



An enhanced assessment of risks impacting the food and agriculture sector

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Foreword

Without food, the world simply cannot function. To sustainably feed a growing global population, the food and agriculture sector needs to produce and supply greater amounts of food while enhancing nutritional quality, conserving natural capital and supporting the development of social and environmental ecosystems. The performance of the sector underpins all human activity; it is fundamental to our cultural identities, societal dynamics and provision of affordable, healthy diets.

The critical need to deliver on these objectives whilst simultaneously ensuring farmers can operate financially sustainable businesses means that the sector must manage multiple variables with highly complex interactions. It is therefore essential that the sector's key dynamics, risks and dependencies are well understood and strategically addressed.

This report shares perspectives from a group of food and agriculture sector participants of the dynamics,

risks and dependencies faced by the system. The report shares an analysis of the network of risks and challenges facing the food and agriculture sector and seeks to highlight how system participants and stakeholders can more effectively:

- Identify key risks and core risk interactions that drive the near-term and longer-term system behavior;
- Assess risks as connected groups rather than as individual risks to build more effective, strategic approaches to risk prioritization; and
- Understand how and where risk management interventions can drive positive system performance.

Understanding these risks and responding to the insights in this report are critical to the development of a resilient food system that is economically sustainable and has the capacity to meet environmental and social goals necessary for the long-term health and prosperity of our planet.



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Executive summary

The complexities and connectivity of environmental, social and governance (ESG)-related risks mean companies must assess risks not just individually but as an interconnected, aggregated and dynamically-dependent group. This is especially true in the food and agriculture sector.

As a key interface between people and nature, the food and agriculture sector must address a wide range of ESG-related challenges and opportunities. Within this sector, a diverse range of companies operate, global supply chains can be complex and vulnerable, and market disruption has the potential to drive catastrophic impacts on financial and non-financial capital (e.g., human, natural and social capital).

This report is intended to help companies assess food system challenges and integrate this knowledge into strategic responses and solution building. It is designed to enable readers to continue to act as advocates for food systems transformation by responding proactively to the critical risks and opportunities identified in this report.

Following on from the 2020 publication, *An enhanced assessment of risks impacting the food and agriculture sector*¹, this report presents further analysis from the application of an enhanced risk assessment technique – KPMG’s Dynamic Risk Assessment methodology – to the risk landscape. It presents perspectives founded on insight shared by 12 companies operating in the food and agricultural sector.

The original analysis highlighted that, by considering risks as an inter-connected network, it is possible for firms to identify the most influential risks and to better target and apply risk mitigation techniques to positively impact key challenges facing the industry. The analysis identified these challenges as understanding agricultural practices, regulation and inefficient production practices.

By extending and introducing new risk dimensions, the current analysis reinforces the importance of considering connected clusters of risks and exploring how the occurrence of one risk may change the likelihood of a connected risk being triggered. The analysis also highlights greater severity and higher velocity of risks when viewed as clusters, compared to the impacts of individual risks captured using traditional approaches.



Four key clusters, including three overlapping clusters identified in this study were:

Cluster 1 – *Changing consumer behavior; Disconnect between farmers & consumers; and Media & image.*

Cluster 2 – *Climate change & episodic events; Diminishing biodiversity; Disconnect between long-term / short-term interests; and Soil degradation & nutrient preservation.*

Cluster 3 – *Diminishing biodiversity; Disconnect between long-term / short-term interests; Focus on scale not diversification; and Soil degradation & nutrient preservation*

Cluster 4 – *Climate change & episodic events; Food quality & affordability; and Uneconomical farming*

The analysis highlights that these overlapping clusters may be best managed as a connected group rather than individually. Further analysis highlighted clusters of risks with weaker linkages between risks, but for which the triggering of the risks and aggregated severity outcomes are not as readily anticipated.

Based on analysis of the insights shared by participant organizations, WBSCD proposes that to more effectively identify, assess and manage core risk interactions and connectivities companies operating in the food and agriculture sector should:

1. Manage clusters of risks and their connections, specifically in primary risk clusters;
2. Continue to focus on mitigating the effects of climate change and strategically managing climate transition actions. *Climate change & episodic*

events is the risk that most determines the overall outcome of the network. The system and company response will be critical to the long-term performance of the system;

3. Formulate a coordinated, strategic approach to address factors that influence *Uneconomical Farming* – the most impacted and likely outcome if current network dynamics are unmitigated. In particular, the analysis highlights that mitigating an outcome of *Uneconomical Farming* cannot be addressed in isolation. There will be limited or no positive impact on that outcome unless risk mitigation targets risks that have a positive network impact on other risks – e.g., *Disconnect between long-term/short-term interests; Focus on scale not diversification and Soil degradation & nutrient preservation.*

4. Allocate resources to target and mitigate the most influential sector risks, namely addressing: *Food quality & affordability; Disconnect between long-term/short-term interests; and Focus on scale not diversification.* In conjunction with climate actions, addressing these risks provides the best opportunity to positively influence the longer-term risk pathway of the system.
5. Continue to encourage individual company and sector-level initiatives to raise food quality and address food affordability challenges. This includes critical consideration of long-term company performance and ensuring a diversity of food supply and production.



1 Introduction



1 Introduction

Humanity's future depends on its ability to create and sustainably operate a circular food system that supports healthy people, healthy economies and a healthy planet.

The food system includes everything involved in feeding people and animals – from growing, harvesting and processing agricultural raw materials to product development, trading, marketing, distribution and consumption, and finally co-product and by-product utilization, waste and disposal. A healthy food system is one with inclusive outcomes for healthy people, a healthy planet and, of course, healthy businesses. As competition for fertile land increases, the system is deeply connected with agriculture, land use and working forests which are managed for non-food purposes, such as timber and fiber.

The ESG-related risks of the food and agriculture sector are particularly complex. As a key interface between people and nature, the food and agriculture

industry must address a wide range of ESG-related challenges and opportunities. A diverse range of companies operate within the sector and global supply chains are complex and vulnerable to external risks and market disruptions. These have the potential to drive catastrophic impacts on food system performance as well as financial and non-financial capital (e.g., natural, human and social capital). Individually and in combination, these risks and disruptions could critically impact the system's ability to deliver healthy and sustainable food and society's ability to achieve the 2030 Sustainable Development Goals.²

The COVID-19 pandemic has further highlighted the fragility of international supply chains, underscored the vulnerability of the global food system and amplified food insecurity and unaffordability. In addition, the food and agriculture sector has critical dependencies and impacts on environmental and natural capitals, water and wastewater systems, transportation systems, energy, and chemical systems.³

As we seek to accelerate the transformation of food systems to address these complex, global challenges, food system participants need a common understanding of the risks, dependencies and dynamics that impact the resilience of the food system. They also need a framework to drive effective performance of the full food and agriculture sector value chain – from production, processing and distribution to consumption and disposal.

Within this context, KPMG's Dynamic Risk Assessment⁴ offers companies an enhanced capability to examine, understand and manage the interconnections, complexities and aggregated impacts of the risks that might impact business performance and strategic resilience of the system. This report highlights critical system dynamics and interactions, areas of focus and risk management actions to more effectively identify, assess and manage systemic risks, improve understanding of system performance and build system resilience.



② Assessing and prioritizing ESG-related risks



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2.1 INTEGRATING ESG-RELATED RISKS IN ENTERPRISE RISK MANAGEMENT

Effective risk management balances risk exposures, benefits and expenditures. Strong ESG-related risk management capability is necessary for companies to assess and address the impact of risks on business strategy and objectives.

ESG-related risks can be challenging to identify, assess and prioritize. By their nature, the financial and business implications of these risks may not be immediately clear or easily measurable. This challenge may be exacerbated by a company's limited knowledge of ESG-related risks, varying risk emergence periods relative to financial or operational risks, and challenges to quantify risks and assess outcomes.

Companies are further challenged by the increasingly complex and interconnected global context and the evolution of markets. Disruption of markets, shifts in global economic power and changes in internal and external stakeholder expectations are driving the need to demonstrate stronger, more transparent and robust management of ESG-related risks across business activities and operating models.

