company exposure to alternative proteins. This is primarily because health and nutrition issues are complex and dependent on local culture and social contexts. There is currently no standardised framework for assessing animal protein consumption in the context of health.

Another key risk for the industry is food waste. According to the FAO, approximately one-third of all food produced in the world is was lost or wasted. The impacts and risks associated with food waste have strong relationships with other risk factors included in the Index: GHG emissions, water use and scarcity, deforestation and biodiversity (through land-use change), and waste and pollution (through fertiliser and pesticide applications).

Similarly, food packaging and the use of plastics are emerging issues for the industry. These are linked to other risks covered by the Index. However, since these risks are not specific to the animal protein sector, the Index does not currently assess them within the risk factor framework.

Our aim is to work with stakeholders to ensure that the framework continues to evolve with time. This will ensure it remains both comprehensive and meaningful for investors and sector companies.

APPENDIX 3: LIMITATIONS IN ESTIMATING THE SIZE OF THE GLOBAL AND REGIONAL PROTEIN MARKET

Using the OECD-FAO Agricultural Outlook 2018-2027[226] and Aquaculture Production[227] statistics datasets; FAIRR looked at actual country, regional and total world meat (beef, veal, lamb, pork, poultry), dairy (milk and dairy products), fish from aquaculture and the associated market value prices to estimate the global size of the animal protein and dairy market.

Our estimates are based on the latest actual figures, which are for the 2017 period for meat and dairy and 2016 for aquaculture. We multiplied production data (volume in tonnes) for each animal protein category by the respective average world market price. The world price data for poultry and lamb and certain dairy products (cheese, butter, skim and whole milk powder, whey powder, casein) are based on the average world prices for 2017 as provided by the OECD- FAO dataset. 2016 world prices were used for beef, veal and pork (due to availability of data). The world price for milk was calculated independently using the year average spot price for raw milk in 2017.

This is the first step towards estimating the global size of the animal protein market using publicly available production data. There are however several limitations to this approach. These figures should be considered estimates due to data inconsistency and availability issues.

The production data for aquaculture covers a subset of countries only (OECD and certain non-OECD countries). Though this doesn't capture the total world market, the most prominent producers are represented in the dataset (including China and Indonesia).

The production data for meat does not capture processed animal-derived products, and it is based on carcass weight equivalent, which does not include heads, feet, entrails and gut fill (e.g. kidneys, livers, hearts etc). For the dairy industry, the data available is more comprehensive because it includes raw milk production, fresh dairy products, and processed dairy products (i.e. cheese, butter, skim milk powder, whey powder, casein). Moreover, this approach does not include the egg industry or trade data and is therefore an underestimate of the real size and value of the market.

Nonetheless, it does provide a useful insight and demonstrates that the meat industry alone (excluding aquaculture and dairy) is a billion-dollar market. Combined, these industries represent a powerful trillion-dollar business that is dependent upon the intensive farming of animals.

Based on this methodology, our estimates indicate that the global production of meat has a market value of approximately $780.19 billion and dairy of $531.05 billion. Asia, Europe and Latin America and the Caribbean are the largest regional producers of beef, veal, lamb and poultry. Asia is also the largest producer of pork, followed by Europe.

APPENDIX 4: LIST OF TABLES AND FIGURES

APPENDIX 5: SPECIES PRODUCED BY TEN PURE AQUACULTURE COMPANIES

Most of these companies primarily produce salmon and a smaller proportion produce other species such as trout, tilapia, yellowtail and shrimp. The table below lists the companies by location and species produced.

Company name	Headquarters	Species farmed	Market capitalisation (USD Mn)	Revenues in 2018 (USD Mn)
Bakkafrost	Faroe Islands	Salmon	2,588	487
AquaChile	Chile	Salmon, trout, tilapia	800	633
Grieg Seafood	Norway	Salmon	1,583	922
Lerøy Seafood	Norway	Salmon and trout (farmed)	4,082	2,439
Mowi ASA	Norway	Salmon, Whitefish, other seafood (value-added)	11,963	4,408
Nippon Suisan Kaisha	Japan	Salmon, yellowtail, bluefin tuna (farmed)	1,900	6,165
SalMar ASA	Norway	Salmon, trout	5,175	1,395
Salmones Camanchaca	Chile	Salmon, mussels, abalone	543	332
Tassal Group	Australia	Salmon, prawn	596	387
Thai Union Group	Thailand	Shrimp, salmon	2735	4,216

APPENDIX 6: MARFRIG'S TRANSITION BOND

OUR COMMENTARY IS AVAILABLE FOR FAIRR INVESTOR MEMBERS.
SEE INDEX.FAIRR.ORG FOR RESOURCES.

REFERENCES

1 12th December 2018. https://www.newscientist.com/article/2187838-when-humans-are-wiped-from-earth-the-chicken-bones-will-remain/

2 The New York Times 'It could be the age of chicken, geologically', 11th December 2018. Available online at: https://www.nytimes.com/2018/12/11/science/chicken-anthropocene-archaeology.html

3 New Scientist 'When humans are wiped from earth the chicken bones will remain', 12th December 2018. https://www.newscientist.com/article/2187838-when-humans-are-wiped-from-earth-the-chicken-bones-will-remain/

4 Food and Agriculture Organisation of the United Nations. Available online at: http://www.fao.org/faostat

5 Oxford Academic; Animal Frontiers 'Livestock and Climate Change: Impact of Livestock on Climate and Mitigation Strategies', 12th November 2018. Available online at: https://academic.oup.com/af/article/9/1/69/5173494

6 Food and Agriculture Organisation for the United Nations 'Livestock Solutions for Climate Change report', 2017. Available online at: http://www.fao.org/3/a-i8098e.pdf

7 Medicos Adventistas 'Biodiversity Conservation: The Key is Reducing Meat Consumption', 5th July 2015. Available online at: http://www.medicosadventistas.org/wp-content/uploads/2018/09/Biodiversity-conservation-The-key-is-reducing-meat-consumption..pdf

8 Food and Agriculture Organisation of the United Nations 'Genetic diversity of livestock can help feed a hotter, harsher world', 27th January 2016. Available online at: http://www.fao.org/news/story/en/item/380661/icode/

9 ETH Zürich 'Global trends in antimicrobial use in food animals', 2018. Available online at: https://www.swissre.com/dam/jcr:b8c6410f-755b-4d13-836d-f611c3510a3d/amr_thomas_boeckel.pdf

10 World Health Organisation 'Stop using antibiotics in healthy animals to prevent the spread of antibiotic resistance', 7th November 2017. Available online at: https://www.who.int/news-room/detail/07-11-2017-stop-using-antibiotics-in-healthy-animals-to-prevent-the-spread-of-antibiotic-resistance

11 World Resources Institute 'World Resources Report: Creating a sustainable food future', July 2019. Available online at: https://wrr-food.wri.org/sites/default/files/2019-07/WRR_Food_Full_Report_0.pdf

12 Science Direct 'Livestock: On our plates or eating at our table? A new analysis of the feed/food debate', September 2017. Available online at: https://www.sciencedirect.com/science/article/abs/pii/S2211912416300013

13 The British Medical Journal 'Mortality from different causes associated with meat, heme iron, nitrates, and nitrites in the NIH-AARP Diet and Health Study: population-based cohort study', 9th May 2017. Available online at: https://www.bmj.com/content/357/bmj.j1957?utm_source=TrendMD&utm_medium=cpc&utm_campaign=TBMJ_UK_TrendMD-0

14 OECD-FAO 'Agricultural Outlook Database'. Available online at: https://stats.oecd.org/Index.aspx?datasetcode=HIGH_AGLINK_2019

15 Australian Government National Health and Medical Research Council Department of Health and Ageing 'Australian Dietary Guidelines Summary', February 2018. Available online at: https://www.eatforhealth.gov.au/sites/default/files/files/the_guidelines/n55a_australian_dietary_guidelines_summary_book.pdf

16 ScienceMag 'Meat consumption, health, and the environment', 20th July 2018. Available online at: https://science.sciencemag.org/content/361/6399/eaam5324

17 United States Environmental Agency 'Estimated animal agriculture nitrogen and phosphorus from manure'. Available online at: https://www.epa.gov/nutrient-policy-data/estimated-animal-agriculture-nitrogen-and-phosphorus-manure

18 The Wall Street Journal 'The world's appetite is threatening the Mississippi river', 2nd July 2019. Available online at: https://www.wsj.com/graphics/mississippi/

19 Barclays Global Food I Can't Believe It's Not Meat https://live.barcap.com/UAB/linkback/registerDevice?action=linkback&target=%2FUAB%2Fanon%2Flinkback%3FcontentPubID%3DFC2458995

20 AT Kearney 'How will cultured meat and meat alternatives disrupt the agricultural and food industry?'. Available online at: https://www.atkearney.com/retail/article/?/a/how-will-cultured-meat-and-meat-alternatives-disrupt-the-agricultural-and-food-industry

21 FIAL 'Protein market: size of the prize analysis for Australia', March 2019. Available online at: https://fial.com.au/Attachment?Action=Download&Attachment_id=200

22 Food and Agriculture Organisation of the United Nations FAOSTAT, retrieved July 16, 2019

23 Pozo & Schroeder (2015) Evaluating the costs of meat and poultry recalls to food firms using stock returns. Available online at: https://www.sciencedirect.com/science/article/abs/pii/S030691921500144X

24 Reuters 'US arm of JBS recalls 6.5 million pounds of beef on salmonella risk', 4th October 2018. Available online at: https://www.reuters.com/article/us-jbs-salmonella/u-s-arm-of-jbs-recalls-6-5-million-pounds-of-beef-on-salmonella-risk-idUSKCN1ME2DS

25 Insurance Journal 'Pork giant loses another nuisance lawsuit by North Carolina neighbours' 11th March 2019. Available online at: https://www.insurancejournal.com/news/southeast/2019/03/11/520115.htm

26 Talk Business. Tyson Foods fined $2 million by EPA over water pollution in Missouri. 27 September 2017. https://talkbusiness.net/2017/09/tyson-foods-fined-2-million-by-epa-over-water-pollution-in-missouri/

27 The Cullman Tribune 'Breaking: Residents, organisations file suit against Tyson over spill, plant conditions', 19th July 2019. Available online at: https://www.cullmantribune.com/2019/07/19/breaking-residents-organizations-file-suit-against-tyson-over-spill-plant-conditions/

28 Bloomberg 'USDA proposal to speed up hog slaughter line is challenged', 6th December 2018. Available online at: https://www.bloomberg.com/news/articles/2018-12-06/usda-plan-to-speed-up-slaughter-line-is-challenged-as-flawed

29 The Guardian 'European parliament approves curbs on use of antibiotics on farm animals', 25th October 2018. Available online at: https://www.theguardian.com/society/2018/oct/25/european-parliament-approves-curbs-on-use-of-antibiotics-on-farm-animals

30 The Bureau of Investigative Journalism 'India bans use of "last hope" antibiotic on farms', 22nd July 2019. Available online at: https://www.thebureauinvestigates.com/stories/2019-07-22/india-bans-use-of-last-hope-antibiotic-colistin-on-farms

31 All About Feed 'China's antibiotic plan and its effect on the feed industry', 23rd November 2018. Available online at: https://www.allaboutfeed.net/Feed-Additives/Articles/2018/11/Chinas-antibiotic-plan-and-its-effect-on-the-feed-industry-363323E/

32 Welfare Commitments Data. Available online at: https://welfarecommitments.com/cage-free/

33 AP News 'Cargill to spend $30< for ideas to end Brazil deforestation', 13th June 2019. Available online at: https://www.apnews.com/0b71f46bfa314a3083ddb1ca16f053dc4

34 State of Sustainability Initiatives 'State of Sustainability Initiatives Review: standards and the blue economy', 2016. Available online at: https://unctad.org/meetings/en/Contribution/ditc-ted-oceans-ssi-blue-economy-2016.pdf

35 Mowi 'Salmon farming industry handbook 2018', 2018. Available online at: https://mowi.com/wp-content/uploads/2019/04/2018-salmon-industry-handbook-1.pdf

36 World Bank 'Fish to 2030: prospects for fisheries and aquaculture'2013. Available online at: http://documents.worldbank.org/curated/en/458631468152376668/Fish-to-2030-prospects-for-fisheries-and-aquaculture

37 Summarised from an IntraFish recording of a presentation from Andy Shinn, director of Fish Vet Group Asia during the World Nutrition Forum 2018.

38 UNIT 'Science archive in Bragekonsortiet', 8th January 2019. Available online at: https://brage.bibsys.no/xmlui/bitstream/handle/11250/2494032/691981.pdf?sequence=1&isAllowed=y

39 IntraFish 'Major salmon escape costs marine Harvest Chile $3.4 million', 2nd November 2018. Available online at: https://www.intrafish.com/aquaculture/1621110/major-salmon-escape-costs-marine-harvest-chile-usd-34-million

40 CNBC 'Alternative meat to become $140 billion industry in a decade, Barclay predicts', "3rd May 2019. Available online at: https://www.cnbc.com/2019/05/23/alternative-meat-to-become-140-billion-industry-barclays-says.html

41 Sustainability Accounting Standards Board 'Meat, poultry and dairy sustainability accounting standard', October 2018. Available online at: https://www.sasb.org/wp-content/uploads/2015/07/CN0102_MeatPoultryDairy_Standard.pdf

42 United States Government Accountability Office 'Concentrated Animal Feeding Operations EPA Needs More Information and a Clearly Defined Strategy to Protect Air and Water Quality from Pollutants of Concern', September 2008. Available online at: https://www.gao.gov/new.items/d08944.pdf

43 2019. Available online at: https://www.nature.com/articles/d41586-019-00896-2?utm_source=commission_junction&utm_medium=affiliate