With the link between ESG factors and risk becoming increasingly explicit, companies must find ways to bring new functions and leaders into the ESG conversation.

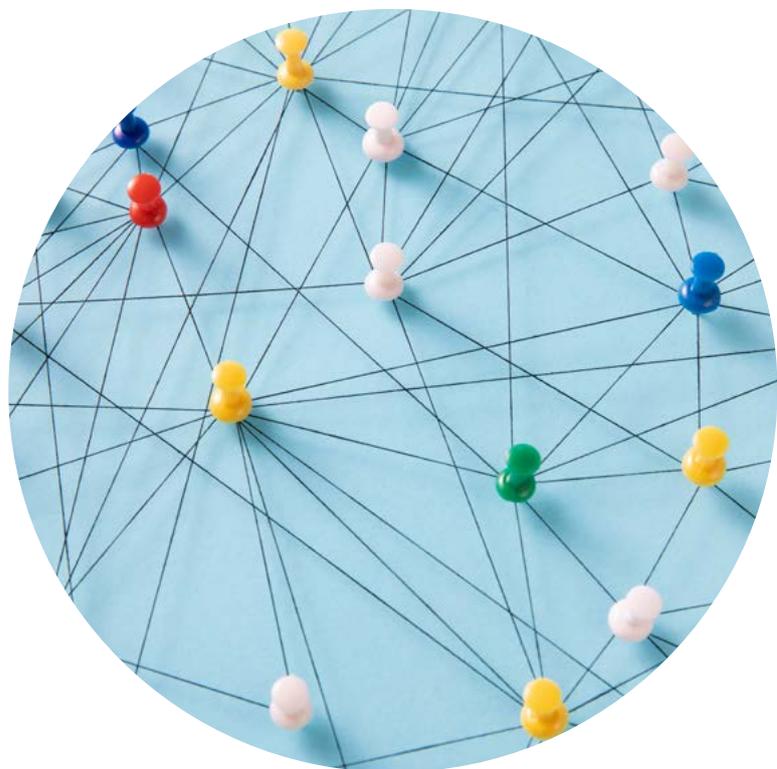
2.2 TRADITIONAL RISK ASSESSMENT APPROACHES

An effective risk assessment examines the extent to which identified risks and opportunities may impact a company's strategy and business objectives.

To support the integration of broad ESG-related and systemic risks into the enterprise risk management process, WBCSD worked with the Committee of Sponsoring Organizations of the Treadway Commission (COSO) to develop

guidance to enhance companies' resilience as they confront the increasing prevalence and severity of ESG-related risks.⁵

The guidance helps risk and sustainability practitioners speak the same language, communicate the broad impacts and dependencies of the company, and address how these might translate into risks. Core components include consideration of how risks may impact company strategy and business objectives and how companies can assess and prioritize risks.



The guidance highlights that companies typically achieve this by:

- Identifying the impacts that a risk may have on the entity; and
- Selecting the most appropriate model, approach, data and assumptions for the assessment.

Once a risk is identified, understanding the potential business impacts allows management to prioritize risks and allocate resources to respond and monitor the risk over time. To achieve this, risks are translated into a common language that captures the risk magnitude.

Traditionally, risk severity is expressed in terms of impact and likelihood. Overviews and examples of these approaches are presented in Chapter 3b (Performance for

ESG-related risks: Assess and Prioritize) of WBCSD and COSO's guidance. An illustration of an impact and likelihood assessment matrix is presented in Figure 1.

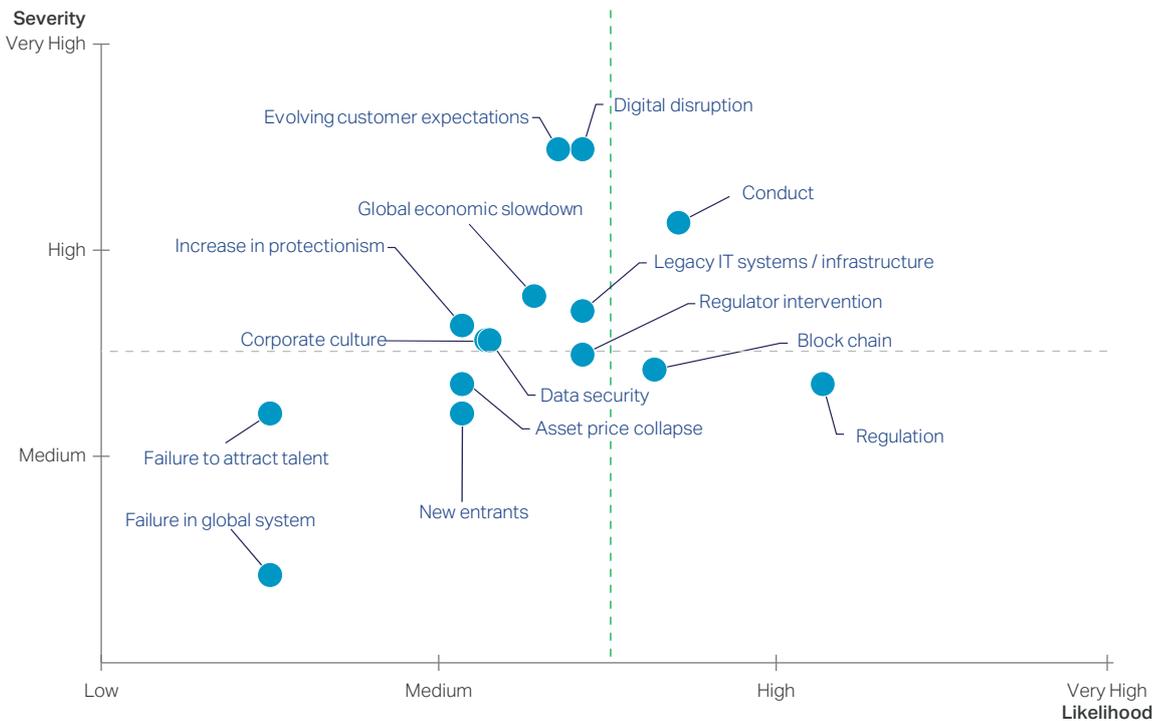
Although impact and likelihood are common criteria for assessing risk severity and prioritizing risks, there are recognized limitations in the effectiveness of their application to ESG-related risks. Characteristics of ESG-related risks that cause challenges include:⁶

- ESG-related risks can be more unpredictable and may manifest over longer and often uncertain time frames;
- It can be difficult to find historical precedence and data to estimate the potential quantitative impact of ESG-related risks;

- Risks may be outside of an entity's control and responding to a risk may rely on collaboration and/or on the actions of other parties; and
- ESG-related risks are macro, complex, multi-faceted and interconnected and can affect the business across many dimensions (including different forms of capital and value).

These complexities and interconnectivities make it crucial for companies to review and assess risks both individually and as an interconnected, aggregated and dynamically-dependent group.

Figure 1: Illustration of an impact and likelihood risk matrix
(Source – KPMG's Dynamic Risk Assessment, p28, KPMG, November 2018)



2.3 MOVING BEYOND IMPACT AND LIKELIHOOD

To overcome the challenges, it is important that companies use criteria that extend the assessment of risk exposure beyond impact and likelihood and present results in a way that supports effective decision-making. For example, an assessment of how vulnerable a company is to a risk (i.e., the capability to adapt or to recover) may better reflect how the severity of a risk is assessed and prioritized beyond simply assessing likelihood.

The choice of assessment criteria is further influenced by the type of ESG-related risks, which may be new to decision-makers. For example, the use of social media has shortened the time period between stakeholder identification

and communication of ESG issues. This has served to accelerate the speed at which markets, stakeholders and companies are informed of issues, reducing the time available for companies to respond. By way of another example, new legislation in some countries holds businesses accountable for modern slavery risks throughout their extended value chain anywhere in the world – challenging businesses to understand and identify modern slavery risks across complex, multi-tiered supply chains involving many players and jurisdictions.

Heightened scrutiny, regulation and awareness of ESG-related challenges require companies to assess risks and impacts beyond traditional, internal business activities and assets – extending risk

assessment requirements to, for example, the external environment, the full supply-chain and value creation across a broad range of capitals and resources (e.g., financial, manufactured, natural, intellectual, human, social and relationship).

A list of example criteria provided by COSO for assessing and prioritizing risks and the relevance of ESG-related risks are presented in Table 1.

Against this backdrop, companies need to enhance their capabilities for assessing ESG-related criteria to support business resilience, adaptability, long-term sustainability and capacity for growth. This requires a forward-looking, sophisticated approach to risk assessment that examines the complexity, interconnectivity and aggregated nature of risks.

Table 1: Application of prioritization criteria to ESG-related risks

Source: WBCSD-COSO, (2018), Applying enterprise risk management to ESG-related risks, available at: <https://www.wbcsd.org/erm>

Criteria	Description	Relevance for ESG-related risks
Adaptability	The capacity of an entity to adapt and respond to risks	A risk may be significant and unpredictable; however, an organization can build in adaptability mechanisms to respond to or absorb the risk. For example, in the 1980s, Shell diversified its portfolio and used scenario planning to prepare and adapt to potential oil price fluctuations that were generally considered unforeseeable.
Complexity	The scope and nature of a risk to the entity's success	Many ESG-related risks are interrelated, global, industry-wide and constantly changing. For example, health care companies are aware of the complex relationship between climate change and health. Climate change impacts may lead to potential disruptions to operations, while also leading to health impacts on individuals (increasing the demand for health care services). CPA Australia, KPMG and GRI reported that companies that incorporated megatrend analysis into the risk processes tended to focus on one characteristic and did not deal with the "complex and systemic megaforce whose impacts are over the short, medium and long term." For example, companies with exposure to water scarcity are more likely to focus on immediate water efficiency than investigating the risks associated with future water scarcity. Similarly, companies looking at resource scarcity and deforestation are considering efficient consumption of energy, water and paper as well as recycling initiatives but are less likely to explore deeper issues of changing land use practices and systemic impacts on ecosystem design.
Velocity or speed of onset	The speed at which risk impacts an entity	ESG-related risks are often emerging and unforeseen until swift events result in extreme consequences. Climate change impacts often manifest in the form of more extreme or frequent occurrences of known events, such as droughts and floods, and are best understood by studying longer temporal horizons than are usually associated with typical risk management.
Persistence	How long a risk impacts an entity	Risk severity should consider the extent to which the impact will be an acute, onetime impact (e.g., cyclones, hurricanes or earthquakes) versus a chronic issue that will cause ongoing impacts (e.g., sustained higher temperatures or droughts).
Recovery	The capacity of an entity to return to tolerance	Consider how quickly the business would recover if a risk occurred today. For some ESG issues, impacts are irreversible. For example, in the food, beverage and agriculture sector, the impacts of climate change have the potential to alter growing conditions and seasons, increase pests and disease and decrease crop yield. Recovery from these impacts requires enhancing capacity to manage and respond to the risk.

3 Understanding the food and agriculture landscape



3 Understanding the food and agriculture landscape

Food and agricultural products play vital health, economic and cultural roles in every society. However, today's food and agricultural systems are outstripping the planet's resources and evolving diets are feeding global health crises involving both over- and undernutrition. Agri-food value chains are also not seeing fair distribution of the value generated, with growing income disparities exacerbating rural poverty.

The food system requires urgent transformation to effectively meet the needs of the world's growing population, which is estimated to exceed 9 billion by 2050.⁷ Prior to the onset of the COVID-19 pandemic, more than 820 million people were identified as chronically food insecure.⁸ The latest data on food security shows at least 155 million people experienced acute food insecurity at 'crisis or worse' level⁹, exacerbated by the impacts of the pandemic.

Pathways for action were identified in the UN Food System Summit's Business Declaration on Food Systems Transformation,¹⁰ signed by over 220 leaders across the sector. The pathways include:

- Scale science-based solutions to enable millions of farmers to adopt regenerative and climate-smart practices;
- Provide investments in research and innovation across the value chain;
- Contribute to improved livelihoods and wellbeing by strengthening decent work, living incomes and wages;

- Incentivize consumers to be agents of change to create demand for sustainability-produced products;
- Create transparency by integrating ESG risks and impacts across their operations; and
- Ensure an equitable transformation for people everywhere with access to training and employment.

3.1 UNDERSTAND AND MANAGE LINKS BETWEEN KEY RISKS AND SYSTEM DYNAMICS

The private sector is responsible for almost all the food and other agricultural products produced, sold and consumed globally. This makes the role of business pivotal to improving food production and consumption patterns worldwide. As Peter Bakker, President & CEO of WBCSD, shared during the UN Food Systems Summit in September 2021, *"Business understands it will, and it must, be held accountable for its impacts...Transparency through ESG disclosures and the development of a system wide approach to the true value of food will be the way forward."* An effective approach to identifying, assessing and mitigating system risks is central to the development and delivery of coordinated strategic approaches to address these challenges.

Operational risk management is crucial; security of supply along the food value chain has significantly deteriorated since the start of 2020 as the consequences of COVID-19 have amplified pre-existing limitations. One

example is the extent to which global supply chains have been stretched to breaking point due to the practical challenges and restrictions surrounding freight and shipping difficulties.¹¹ Trade logistics remain a critical, ongoing area of concern for business, governments and consumers. The global trade system was put to the test during the pandemic and could face a similar shock again – with long-lasting implications for food security, pricing and affordability.

Another example of an operational risk the sector must consider is the extent to which farming must deliver a viable livelihood for the 400+ million smallholders who underpin the industry worldwide. The farming population is aging and, for the first time in history, the majority of the world's population live in urban areas¹² due to migration out of rural communities where poverty seems inescapable. The challenge for agribusiness to combine reliance on globally integrated value chains and systems with meaningful engagement of local stakeholders in a way that recognizes power imbalances and appropriately rewards labor with living incomes and wages.



Managing reputational risk and maintaining a license to operate is another challenge faced by the sector. The UN Food Systems Summit worked to bring stakeholders together to commit to responsible and proactive action towards a sustainable food system. Consumer and government expectations of the private sector are continuously lifting with demand increasing for transparency, certified sustainable products, in-depth sustainability reports, and more. In 2021, the World Benchmarking Alliance (WBA) measured and ranked 350 keystone companies on issues underpinning the food systems transformation agenda.¹³ According to the WBA,

“key findings reveal worrying gaps in the industry’s preparedness for climate change, progress on human rights and contribution to nutritious diets. The benchmarked companies account for more than half of the world’s food and agriculture revenue, and directly employ over 23 million people. If these companies do not take action now, the SDGs and the Paris Agreement will be further out of sight than ever before.”

The report found that the sector is not taking responsibility for its environmental impacts, is performing poorly on critical social issues and is not prioritizing nutritious food choices. The onus will be on the sector to respond to this report and improve its performance to minimize reputational risk, among other goals. Positively, many companies have achieved significant improvements in their risk management capabilities and performance but it is clear that all still have a significant road ahead.

3.2 PERSPECTIVES ON RISKS AND OPPORTUNITIES

Opportunities abound for the sector to amplify its positive impact through new product lines, use of innovative production techniques and experimentation with transformational business models. The food system is being asked to meet increasing demand for more and nutritionally better food to support a continuously growing global population while using less inputs – both synthetic and natural. This is driving massive investment in new ways of producing food, taking advantage of fusion technologies that underpin the fourth industrial revolution – solutions that fuse physical, digital and biological technologies in new and transformational ways. This is unlocking the potential to make the biggest change in the global food system in the approximately 13,000-year history of formal agriculture.

Increasing demand across geographies for plant-based protein alternatives, the growing interest in biofuels as a renewable energy source and focus on circular economy models are examples of opportunities for business leadership and innovation in the new frontier of agriculture. Regulatory changes and consumer demand in parallel push the sector to deviate from “business as usual” and explore new ways of producing and distributing the world’s agricultural products. Scientific advancements in seed development and artificial intelligence, for example, can offer the tools necessary for the private sector to step up to this challenge.