44 - mate skeptic president Bolsonaro', 7 August 2019. Available online at: https://www.telegraph.co.uk/news/2019/08/07/amazon-deforestation-increases-278-year-institute-warns-climate/

45 Food and Agriculture Organisation of the United Nations FAOSTAT data, retrieved July 16, 2019

46 OECD-FAO 'Agricultural Outlook Database'. Available online at: http://www.agri-outlook.org/data/

47 NCBI 'Current situation and future trends for beef production in the United States of America – a review', 21st June 2018. Available online at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6039332/

48 Zero Deforestation Cattle 'Complexities of the cattle supply chain', 2015. Available online at: http://www.zerodeforestationcattle.org/#/reading/ch5t1
49 Food and Agriculture Organisation of the United Nations 'Reducing enteric methh ane for improving food security and livelihoods. Available online at: http://www.fao.org/in-action/enteric-methane/background/what-is-enteric-methane/en/
50 Oxford Academic: Animal Frontiers 'Livestock and climate change: impact of livee stock on climate and mitigation strategies', 12th November 2018. Available online at: https://academic.oup.com/af/article/9/1/69/5173494
51 IOP Science 'Trading forests: land-use change and carbon emissions embodied in production and exports of forest-risk commodities', 22nd December 2015. Available online at: https://iopscience.iop.org/article/10.1088/1748-9326/10/12/125012/meta
52 USDA Economic Research Service 'Brazil projected to outpace other top beef-exporting countries over the next decade', 15th July 2019. Available online at: https://www.ers.usda.gov/data-products/chart-gallery/gallery/chart-detail/?chartId=93444
53 Water Footprint Network 'Water footprint of a crop and animal products: a comparison'. Available online at: https://waterfootprint.org/en/water-footprint/product-water-footprint/water-footprint-crop-and-animal-products/
54 NPR 'Some in the beef industry are bucking the widespread use of antibiotics. Here's how', 2nd April 2019. Available online at: https://www.npr.org/sections/thesalt/2019/04/02/707406946/some-in-the-beef-industry-are-bucking-the-widespread-use-of-antibiotics-heres-ho
55 Business and Human Rights Resources Centre 'Cattle Route: Modern Slavery and the British Market' 15th March 2019. Available online at: https://www.business-humanrights.org/sites/default/files/documents/Cattle_2018_1.pdf
56 Marfrig 'Management Report 2018', December 31st 2018. Available online at: http://ir.marfrig.com.br/EN/Documentos/5638_Financial%20Statements_2018_Site.pdf;
57 Food and Agriculture Organisation of the United Nations 'Tackling climate change through livestock', 2013. Available online at: http://www.fao.org/3/a-i3437e.pdf
58 Cargill 'Cargill announces commitment to reduce greenhouse gas emissions across its North American beef supply chain', 24th July 2019. Available online at: https://www.cargill.com/2019/cargill-announces-commitment-to-reduce-greenhouse-gas-emissions
59 Reuters 'Major grain traders face one-two punch from US floods, trade war' 10th July 2019. Available online at: https://www.reuters.com/article/us-usa-weather-earnings/major-grain-traders-face-one-two-punch-from-u-s-floods-trade-war-idUSKCN1U5259
60 The Guardian '" Global deforestation hotspot": 3m hectares of Australian forest to be lost in 15 years', 4th March 2018. Available online at: https://www.theguardian.com/environment/2018/mar/05/global-deforestation-hotspot-3m-hectares-of-australian-forest-to-be-lost-in-15-years
61 The Guardian 'Revealed: rampant deforestation of Amazon driven by global greed for meat', 2nd July 2019. Available online at: https://www.theguardian.com/environment/2019/jul/02/revealed-amazon-deforestation-driven-global-greed-meat-brazil
62 The Guardian 'Amazon deforestation accelerating towards unrecoverable "tipp ping point"', 25th July 2019. Available online at: https://www.theguardian.com/world/2019/jul/25/amazonian-rainforest-near-unrecoverable-tipping-point
63 Australian Agricultural Company 'AACo FY19 Financial Report', 22nd May 2019. Available online at: https://aaco.com.au/investors-media/annual-reports
64 Environmental Integrity Project 'Water pollution from slaughterhouses', 11th Octoo ber 2018. Available online at: http://www.environmentalintegrity.org/wp-content/uploads/2018/10/Slaughterhouse-report-2.14.2019.pdf
65 ibid
66 WATTAgNet 'Tyson faces lawsuit after a wastewater spill kills fish', 19th June 2019. Available online at: https://www.wattagnet.com/articles/38038-tyson-faces-lawsuit-after-wastewater-spill-kills-fish
67 Environmental Integrity Project 'Water pollution from slaughterhouses', 11th Octoo ber 2018. Available online at: http://www.environmentalintegrity.org/wp-content/uploads/2018/10/Slaughterhouse-report-2.14.2019.pdf
68 United States Government Accountability Office 'Concentrated animal feeding operations', September 2008. Available online at: https://www.gao.gov/new.items/d08944.pdf
69 CPR News 'Are Colorado's cattle feedlots a risk to waterways?', 30th November 2017. Available online at: https://www.cpr.org/2017/11/30/are-colorados-cattle-feedlots-a-risk-to-waterways/
70 KCUR 'Why the cattle industry might not use a drug that cuts the pollution of maa nure and pee', 8th July 2019. Available online at:https://www.kcur.org/post/why-cattle-industry-might-not-use-drug-cuts-pollution-manure-and-pee-0#stream/0
71 ACS Publications 'Feedlots and pollution – a growing threat to water resources of agro-production zone in Argentina', 15th October 2013. Available online at: https://pubs.acs.org/doi/pdf/10.1021/es4040683
72 Semantics Scholar 'Brazilian beef cattle feedlot manure management: a country survey', 2nd December 2014. Available online at: https://pdfs.semanticscholar.org/ac3a/08ec901da728340647ec6b3aee81c488d5fb.pdf
73 USDA Food Safety and Inspection Service Data. Available online at: https://www.fsis.usda.gov/wps/portal/fsis/topics/recalls-and-public-health-alerts/current-recalls-and-alerts
74 GFSi Recognised Certification Programmes. Available online at: https://www.mygfsi.com/certification/recognised-certification-programmes.html
75 NBC News. 14th August 2019. Tyson wants fewer government inspectors in one of its beef plants. Food safety advocates are raising alarms. https://www.nbcnews.com/politics/white-house/tyson-wants-fewer-government-inspectors-one-its-beef-plants-food-n1041966
76 Marfrig 'Marfrig Sustainable Transition Bond', July 2019. Available online at: http://www.marfrig.com.br/Arquivos/Marfrig_Sustainable_Transition_Bond_Framework.pdf
77 Food and Agriculture Organisation of the United Nations FAOSTAT data, retrieved July 16, 2019
78 OECD-FAO 'Agricultural Outlook Data'. Available online at: https://stats.oecd.org/Index.aspx?datasetcode=HIGH_AGLINK_2019
79 Civil Eats 'The race to produce a slower-growing chicken', 28th May 2019. Available online at: https://civileats.com/2019/05/28/the-race-to-produce-a-slower-growing-chicken/
80 National Chicken Council 'Vertical Integration: What it is – and why it's good for the chicken industry...and you.'. Available online at: https://www.nationalchickencouncil.org/industry-issues/vertical-integration/
81 European Commission 'Executive Summary'. Available online at: https://ec.europa.eu/food/sites/food/files/animals/docs/aw_practice_farm_broilers_653020_executive-summary_en.pdf
82 Business and Human Rights Resource Centre '" Lives on the line": Oxfam report documents poor working conditions in the US poultry industry'. Available online at: https://www.business-humanrights.org/en/lives-on-the-line-oxfam-report-documents-poor-working-conditions-in-the-us-poultry-industry
83 Fern's AG Insider 'Justice Dept. intervenes in major poultry-fixing case', 24th June 2019. Available online at: https://thefern.org/ag_insider/justice-dept-intervenes-in-major-poultry-price-fixing-case/
84 Carys E. Bennett et al., "The broiler chicken as a signal of a human reconfigg ured biosphere". Available at: https://royalsocietypublishing.org/doi/10.1098/rsos.180325
85 Food and Agriculture Organisation of the United Nations FAOSTAT data, retrieved July 16, 2019
86 United Egg Producers 'US Egg production and hen population'. Available online at: https://unitedegg.com/facts-stats/
87 Huffpost 'Here's what farms do to hens who are too old to lay eggs', 14th May 2018. Available online at: https://www.huffpost.com/entry/egg-laying-hens_n_59c3c93fe4b0c90504fc04a1?guccounter=1&guce_referrer=aHR0cHM6Ly93d3cuZ29vZ2xlLmNvbS8&guce_referrer_sig=AQAAALMZoi-6No3iL9upMXJdrfmltYsk3bfGT72ne5T3ZeJrIs06RfvfNlUND-buXUUSFtxm7a7k-JhURkxkBQYDw6yoBAYOqOC_5UIz1drWfo5r98eXGmVd1sC5orA_4Cb-tmKz90vL-WX8tD25hbMPPTQNgnJT7_NjGtg7deLJpwwQ4wp
88 Food and Agriculture Organisation of the United Nations 'Executive Summary'. http://www.fao.org/3/i3460e/i3460e01.pdf
89 Fern 'Agriculture and Deforestation: The Eu Common Agricultural Policy, soy, and forest destruction', May 2017. Available online at: https://www.fern.org/fileadmin/uploads/fern/Documents/Fern%20CAP%20SUMMARY%20FINAL_0.pdf
90 Mongabay 'Brazilian hunger for meat fattened on soy is destroying the Cerr rado: report', 16th January 2019. Available online at: https://news.mongabay.com/2019/01/brazilian-hunger-for-meat-fattened-on-soy-is-deforesting-the-cerrado-report/
91 NPR 'In Oklahoma, critics say Pruitt stalled pollution case after takk ing industry funds', 2nd May 2018. Available online at: https://www.npr.org/2018/05/02/607180065/in-oklahoma-pruitt-ended-environmental-unit-declined-to-push-pollution-case
92 Tulsa World 'Chicken litter poles highlight enforcement issues for Save the Illinois River founder', 28th May 2019. Available online at: https://www.tulsaworld.com/news/local/chicken-litter-piles-highlight-enforcement-issues-for-save-the-illinois/article_d8a22703-d380-5feb-9ac5-88f27310c0d4.html
93 The Guardian 'Living next door to 17 million chickens: "We want a normal life"', 23rd June 2018. Available online at: https://www.theguardian.com/environment/2018/jun/23/living-next-door-to-17-million-chickens-we-want-a-normal-life
94 Oxford Academic: Poultry Science 'The application of antibiotics in broiler production and the resulting antibiotic resistance in Escherichia coli: a global review', 13th December 2018. Available online at: https://academic.oup.com/ps/article/98/4/1791/5244341
95 Oxfam America 'Lives on the line', 2015. Available online at: https://www.oxfamamerica.org/livesontheline/
96 National Safety Council 'USDA announces criteria for allowing poultry processors to operate at faster line speeds', 9th October 2018. Available online at: https://www.safetyandhealthmagazine.com/articles/17565-usda-announces-criteria-for-allowing-poultry-processors-to-operate-at-faster-line-speeds
97 The Atlantic 'The rise of the zombie small businesses', 4th September 2018. Availll able online at: https://www.theatlantic.com/ideas/archive/2018/09/whose-farm-is-this-anyway/569227/
98 Reuters 'Brazil's "chicken catchers" are victims of forced labour: report', 30th Noo vember 2017. Available online at: https://www.reuters.com/article/us-brazil-slavery/brazils-chicken-catchers-are-victims-of-forced-labor-report-idUSKBN1DU2ZR
99 JBS 'Annual and Sustainability Report 2016', 2016. Available online at: https://jbss.infoinvest.com.br/enu/4070/JBS%20RAS%202016%20EN%20170502%20