3.3 STRATEGIC IMPORTANCE OF BUILDING SUSTAINABLE AND RESILIENT FOOD AND AGRICULTURE SOLUTIONS

The sector is at a critical juncture. The pandemic jolted the food and agriculture sector, increasing rates of food loss and waste in some parts of the value chain while millions of people plunged into varying levels of hunger, often for the first time in their lives. In response, the United Nations’ first-ever Food Systems Summit brought stakeholders together from the private sector, governments and the public to agree on commitments for action. CEOs stepped up to publicly declare their companies’ support for a new way of doing business that will create an equitable, natural and nature-positive food and agricultural system capable of nourishing all people.

For businesses to be successful in the next iteration of the system, they will need to react with urgency, boldness and creativity to supply and demand forces that will challenge them to pursue new ways of doing business. It is against this background that we have conducted this project to assess the dynamic nature of risks facing the global food system. The connections between risks provide unique insights into where efforts must be focused to create healthy sustainable, equitable, accessible and prosperous food systems.



4 KPMG's Dynamic Risk Assessment methodology



4 KPMG's Dynamic Risk Assessment methodology

4.1 BACKGROUND

The macro-economic and geo-political environments that operated in the 1950s, when we first measured risk as volatility around a long-term average, were vastly different to those today.

Foreign direct investments, integrated supply chains, the rapid developments in technology, satellite communication and financial derivatives affected just a small fraction of the world's markets compared to today's globalized economy. Post-World War II domestic economies were isolated by design and, while economies varied in structure, they were aligned in slowing free trade. Where financial markets did exist, they were substantially more inward-looking. Fragmented markets and

localized conditions confined risk to national boundaries and immunized markets from international sources of volatility so that they would return to long-term average levels. This became the essential assumption and the central premise for measuring risk. In this context, the only risk attributes requiring analysis were likelihood and severity.

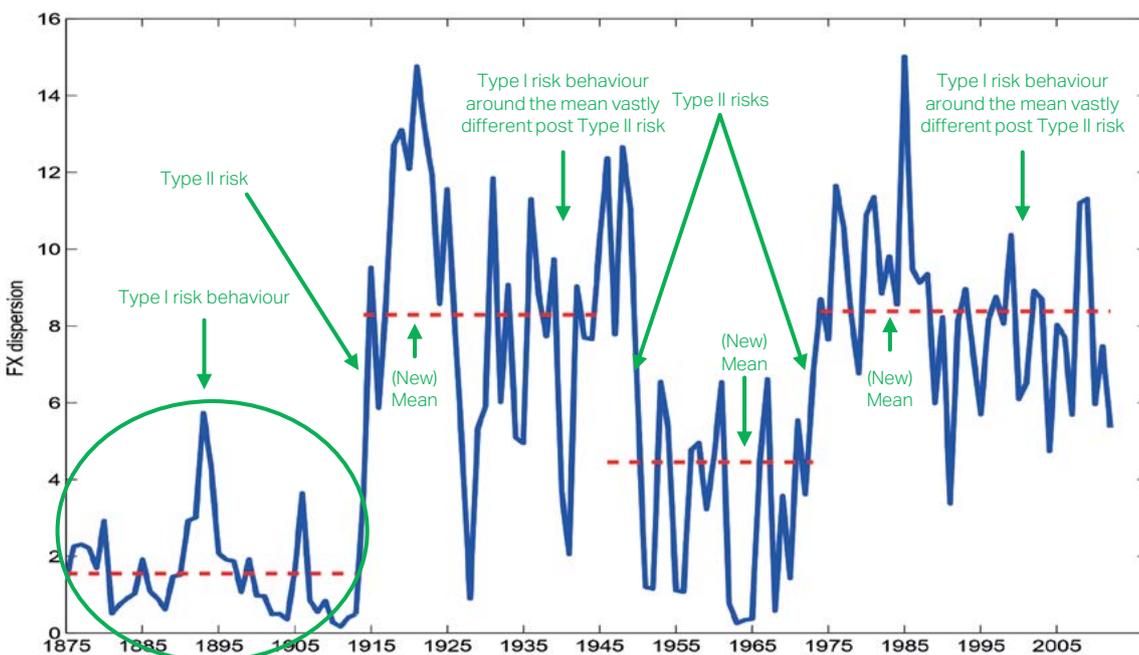
The isolation of domestic economies ended during the 1980s. Democratization, deregulation, the opening of national economies and the floating of currencies became widely accepted and enthusiastically implemented after the models of economic success of the UK and USA when they opened and privatized their economies. The steady unravelling of global economic isolation enabled foreign direct investment,

exports, the use of derivatives and the reach of technology to escalate radically. Connections inside domestic economies and between economies grew in ways and to levels not witnessed before. These new connections brought about interdependencies which expanded risk exposures beyond what was originally seen within contained domestic economies. Determining only risk likelihood and severity was no longer enough; analyzing interconnectedness and velocity – the *time to impact once a risk arises* – became vital.

The broadening of risk attributes affects not only the variance of traditional risks around their historic average, which we term 'Type I risks'. It also re-introduces a second, post-1950s, 'Type II' risk, which are *risks of a structural or permanent nature*.

Figure 2: Exchange rate flexibility - Type I and II risks¹⁴

Source: Rangvid, J., Santa-Clara, P. & Schmeling, M.: Capital Market Integration and Consumption Risk Sharing over the Long Run. 12 Jan. 2016: p. 46. Own emphases.



Type II risks have almost no precedent, have limited prior data to model and do not display behavior around an average. In statistical terms, their underlying data, when we do eventually collect it, is non-stationary. This makes them undetectable by traditional (Type I) statistical modelling and unsuited to it.

It is unsurprising then that, following the transition towards globalization in the 1980s, there have been several globally significant Type II risk events. Recent examples include the September 11th attacks, the global financial crisis, Brexit and COVID-19.

It follows that any risk analysis related to food and agriculture must address risks' interconnectedness and velocity. Individual food and agriculture risks are components of a self-influencing, broader risk ecosystem in which they interact. In this system, mitigating any single risk has knock-on effects on the rest of the food system, and beyond. An assessment of food and agriculture risks requires the inclusion of second, third and all higher-order consequences that flow from their causal connections and velocities.

Accepting that knock-on effects exist, we analyze food and agriculture risks using network theory to allow for:

1. Identifying contagion between individual risks;
2. Their respective velocities; and
3. The consequences of these interactions on other risks and on the wider system.

4.2 KPMG'S DYNAMIC RISK ASSESSMENT

KPMG's Dynamic Risk Assessment (DRA) represents an evolution in traditional risk assessment in the following ways:

1. It includes future trends / evolving developments and their potential downstream exposures (Type II risks) in risk management and modelling. This broadens the scope beyond only Type I risks and events seen before, where modelling is reliant on historical data.
2. It expands the analysis of identified risks by detecting how risks may be connected and the speed of their impacts, adding

to the traditional measurements of risk severity and likelihood.

3. It applies the latest known science from expert elicitation practice and behavioral finance to obtain the key information in ways that reduce human bias.
4. It applies graph theory to best represent the expert panel's data.
5. It applies graph theory algorithms to extract findings naturally due to the network's causal structure and operation.

In this way, DRA captures and best represents the wisdom of a scientifically-selected crowd as a mathematical network: vastly experienced professionals on the topic under investigation who display specific attributes in their thinking and forming of conclusions. This process enables the identification of insights foreseen by the scientifically selected group but which no individual – not even a subject matter expert – can single-handedly bring about. At a time of significant macro-economic and geo-political change, methodologies must consider both Type I and Type II risks to have any chance of being accurate.

Table 2: Current disruptive transitions which create Type II risks

Source: Terblanche, A.B.

Old Economy (1980 -c. 2014)	New / Future Economy (2014 ff.)
Globalization	De-globalization, bifurcation. Trade wars, currency wars, cyber wars
Open, deregulated domestic economies	National interests first
Optimization of quarterly returns	Purpose and ESG
Private sector influence over politics	Politics influencing private sector
Democratization	Democracy waning in credibility. Age of leadership impunity
Attempt to balance big fiscal budgets	Highest fiscal debt levels, ever, in peace time
Cash is king	Cash is virtual
Success: (single metric of) shareholder returns	Success: optimization of competing interests
Climate change: talked/written about	Climate change manifesting
Just in Time, global supply chains	Return to local, inventories, trade finance
Travel: open to most	Return of screening entrants (post COVID)

A cautionary note on precision

Statistical precision in Type I risk modelling has, on too many occasions, lulled readers into a false sense of accuracy. Statistical modeling, suited to Type I but not Type II risks, are by their nature precise. However, statistical precision does not imply future accuracy. The statistically derived Value at Risk numbers used during the lead up to the September 2008 crisis were precise to decimal points. However, they were wholly inaccurate about the future. When it comes to Type II risks, statistical risk modelling tools tend to be precisely wrong (inaccurate) about the future.

4.3 THE DRA PROCESS

DRA comprises a four step process that can be applied and scaled to industry, company, business unit, project or risk-theme levels.

The first two steps form the risk identification phase: to capture past risks that may re-occur (Type I risks), over-the-horizon risks and completely new risks (both Type II risks). As stated before, there is typically no relevant historical data for Type II risks. Instead, a scientific process of expert elicitation and behavioral finance determine:

- How we identify experts; and
- The protocols we use to gather data from the expert panel.

Step 3 introduces technology into the process in the form of an interactive, gamified and human bias-reducing software tool. It aids risk quantification by the experts who provide data independently and anonymously.

The final step generates the network that best represents how the group of experts think about the topic. This network is analyzed using graph theory and network algorithms to extract the findings that naturally

result from the network's operation. The analyses include:

1. The scenarios most expected by the panel;
2. The longer-term risk pathway that the network will follow; and
3. The optimum strategy to mitigate the outcome in the point above.

Table 3 outlines the approach and performance of the four steps as applied in this assignment of the food and agriculture sector:



Table 3: Steps in KPMG's Dynamic Risk Assessment process

Step I: Expert identification and Interviews	<p>Experts from across the industry participated to capture a diverse range of views. They collectively represent many roles across 14 different companies, multiple continents and varying positions in the food and agriculture value chain.</p> <p>We conducted individual interviews with 23 of the experts applying our expert elicitation protocols. Each interview aimed to seek a base-level understanding of the industry's risks.</p>
Step II: Group Interview	<p>All experts participated in a group interview process, structured in accordance with expert elicitation and behavioral finance protocols. This included bias reduction training and external reference data to prompt consideration of exogenous and endogenous risks and trends that pose risk consequences to the industry, both today and in the future.</p>
Step III: Survey	<p>Each expert accessed a patented, interactive software tool which facilitates the collection of data points on their individual estimate of four dimensions of each risk: likelihood, severity, interconnectivity, and velocity. We designed the survey applying expert elicitation principles to:</p> <ul style="list-style-type: none"> • Apply non-linear thinking processes; • Reduce survey fatigue effects; • Reduce biased estimates; • Collect continuous-valued data collection avoiding categorical analysis; and • Support self-consistent estimates of the most challenging risks commonly seen in ESG.
Step IV: Findings	<p>We generated the risk network and analyzed it to produce five key insights which are set out in Chapter 5. We presented the findings back to industry experts and discussed next steps with them.</p>

5 Food and agriculture study – insights and findings



5 Food and agriculture study – insights and findings

5.1 PROJECT BACKGROUND

Twelve organizations across the food and agriculture sector collaborated with WBCSD and KPMG to produce a network view of the risks and opportunities faced by the industry.

They do not represent the whole sector but are indicative based on the expert input received, their geographical spread and industry focus.

5.2 THE RISK LIST

Table 4 sets out the risks we identified for the industry by means of the individual and group interviews (Steps I and II).

Table 4: Expert-identified industry risks

No.	Risk name	Risk description
1	Changing consumer behavior	Changing dietary patterns, shifts in consumption (e.g., convenience foods) and generational food trends (e.g., vegetarianism) create demand for products the industry is not producing, cannot produce, can produce but with lower margins, or cannot produce within a short timeframe.
2	Climate change & episodic events	Increasing frequency and severity of extreme weather events (potentially exacerbated by climate change) lead to land damage, equipment and infrastructure impairment and possible loss of life, impacting costs and sales.
3	Commodity price volatility	Food price volatility negatively impacts food security for the most vulnerable groups. Volatile commodity pricing makes it difficult for farmers to plan and adjust supply. This increases financial risks and uncertainty for investors, producers and traders.
4	Diminishing biodiversity	Inattention to dependencies in nature or lack of understanding of / focus on key pillars of biodiversity (e.g., bees / pollinators, deforestation consequences, extinction of species and plants) heighten vulnerabilities (e.g., pests, disease) to food production and supply.
5	Disconnect between farmers & consumers	Populations becoming more detached from farming and dispassionate about the criticality of farming adopt increasingly popular, urbanized views with adverse consequences to farming. Result leads to more regressive practices, higher costs, lower yields and other unintended consequences.
6	Disconnect between long-term / short-term interests	Disconnect or misalignment between short-term and long-term performance results in disproportionate emphasis by business, investors and government on short-term performance. ESG impacts and business opportunities emerging over the longer term are neither prioritized nor supported.
7	Focus on scale not diversification	Continued focus on corporates' mass production of cheap foods based on a limited range of crops marginalizes farmers with small holdings and undermines crop and dietary diversity and soil health. These outcomes negatively impact system productivity and sustainability at local and regional levels.
8	Food concentration / supply chain structure (safety and wastage)	Over-concentration on a limited range of crops results in concentration of risks to global food safety and availability. Inefficient infrastructure and distribution practices contribute to resource wastage and failure to deliver excess food to where it is needed.
9	Food quality and affordability	Food prices do not reflect the nutritional value or the true social, environmental and health impacts of food production. The market is distorted in favor of those who produce food unsustainably, while those who farm in an environmentally and socially responsible manner bear the additional costs.
10	Food supply chain transparency & traceability	Poor transparency and traceability in supply chains result in lack of identification and management of inefficient, inappropriate or irresponsible (including criminal) behaviors.
11	Geo-political	International trade is disrupted or impaired due to erratic geopolitical decisions. This impacts access to markets, sales and cost of sales. Includes governmental actions introduced to obtain 'food security' and governments failing to act on key issues while leaving it to industry to act.
12	Investment and access to finance	Low and fluctuating profit margins and cash flows limit access to finance for farmers and / or result in unattractive loan conditions. This leads to under-investment in the sector, reduced / inefficient production and unsustainable business models.

No.	Risk name	Risk description
13	Media and image	A disconnect between the industry and social media renders it vulnerable to social activism, including inaccuracies and mis-information. This can negatively impact sales and profitability.
14	Regulations	Possibility of sudden, non-science based and / or increased regulation being introduced. This may lead to escalating compliance costs, sub-optimal responses, existing markets all becoming inaccessible, a rise in the number of breaches and / or increased production costs.
15	Social inequalities	Failure of governments and business to address social-economic inequalities increases the risk of food insecurity for individuals and households.
16	Soil degradation & nutrient preservation	Overcultivation, inappropriate intensive farming methods, misuse or excessive use of pesticides and / or fertilizers, and insufficient attention to nutrient requirements lead to soil degradation and misuse, impacting production capabilities and long-term viability.
17	Technological developments	Limited engagement with and application of technology lead to inefficient practices, public disillusion and producer frustration.
18	Treatment of farm workers	Lack of transparency at a sufficiently granular operational level on the application of labor rights, equitable treatment and health and safety practices exposes farmworkers' vulnerabilities and heightens risks of damage arising from operational, reputational and social risks.
19	Uneconomical farming	High risks faced by farmers and poor income / cost ratios result in uneconomic business models that challenge recruitment / retention of knowledgeable farmers. Also vulnerable to changes in business drivers – e.g., energy transition. These, in turn, impact the level and quality of production.
20	Water scarcity and usage	Lack of coordinated, strategic water management practices contribute to regional water stress and water shortages, resulting in excess use and water wastage in food production.