Final.pdf; United States Securities and Exchange Commission, 'Form 10-K Tyson Foods Inc'. Available online at: https://s22.q4cdn.com/104708849/files/doc_financials/quartely/2018/q4/TSN-FY18-10-K.pdf ; United States Securities and Commission 'Form 20-F BRF S.A.'. Available online at: https://s3.amazonaws.com/mz-filemanager/4d44a134-36cc-4fea-b520-393c4aceabb2/141a2dae-83be-4935-8a9f-805e3f6aa3c0_BRF%2020-F%202018_vFINAL_.pdf ; Sanderson Farms 'Annual Report to shareholders', 2018. Available online at: http://ir.sandersonfarms.com/static-files/da78119f-fe24-4753-991b-b23665f4c916 ; Cherkizovo 'Annual Report', 2018. Available online at: http://cherkizovo.com/upload/files/cherkizovo-ar-en-18.pdf; RCL Foods Annual Report, 2018. Available online at: https://www.rclfoods.com/sites/default/files/2018_abridged_integrated_annual_report.pdf

100 Food and Agriculture Organisation of the United Nations FAOSTAT, retrieved 28 July, 2019

101 Proforest 'Addressing soy and beef driven deforestation in Brazil, Argentina and Paraguay', 31st January 2018. Available online at: https://www.proforest.net/en/news/addressing-soy-and-beef-driven-deforestation-in-brazil-argentina-and-paraguay

102 Pensions and Investments 'Commentary: Water risks and the food sector's bottom line', 2nd July 2019. Available online at: https://www.pionline.com/industry-voices/commentary-water-risks-and-food-sectors-bottom-line

103 Indy Week 'A new report says the state has ignored the risks of poultry farms' proliferation', 13th February 2019. Available online at: https://indyweek.com/news/northcarolina/report-poultry-farms-waterkeeper-alliance-environmental-working-group/

104 Accountability Counsel 'MHP complaint found eligible by the World Bank's Accountability Office, the CAO', 15th June 2018. Available online at: https://www.accountabilitycounsel.org/2018/06/mhp-complaint-found-eligible-by-the-world-banks-accountability-office-the-cao/

105 Bank Watch Letter regarding EBRD investment in MHP, 5th June 2018. Available online at: https://bankwatch.org/wp-content/uploads/2018/06/6.5.2018-Complaint-to-the-PCM-from-3-Ukrainian-communities-regarding-EBRD-investment-in-MHP-final.pdf

106 PNAS 'Global trends in antimicrobial use in food animals', 5th May 2015. Available online at: https://www.pnas.org/content/112/18/5649

107 Poultry World 'Poultry and eggs remain the major source of food poisoning in the US', 17 May 2019. Available online at: https://www.poultryworld.net/Health/Articles/2019/5/Poultry-and-eggs-remain-the-major-source-of-food-poisoning-in-the-US-429017E/

108 US Food and Drug Administration 'Recalls, Market Withdrawals, & Safety Alerts' Available online at: https://www.fda.gov/safety/recalls-market-withdrawals-safety-alerts/cal-maine-foods-inc-announces-voluntary-shell-egg-recall-due-possible-health-risk

109 Cal-Maine Foods 'About Cal-Maine Foods'. Available online at: https://www.calmainefoods.com/company/

110 EUR-Lex 'Council Directive 1999/74/EC of J19 July 1999 laying down minimum standards for the protection of laying hens'. Available online at: https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1435151498494&uri=CELEX:31999L0074

111 The New Food Economy 'Washington passed a cage-free egg bill in the name of animal welfare. Why are the egg industry's fingerprints all over it?', 9th May 2019. Available online at: https://newfoodeconomy.org/washington-cage-free-egg-bill-animal-welfare-egg-industrys-fingerprints/

112 Mass Live 'US Supreme Court: States cannot sue Massachusetts in high court over cage-free egg law', 8th January 2019. Available online at: https://www.masslive.com/news/2019/01/us-supreme-court-states-cannot-sue-massachusetts-in-high-court-over-cage-free-egg-law.html

113 PEW 'Cage-free-egg laws spur cage match between states', 23rd April 2018. Available online at: https://www.pewtrusts.org/en/research-and-analysis/blogs/stateline/2018/04/23/cagefree-egg-laws-spur-cage-match-between-states

114 Open Philanthropy Project 'Why are the US Corporate cage-free campaigns succeeding?', 11th April 2017. Available online at: https://www.openphilanthropy.org/blog/why-are-us-corporate-cage-free-campaigns-succeeding

115 CNBC 'Egg makers are freaked out by the cage-free future', 22nd March 2017. Available online at: https://www.cnbc.com/2017/03/22/egg-makers-are-freaked-out-by-the-cage-free-future.html

116 Science Based Targets 'What is a science based target?'. Available online at: https://sciencebasedtargets.org/what-is-a-science-based-target/

117 Food and Agriculture Organisation of the United Nations 'Tackling climate change through livestock', 2013. http://www.fao.org/3/a-i3437e.pdf

118 Food and Agriculture Organisation of the United Nations FAOSTAT data, retrieved July 24, 2019FAOSTAT data, retrieved July 24, 2019

119 OEDC-FAO 'Agricultural Outlook Data'. Available online at: https://stats.oecd.org/Index.aspx?datasetcode=HIGH_AGLINK_2019

120 The Guardian '"We've bred them to their limit": death rates surge for female pigs in the US', 1st October 2018. Available online at: https://www.theguardian.com/environment/2018/oct/01/death-rates-surge-female-pigs-us

121 Food and Power 'Pork'. Available online at: http://www.foodandpower.net/pork/?_ga=2.71915989.797020861.1564853213-845977809.1564853213

122 2016 SmithField Foods Annual Report, Page 4, available at https://smithfieldfoods.gcs-web.com/static-files/810265da-6e0f-449c-a6a7-44405390ba69

123 2018 Seaboard Annual Report, Page 6, available at https://www.seaboardcorp.com/investors/

124 USDA Foreign Agricultural Service 'Livestock and products semi-annual consolidation and modernisation continue to shape China's livestock outlook', 30th March 2018. Available online at: https://gain.fas.usda.gov/Recent%20GAIN%20Publications/Livestock%20and%20Products%20Semi-annual_Beijing_China%20-%20Peoples%20Republic%20of_4-1-2018.pdf

125 Feed Navigator 'Rabobank: ASF to catalyse widespread pig production consolidation in China', 29th October 2018. Available online at: https://www.feednavigator.com/Article/2018/10/29/Rabobank-ASF-to-catalyze-widespread-pig-production-consolidation-in-China

126 National Hog Farmer 'Making 30 pigs per sow per year dream come true', 15th January 2009. Available online at: https://www.nationalhogfarmer.com/genetics-reproduction/0109-producers-nearing-thershold

127 The Guardian '"We've bred them to their limit": death rates surge for female pigs in the US', 1st October 2018. Available online at: https://www.theguardian.com/environment/2018/oct/01/death-rates-surge-female-pigs-us

128 Food and Agriculture Organisation of the United Nations 'Executive Summary'. Available online at: http://www.fao.org/3/i3460e/i3460e01.pdf

129 AG Web 'The US hog industry – then and now', 22nd December 2016. Available online at: https://www.agweb.com/blog/straight-from-dc-agricultural-perspectives/the-us-hog-industry-then-and-now

130 Reuters 'Factbox: China's low-soy pig diet and the impact on soybean use', 19th September 2018. Available online at: https://www.reuters.com/article/us-usa-trade-china-soybeans-factbox/factbox-chinas-low-soy-pig-diet-and-the-impact-on-soybean-use-idUSKCN1LZ0KN

131 Mongabay 'Brazilian hunger for meat fattened on soy is deforesting the Cerrado: report', 16th January 2019. Available online at: https://news.mongabay.com/2019/01/brazilian-hunger-for-meat-fattened-on-soy-is-deforesting-the-cerrado-report/

132 OECD 'Meat consumption data'. Available online at: https://data.oecd.org/agroutput/meat-consumption.htm

133 Nature 'Why the US-China trade war spells disaster for the Amazon', 27th March 2019. Available online at: https://www.nature.com/articles/d41586-019-00896-2?utm_source=commission_junction&utm_medium=affiliate

134 The New Yorker 'After Florence, manure lagoons breach, and residents brace for the rising filth', 21st September 2018. Available online at: https://www.newyorker.com/news/dispatch/after-florence-manure-lagoons-breach-and-residents-brace-for-the-rising-filth

135 Clean Air Carolina 'The effects of hog farms waste on human health'. Available online at: https://cleanaircarolina.org/wp-content/uploads/2016/04/BREATHE-2016-Breakout-CAFO-PPT-Kravchenko-4-8-16.pdf