5.3 SCALES

Risks have metrics which are naturally measured by a continuous range of numbers. To model risks effectively, smooth-valued risk scales are essential. Combined with scale labels, experts can interpret terms like 'minor' or 'likely' and consistently estimate risk metrics. Together with values collected via an analogue user interface,

they form the base estimates for graph theory analysis. The process collects data in natural units and avoids problems due to the use of coarse risk categories.

A typical corporate time horizon for risk time-to-impact scale is one to five years. However, the food and agriculture sector has a longer time horizon due to its biological nature, potential for risk accumulation and

longer-term climate-cycle effects. For this reason, and recognizing its vital role in sustaining a growing global population, we use a risk velocity scale up to 10 years.

The calibration of the likelihood and severity risk scales uses values aligned to these types of risk analyses in the food and agriculture industry – see Table 5.

Table 5: Severity and likelihood quantitative risk scales

Severity (Impact USD)	Minor 0.3m – 10m	Low 10m – 30m	Moderate 30m – 100m	Significant 100m – 300m	Major 300m – 1000m
Likelihood (% events/yr)	Rare 0.3% – 1%	Unlikely 1% – 3%	Possible 3% - 10%	Likely 10% - 30%	Almost Certain 30% - 100%
Velocity	3m-1yr	1yr-3yrs	3yrs-6yrs	3yrs-6yrs	6-10yrs

5.4 INITIAL ANALYSIS

The DRA analysis generates:

- A smooth, graph-like, *high resolution heat map* that depicts each risk in two dimensions according to its severity and likelihood over the time period (i.e., the *anticipated event rate*); and
- A *risk network* from which we identify three key *risk contagion insights*.

We obtained expert panel estimates using an analogue-style, high resolution and academically researched user interface. This was custom-built to elicit risk contagion data from expert panels. It represents a necessary improvement to the traditional risk-reporting heat map where the focus is usually on the top right quadrant. As a result, our analysis highlights three key insights that traditional Type I risk models cannot determine:

- 1. The near-term scenarios or risk clusters:** as a group, the experts most anticipate these risks to spread to each other directly and causally due to strong bi-directional connections. These risks then combine and represent the scenarios most expected.
- 2. The longer-term risk pathway we are now heading towards:** the network's causal connectivity predicts a tendency over time to follow a series of events to a final outcome. Graph theory allows us to find this path in the panel's data.
- 3. The highest pay-off mitigation points to change the above longer-term risk pathway:** risk networks possess *leverage points* where we can alter the outcome by intervening at a few key points. Using these points, we can change the longer-term pathway and mitigate risk optimally. Again, graph theory calculations can identify these critical *systemic mitigation points*.

5.5 FINDINGS OF THE RISK HEAT MAP DEPICTION

The traditional heat map depiction of individual risks is by means of a colored, categorical and tabular matrix. KPMG's DRA presents a two-dimensional graph of individual risks, more accurately positioned by likelihood and severity and using the full information obtained from the expert panel.

Each risk's position marks the group average of these risk metrics, applying the scales in Section 7.3. Figure 3 shows the relative positioning of risks compared to the full risk scale range. The graph mainly shows the risks clustered in the top right corner, implying they are all at or above *likely* band of values (between 1-in-10yr to 1-in-3yr event rate) and around the *significant to major* impact bands (equal to 100m – 1bn USD). This is even before possible interconnections and expected clustering is analyzed (Section 7.6).

Figure 3: High resolution version of the traditional two-dimensional risk heat map

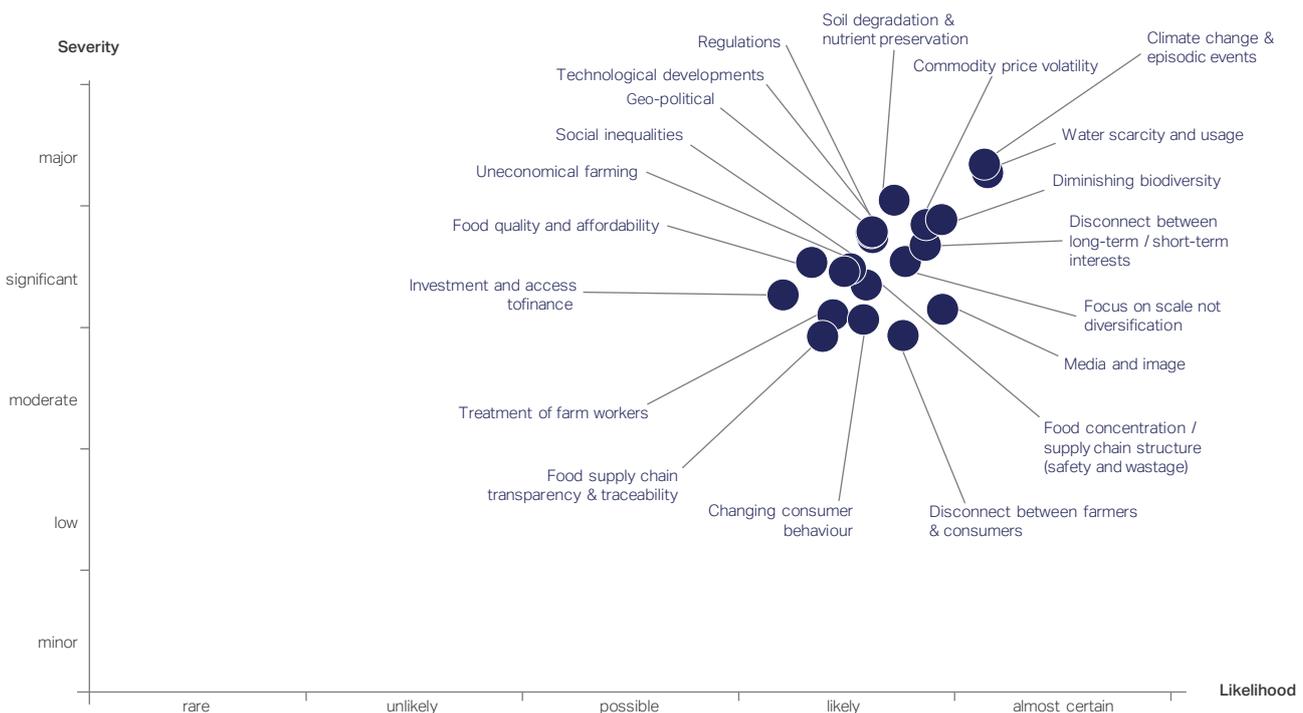


Figure 4 represents the analysis of Figure 3 in close-up. It shows that the most severe individual risk before including interconnectedness is *Climate change & episodic events*. The most likely risk without including connections between risks is *Water scarcity and usage*.

Climate change & episodic events is almost certain to occur (1 event every 2.8 years) with *major* severity (450m USD average severity per event). *Water scarcity and usage* is marginally more certain (1 event every 2.77 years) but similarly major (420m USD average severity per event).