136 The New Yorker. "After Florence, manure lagoons breach, and residents brace for the rising filth." 21 September 2018. Available at: https://www.newyorker.com/news/dispatch/after-florence-manure-lagoons-breach-and-residents-brace-for-the-rising-filth

137 NPR 'Overflowing hog lagoons raise environmental concerns in North Carolina', 22nd September 2018. Available online at: https://www.npr.org/2018/09/22/650698240/hurricane-s-aftermath-floods-hog-lagoons-in-north-carolina

138 PNAS 'Global trends in antimicrobial use in food animals', 5th May 2015. Available online at: https://www.pnas.org/content/pnas/112/18/5649.full.pdf

139 CIDRAP 'Report: US pigs consume nearly as many antibiotics as people do', 6th June 2018. Available online at: http://www.cidrap.umn.edu/news-perspective/2018/06/report-us-pigs-consume-nearly-many-antibiotics-people-do

140 Frontiers in Veterinary Science 'Antibiotic application and resistance in swine production in China: current situation and future perspectives', 17th May 2019. Available online at: https://www.frontiersin.org/articles/10.3389/fvets.2019.00136/full

141 Rabobank RaboResearch 'China's antibiotics reduction campaign will impact the entire livestock supply chain', November 2018. Available online at: https://research.rabobank.com/far/en/sectors/farm-inputs/china-s-antibiotics-reduction-campaign-will-impact-the-entire-livestock-supply-chain.html?qsl_reqcnt=1

142 IowaNow 'Study finds swine farming is risk factor for drug-resistant staph infections', 27th April 2015. Available online at: https://now.uiowa.edu/2015/04/study-finds-swine-farming-risk-factor-drug-resistant-staph-infections

143 North Carolina Health News 'MRSA infection found in communities near pig farms', 25th September 2013. Available online at: https://www.northcarolinahealthnews.org/2013/09/25/mrsa-infection-found-in-nc-communities-near-pig-farms/

144 EWG 'Report: superbugs found in more than three-fourths of US supermarket meat', 28th June 2018. Available online at: https://www.ewg.org/release/report-superbugs-found-more-three-fourths-us-supermarket-meat

145 World Animal Protection 'What's in your pork?'. Available online at: https://www.worldanimalprotection.org.uk/whats-in-your-pork

146 The New York Times 'Tainted pork, ill consumers and an investigation thwarted', 4th August 2019. Available online at: https://www.nytimes.com/2019/08/04/health/pork-antibiotic-resistance-salmonella.html

147 Washington Post 'Pork industry soon will have more power over meat inspections', 3rd April 2019. Available online at: https://www.washingtonpost.com/business/economy/pork-industry-soon-will-have-more-power-over-meat-inspections/2019/04/03/12921fea-4f30-11e9-8d28-f5149e5a2fda_story.html

148 Bloomberg 'Killing 22 hogs a minute, meatpackers test old limits of safety'. 1st

February 2019. Available online at: https://www.bloomberg.com/news/articles/2019-02-01/killing-22-hogs-a-minute-meatpackers-test-old-limits-of-safety
149 Global Meat News 'Asian ASF pig cull reaches five million', 9th August 2019. Available online at: https://www.globalmeatnews.com/Article/2019/08/09/Asian-ASF-pig-cull-reaches-five-million
150 https://www.washingtonpost.com/world/asia_pacific/as-swine-fever-spreads-asian-countries-cull-millions-of-pigs/2019/06/28/d507d6bc-984d-11e9-9a16-dc551ea5a43b_story.html
151 European Commission 'African Swine Fever'. Available online at: https://ec.europa.eu/food/animals/animal-diseases/control-measures/asf_en#description
152 Global Meat News 'Smithfield Foods completes "manure-to-energy" project', 6th August 2019. Available online at: https://www.globalmeatnews.com/Article/2019/08/06/Smithfield-Foods-completes-manure-to-energy-project
153 The New York Times 'US climate report warns of damaged environment and shrinking economy', 23rd November 2018. Available online at: https://www.nytimes.com/2018/11/23/climate/us-climate-report.html
154 Intergovernmental Panel on Climate Change 'Impacts of 1.5°C of Global Warming on natural and human systems'. Available online at: https://www.ipcc.ch/site/assets/uploads/sites/2/2019/05/SR15_Chapter3_Low_Res.pdf; Page 237
155 Wiley Online Library 'Climate change impacts on selected global rangeland ecosystem services', 21st November 2017. Available online at: https://onlinelibrary.wiley.com/doi/full/10.1111/gcb.13995
156 Food and Agriculture Organisation of the United Nations 'Impacts of climate change on fisheries and aquaculture', 2018. Available online at: http://www.fao.org/3/i9705en/i9705en.pdf
157 CNBC 'The farm belt faces an expensive clean up after already-costly record flooding', 29th March 2019. Available online at: https://www.cnbc.com/2019/03/29/farm-belt-faces-an-expensive-cleanup-after-already-costly-record-flooding.html
158 American Farm Bureau Federation 'Crop planting delays reach historic levels resulting in high levels of uncertainty for 2019', 31st May 2019. Available online at: https://www.fb.org/market-intel/crop-planting-delays-reach-historic-levels-resulting-in-high-levels-of-unce
159 Politico 'Perdue rules out trade aid for unplanted acres', 11th June 2019. Available online at: https://www.politico.com/newsletters/morning-agriculture/2019/06/11/perdue-rules-out-trade-aid-for-unplanted-acres-650341
160 Bloomberg 'Corn surge fuels biggest meat selloff of '19 amid feed-cost fear', 29th May 2019. Available online at: https://www.bloomberg.com/news/articles/2019-05-29/corn-surge-fuels-biggest-meat-selloff-of-19-amid-feed-cost-fear
161 The Guardian 'Up to 500,000 drought-stressed cattle killed in Queensland floods', 11th February 2019. Available online at: https://www.theguardian.com/australia-news/2019/feb/11/up-to-500000-drought-stressed-cattle-killed-in-queensland-floods
162 The Straits Times 'Australian central bank points to climate change risk, says drought seen hurting GDP', 12th March 2019. Available online at: https://www.straitstimes.com/asia/australianz/australian-central-bank-points-to-climate-change-risks-says-drought-seen-hurting
163 Journal of Dairy Science 'Invited review; Enteric methane in dairy cattle production: quantifying the opportunities and impact of reducing emissions', 2014. Available online at: https://www.journalofdairyscience.org/article/S0022-0302(14)00289-6/pdf
164 NPR 'Soaring popularity of grass-fed beef may hit roadblock: less nutritious grass', 8th January 2018. Available online at: https://www.npr.org/sections/the-salt/2018/01/08/575413910/soaring-popularity-of-grass-fed-beef-may-hit-road-block-less-nutritious-grass
165 Morningstar 'Long-term opportunities in agriculture stocks', 29th July 2019. Available online at: https://www.morningstar.com/articles/938233/long-term-opportunities-in-agriculture-stocks
166 Reuters 'Dry weather crimps Fonterra's NZ, Australia milk output', 30th May 2019. Available online at: https://www.reuters.com/article/us-fonterra-production/dry-weather-crimps-fonterras-nz-australia-milk-output-idUSKCN1T003L
167 QAF 'Annual Report', 2018. Available online at: https://www.qaf.com.sg/wp-content/uploads/2019/03/QAF-Limited_2018-Annual-Report-and-Appendix.pdf
168 The Motley Fool 'Cal-Maine foods drops dividend as egg prices plunge', 22nd July 2019. Available online at: https://www.fool.com/investing/2019/07/22/cal-maine-foods-drops-dividend-as-egg-prices-plung.aspx
169 Food and Agriculture Organisation of the United Nations FAOSTAT, retrieved 26 July 2019
170 OECD-FAO Agricultural Outlook 2018-2027 Statistics https://stats.oecd.org/
171 Fonterra 'Shares and Units'. Available online at: https://www.fonterra.com/nz/en/investors/farmgate-milk-prices/shares-and-units.html
172 Compassion in World Farming 'About calves reared for veal'. Available online at: https://www.ciwf.org.uk/farm-animals/cows/veal-calves/
173 Food and Agriculture Organisation of the United Nations 'Reducing enteric methane for improving food security and livelihoods'. Available online at: http://www.fao.org/in-action/enteric-methane/background/what-is-enteric-methane/en/
174 Oxford Academic: Animal Frontiers 'Livestock and climate change: impact of livestock on climate and mitigation strategies', 12th November 2018. Available online at: https://academic.oup.com/af/article/9/1/69/5173494
175 Food and Agriculture Organisation of the United Nations 'Climate change and the global dairy cattle sector', 2019. Available online at: http://www.fao.org/3/CA2929EN/ca2929en.pdf
176 Chain Reaction Research 'Deforestation risk in Columbia: Beef and Dairy sectors may expose investors', December 2018. Available online at: https://chainreaction-research.com/wp-content/uploads/2018/12/Deforestation-Colombia-1.pdf
177 Cranfield University 'The volumetric water consumption of British milk', November 2012. Available online at: https://dairy.ahdb.org.uk/non_umbraco/download.aspx?media=16704
178 NRDC 'How the dairy industry is fouling the drinking water of these Wisonsinites', 6th March 2019. Available online at: https://www.nrdc.org/stories/how-dairy-industry-fouling-drinking-water-these-wisconsinites
179 Save Our Antibiotics 'Antibiotic use in the UK dairy sector', Autumn 2016. Available online at: http://www.saveourantibiotics.org/media/1762/antibiotic-use-in-the-uk-dairy-sector.pdf
180 PubMed 'Association of dry cow therapy with the antimicrobial susceptibility of fecal coliform bacteria in dairy cows', August 2010. Available online at: https://www.ncbi.nlm.nih.gov/pubmed/20573412
181 PubMed 'Work-related injuries and fatalities on dairy farm operations – a global perspective', 2013. Available online at: https://www.ncbi.nlm.nih.gov/pubmed/23844792
182 Food and Agriculture Organisation of the United Nations 'Greenhouse Gas emissions from the dairy sector', 2010. Available online at: http://www.fao.org/3/k7930e/k7930e00.pdf
183 M. Melissa Rojas-Downing, et al. 'Climate Change and livestock: Impacts, adaptation and mitigation', 12th February 2017. Available online at: https://www.sciencedirect.com/science/article/pii/S221209631730027X?via%3Dihub
184 The Guardian 'Who keeps buying California's scarce water? Saudi Arabia', 25th March 2019. Available online at: https://www.theguardian.com/us-news/2019/mar/25/california-water-drought-scarce-saudi-arabia
185 New Zealand Farm Source 'Fonterra Farmers' Handbook', 2016/2017. Available online at: https://nzfarmsource.co.nz/assets/Resources/Dairy-Diary/Fonterra-Farmers-Handbook.pdf
186 Compassion in World Farming 'About dairy cows'. Available online at: https://www.ciwf.org.uk/farm-animals/cows/dairy-cows/
187 Dairy Australia 'Cows and Farms'. Available online at: https://www.dairyaustralia.com.au/industry/farm-facts/cows-and-farms
188 TEARA 'Story: Dairying and dairy products; Dairy cattle breeds'. Available online at: https://teara.govt.nz/en/dairying-and-dairy-products/page-6
189 Compassion in World Farming 'About dairy cows'. Available online at: https://www.ciwf.org.uk/farm-animals/cows/dairy-cows/
190 Food and Agriculture Organisation of the United Nations FAOSTAT, retrieved 11 August 2019
191 The Guardian 'Can the world quench China's bottomless thirst for milk?'. Available online at: https://www.theguardian.com/environment/2019/mar/29/can-the-world-quench-chinas-bottomless-thirst-for-milk
192 Forbes 'The 2008 milk scandal revisited', 16th July 2014. Available online at: https://www.forbes.com/sites/yanzhonghuang/2014/07/16/the-2008-milk-scandal-revisited/#74b584e44105
193 Food and Agriculture Organisation of the United Nations 'Global aquaculture production 1950-2017'. Available online at: http://www.fao.org/fishery/statistics/global-aquaculture-production/query/en
194 Food and Agriculture Organisation of the United Nations 'Global aquaculture production 1950-2017'. Available online at: http://www.fao.org/fishery/statistics/global-aquaculture-production/query/en
195 Encourage Capital 'Towards a blue revolution: catalysing private investment in sustainable aquaculture production systems', 2019. Available online at: http://encouragecapital.com/wp-content/uploads/2019/05/Towards-a-Blue-Revolution-TNC-and-Encourage-Capital-FINAL-5-5-2019-for-email.pdf
196 Encourage Capital 'Towards a blue revolution: catalysing private investment in sustainable aquaculture production systems', 2019. Available online at: http://encouragecapital.com/wp-content/uploads/2019/05/Towards-a-Blue-Revolution-TNC-and-Encourage-Capital-FINAL-5-5-2019-for-email.pdf
197 Encourage Capital 'Towards a blue revolution: catalysing private investment in sustainable aquaculture production systems', 2019. Available online at: http://encouragecapital.com/wp-content/uploads/2019/05/Towards-a-Blue-Revolution-TNC-and-Encourage-Capital-FINAL-5-5-2019-for-email.pdf
198 J. S. Lucas, P. C. Southgate, and C. S. Tucker, Aquaculture: Farming aquatic animals and plants, 2019. As quoted in http://encouragecapital.com/wp-content/uploads/2019/05/Towards-a-Blue-Revolution-TNC-and-Encourage-Capital-FINAL-5-5-2019-for-email.pdf
199 Science Direct 'Combined climate and nutritional performance of seafoods', 1st September 2019. Available online at: https://www.sciencedirect.com/science/article/pii/S0959652619313162
200 ScienceMag 'Reducing food's environmental impacts through producers and consumers', 1st June 2018. Available online at: https://science.sciencemag.org/content/360/6392/987
201 Springer Link 'Unpacking factors influencing antimicrobial use in global aquaculture and their implication for management: a review from a systems perspective', July 2018. Available online at: https://link.springer.com/article/10.1007/s11625-017-0511-8