Soil degradation & nutrient preservation is major in severity

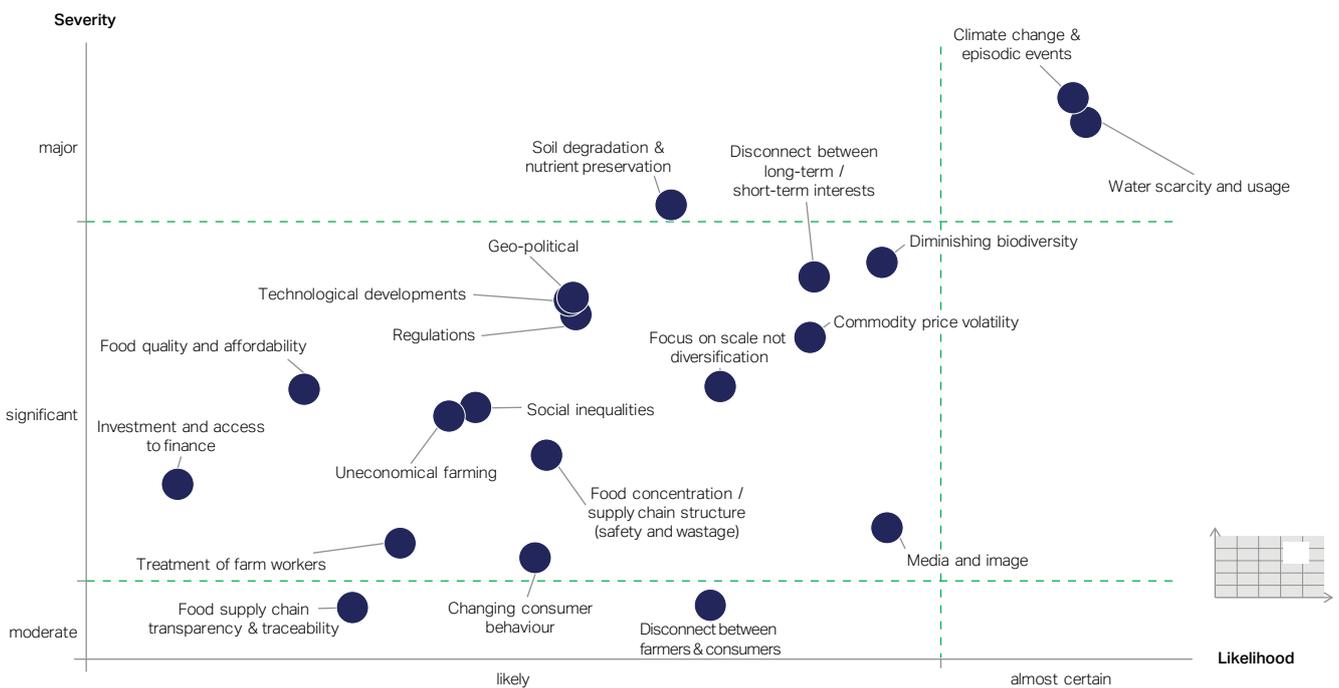
and *likely* in event rate. Except for *Food supply chain transparency & traceability* and *Disconnect between farmers & consumers*, all other risks have been rated by our expert contributors as individually *significant* in severity and *likely* in event rate. Figure 4 also shows the positioning relative to the entire risk scale range. This expanded view paints a concerning picture.

Without further information, Figure 4 finishes what would be a traditional analysis of the food and agriculture sector's risk environment. Only if we extend the analysis to causal interconnectedness and risk velocities is deeper insight possible. We explore this in the following sections.

5.6 FINDINGS OF THE NETWORK RISK MAP VISUALIZATION

Figure 5 shows a graphical representation of the network and displays how the expert panel expects individual risks to interact and affect each other. The network uses inputs from all participants and gives an all-inclusive, sector participant-wide view. The circles represent the risks and the circle diameter depicts severity. These are consistent with the severity and likelihood results presented in Figure 4. Most importantly, the enhanced analysis in Figure 5 captures the expected connections between the risks.

Figure 4: Close up of the risks in the previous the severity-likelihood heat-map



The direction of arrow heads indicate the contagion flow and the strength of that flow is represented by the number of arrow heads. Figure 5 depicts the full data set collected from the participants.

Figure 6 shows the same network as presented in Figure 5 but displays only the highest

consensus connections. Participants individually called out these contagion connections with a consensus weight of 32% or greater.^a We suppress the weaker links between risks in the visual illustration that follows, but not in our data analysis to reveal its key features.

While the network visualization in Figure 6 displays only those connections with votes exceeding the 32% consensus weight level, we do not analyze this network. Instead, we use *every vote by every participant* to analyze the network and generate results.

Figure 5: A view of the full network data for the risks including relative impact and connectivity

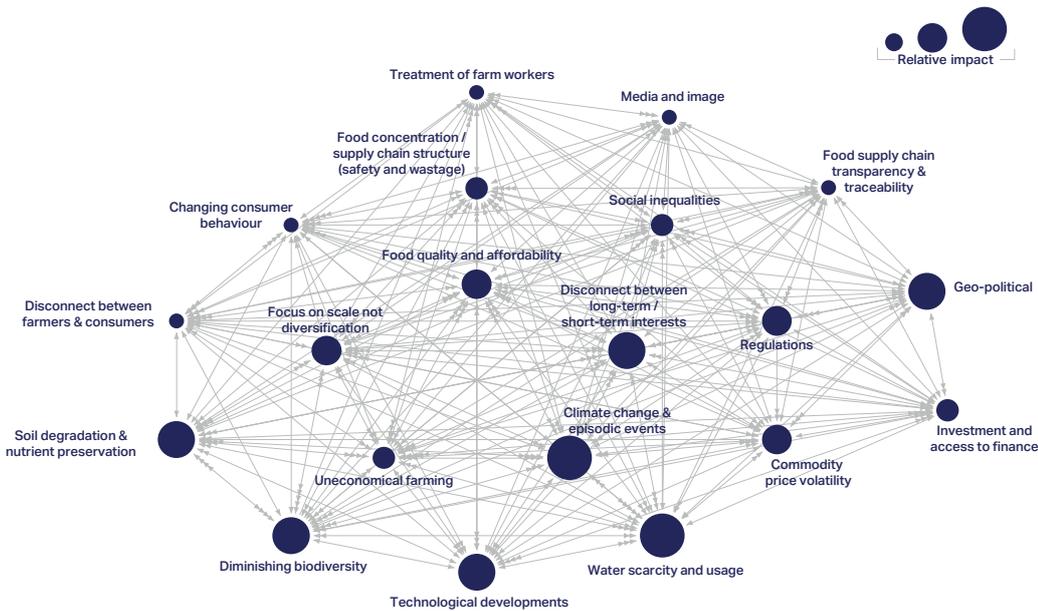
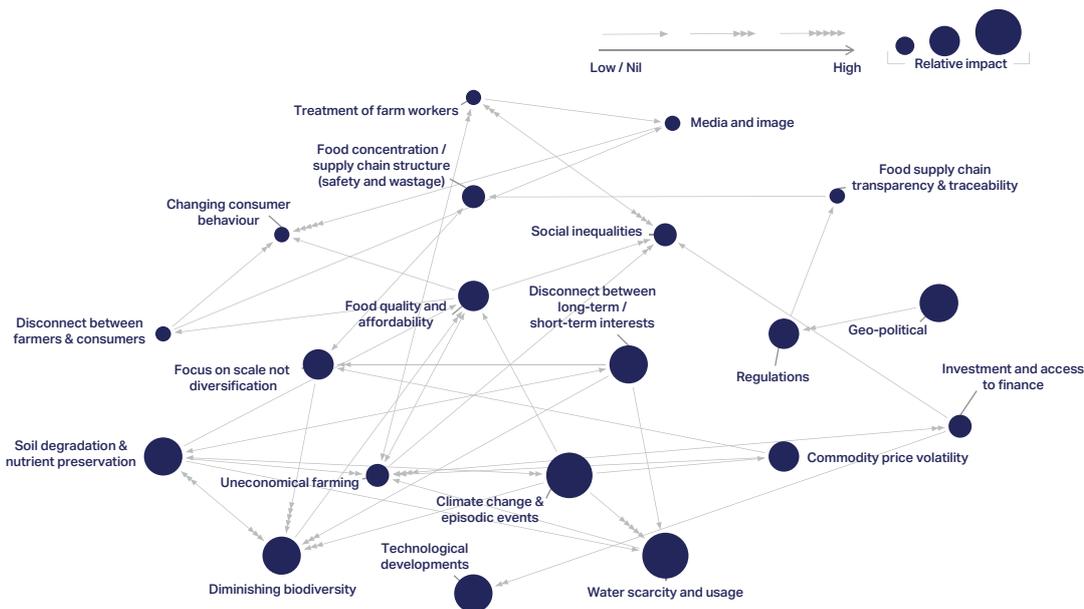


Figure 6: A network view of the risks identified showing only the highest consensus connections



^a At least 32% of the expert panel identified a connection between risks.