202 ResearchGate 'Antibiotics in aquaculture', January 2011. Available online at: https://www.researchgate.net/publication/215589805_Antibiotics_in_aquaculture_An_overview

203 Business Standard 'US FDA cracks down on India's shrimp shipments over banned antibiotics', 12th February 2019. Available online at: https://www.business-standard.com/article/companies/us-fda-cracks-down-on-india-s-shrimp-shipments-over-banned-antibiotics-119021101433_1.html

204 Imares 'GHG Emissions in aquatic production systems and marine fisheries', 13th June 2013. Available online at: https://core.ac.uk/download/pdf/29222560.pdf

205 Food and Agriculture Organisation of the United Nations 'Main ethical issues in fisheries'. Available online at: http://www.fao.org/3/y6634e/y6634e04.htm

206 Changing Markets 'Until the seas run dry'. Available online at: http://changingmarkets.org/wp-content/uploads/2019/04/REPORT-WEB-UNTILL-THE-SEAS-DRY.pdf

207 Science Direct 'Combined climate and nutritional performance of seafoods', 1st September 2019. Available online at: https://www.sciencedirect.com/science/article/pii/S0959652619313162

208 ScienceMag 'Reducing food's environmental impacts through producers and consumers', 1st June 2018. Available online at: https://science.sciencemag.org/content/360/6392/987

209 DNB Markets 'Seafood – special report', 11th February 2019. Available online at: https://www.aquabounty.com/wp-content/uploads/2019/02/DNB_Landbased-11Feb2019.pdf

210 ResearchGate 'Assessing alternative aquaculture technologies: life cycle assessment of salmonid culture systems in Canada', February 2009. Available online at: https://www.researchgate.net/publication/222568250_Assessing_alternative_aquaculture_technologies_life_cycle_assessment_of_salmonid_culture_systems_in_Canada

211 FAIRR 'Shallow returns? ESG risks and opportunities in aquaculture',5th June 2019. Available online at: https://www.fairr.org/article/shallow-returns-esg-issues-in-aquaculture/

212 Abolofia, J., Asche, F. & Willen, J. E. (2017) The cost of lice: quantifying the impacts of parasitic sea lice on farmed salmon', 8th January 2019. Available online at: https://brage.bibsys.no/xmlui/bitstream/handle/11250/2494032/691981.pdf?sequence=1&isAllowed=y

213 DNB Markets 'Seafood – special report', 11th February 2019. Available online at: https://www.aquabounty.com/wp-content/uploads/2019/02/DNB_Landbased-11Feb2019.pdf

214 PNAS 'Global trends in antimicrobial use in food animals', 19th March 2015. Availaa ble online at: https://www.pnas.org/content/112/18/5649

215 Frontiers in Microbiology 'Current status of the use of antibiotics and the antimicrobial resistance in the Chilean salmon farms', 18th June 2018. Available online at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6016283/

216 ResearchGate 'Antibiotics in aquaculture: an overview', January 2011. Available online at: https://www.researchgate.net/publication/215589805_Antibiotics_in_aquaculture_An_overview

217 Science Direct 'Antibiotic residues in meat, milk and aquatic products in Shanghai and human exposure assessment', October 2017. Available online at: https://www.sciencedirect.com/science/article/pii/S0956713517302219

218 Compassion in World Farming 'The welfare of farmed fish', August 2009. Available online at: https://www.ciwf.org.uk/media/3818654/farmed-fish-briefing.pdf

219 FAIRR 'Shallow returns? ESG risks and opportunities in aquaculture', 5th June 2019. Available online at: https://www.fairr.org/article/shallow-returns-esg-issues-in-aquaculture/

220 Associated Press (2015:A). An AP investigation helps free slaves in the 21st century. Source: https://www.ap.org/explore/seafood-from-slaves/

221 Human Rights Watch (2018). Hidden Chains: Rights Abuses and Forced Labor in Thailand's Fishing Industry. Source: https://www.hrw.org/report/2018/01/23/hidden-chains/rights-abuses-and-forced-labor-thailands-fishing-industry

222 Sustainalytics 'Slavery in the Seafood Industry', 2019. Available online at: https://www.sustainalytics.com/esg-blog/slavery-forced-labor-seafood-industry/

223 Meat and Poultry 'Maple Leaf Foods to keep eyes on the plant-based prize', 8th June 2019. Available online at: https://www.meatpoultry.com/articles/21698-maple-leaf-foods-to-keep-eyes-on-the-plant-based-prize

224 IPCC 'Food Security', 7th August 2019. Available online at: https://www.ipcc.ch/site/assets/uploads/2019/08/2f.-Chapter-5_FINAL.pdf

225 IPCC 'Food Security' 7th August 2019. Available online at: https://www.ipcc.ch/site/assets/uploads/2019/08/2f.-Chapter-5_FINAL.pdf

226 OECD-FAO 'Agricultural Outlook Database'. Available online at: https://stats.oecd.org/Index.aspx?DataSetCode=HIGH_AGLINK_2018

227 ibid

Awards & recognition

The FAIRR Initiative is delighted to be named among the world's leading organisations for sustainable and responsible investment research.

PRI Principles for Responsible Investment

Shortlisted, ESG Research Report of the Year

This award recognises research that has broken new ground in the development and knowledge transfer of responsible investment approaches. Judges look for research that offers new and meaningful insights into the practical implications of macro trends for responsible investment.

IRRI SURVEY 2019

Top 3 Provider of Specialist Sustainable Investment Research

The IRRI Survey 2019 is a globally authoritative annual survey of capital market professionals, including institutional investors, on the dynamics of sustainable investment. It ranked FAIRR as one of the top three providers of specialist sustainable investment research, placing it ahead of global research giants such as Bloomberg, ISS ESG and HSBC Investment Research.

AI 2019 Global Excellence Awards WINNER

FAIRR Initiative
Most Outstanding Initiative on Sustainable Animal Agriculture – 2019

FAIRR also received an award from AI Magazine as 'Most Outstanding Initiative on Animal Agriculture'. In its summary, the magazine recognised FAIRR for 'Driving impact through collaborative engagements'

FAIRR
A COLLER INITIATIVE

Established by the Jeremy Coller Foundation, the FAIRR Initiative is a collaborative investor network that raises awareness of the material ESG risks and opportunities caused by intensive animal production. FAIRR helps investors to identify and prioritise these factors through cutting-edge research that investors can then integrate into their investment decision-making and active stewardship processes. FAIRR also runs collaborative investor engagements with global food companies to improve performance on selected ESG issues in intensive animal production.

CONTACT DETAILS

Aarti Ramachandran
Head of Research & Engagements at FAIRR
aarti.ramachandran@fairr.org

Iman Effendi
Research & Engagement Manager at FAIRR
iman.effendi@fairr.org

IMPORTANT NOTICE


FAIRR
A COLLER INITIATIVE