It can be seen from Figure 5 that the network is not symmetric; the risks do not have the same severity and are not equally influential on each other. Across the network, the connection strength varies considerably.

Network asymmetry generates measurable longer-term outcomes. If the network were symmetric, the outcomes would be random; every risk would be equally able to trigger others or be equally affected by others. The randomness of a symmetric network makes the final result unknowable in the sense that there is no identifiable *systemic flow*, which generates a future path through network imbalances.

As this is not the case with Figure 5, we can identify the causally-destined path which, on balance, we are heading towards.

5.7 INSIGHTS FROM THE ANALYSIS

In this section, we discuss key insights from the analysis.

5.7.1 Insight 1 - The most expected scenarios

We term the most expected near-term scenarios *risk clusters*. We find risk clusters algorithmically by identifying groups of three or more risks that all link in both directions, and where the experts agree that the link strengths have the strongest connections in the network. These represent combined risk scenarios; groups of risks which the panel most expect to connect to each other directly and in any direction if any one of them triggers. The clusters found represent the scenarios the experts most expect to see.

Between 25-30% of experts from different organizations and positions along the food and agriculture value chain anticipate four risk clusters. The individual risks expected to link up first within the network to form these scenarios are listed in Table 6 and presented in Figure 7.

To identify the most expected scenarios, our algorithms first

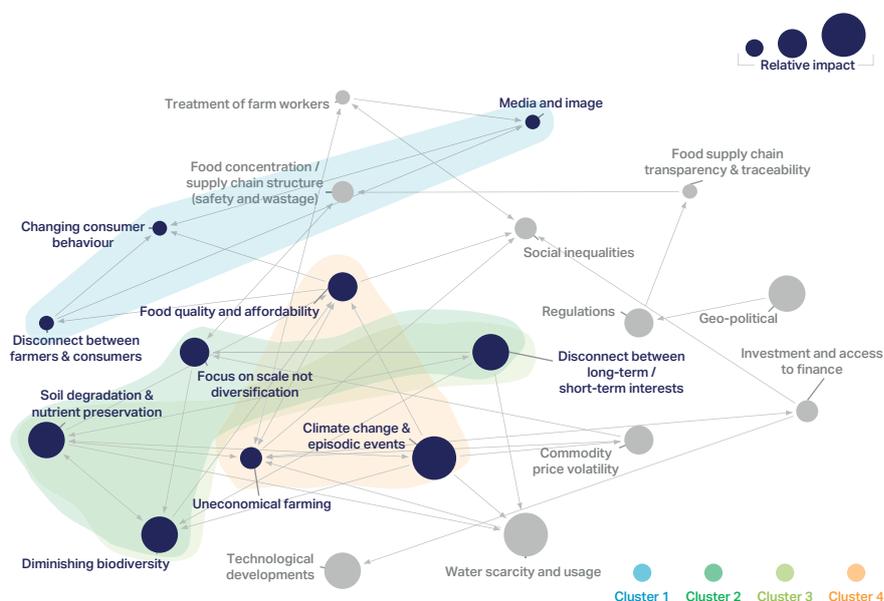
find the expected scenario by the *minimum expert consensus level*. The scenarios are then rank ordered by level of agreement measure, with the primary ones having the greatest agreement among the expert panel.

The four most-expected scenarios each have lower-bound estimated aggregate severities ranging between 320m-1.3b USD per scenario event.

Table 6: Four expected near-term scenarios

No	Scenario cluster
1	<ul style="list-style-type: none"> • Changing consumer behavior • Disconnect between farmers & consumers • Media and image
2	<ul style="list-style-type: none"> • Climate changes & episodic events • Diminishing biodiversity • Disconnect between long-term / short-term interests • Soil degradation & nutrient preservation
3	<ul style="list-style-type: none"> • Diminishing biodiversity • Disconnect between long-term / short-term interests • Soil degradation & nutrient preservation
4	<ul style="list-style-type: none"> • Climate changes & episodic events • Food quality & affordability • Uneconomical farming

Figure 7: A network view of the risks identified in the four expected scenarios



The primary (most expected) scenario, *Cluster 1*, occurs with a minimum level of 30% contagion between every link and comprises the combination of *Changing consumer behavior* linking to *Disconnect between farmers & consumers* and *Media and image*.

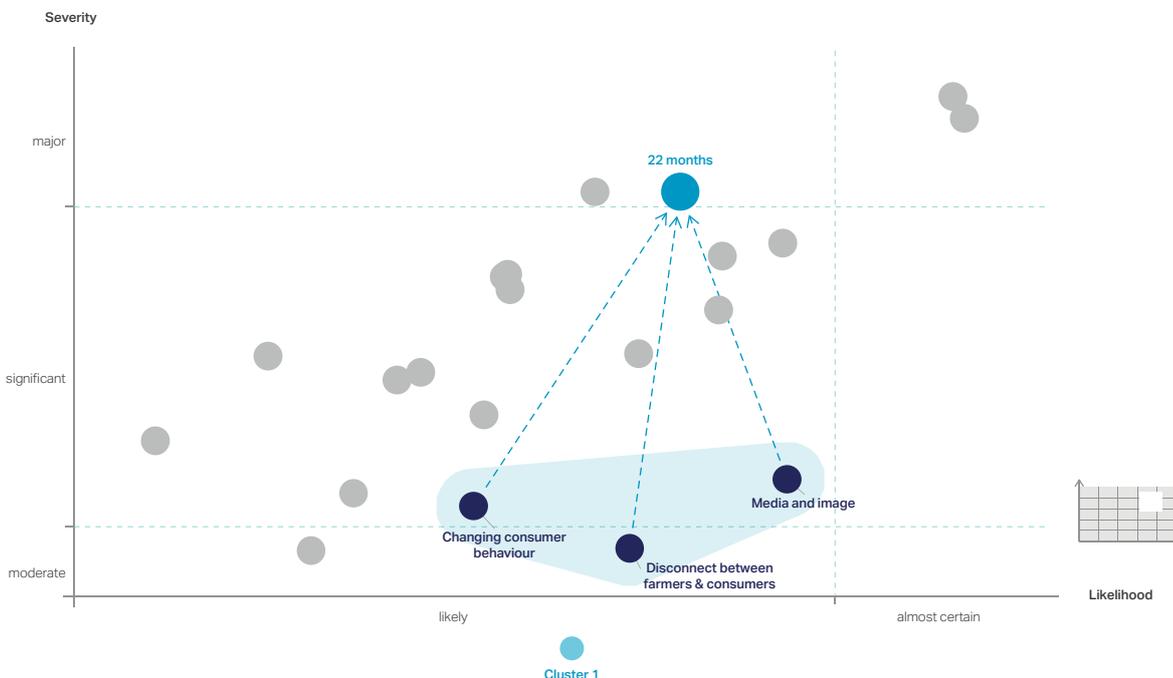
Identification of this *Cluster 1* as a primary scenario is consistent with the finding of the previous WBCSD 2020 Food and Agriculture Report.¹⁵ This report identified the reduced understanding of the reality of farming and the disconnect it causes as key systemic influences on the sector's risk profile. This is because increasingly urbanized consumers shift consumption patterns without appreciating the consequences on the food production system.

According to findings in the 2021 updated network, the role of *Media and image* is equally important.

The composition of risks within *Cluster 1* may be considered rather surprising when examined through the lens of a traditional risk assessment approach. The cluster contains three risks that individually are comparatively unremarkable; they show relatively low severities although they have more prominent expected likelihoods. However, they are a perfect example of where Type I risk modelling fails to identify Type II risks because traditional risk modelling does not include the expected contagion between risks. Time and again, we see catastrophes as the result of a union of individual risk events.

Figure 8 shows the primary scenario and the aggregate severity lower-bound which is rated as *major*. Note that when assessed as a cluster, the aggregated severity of *Cluster 1* ranks equivalent to the third most severe of the individual risks and sixth most likely risk, even though severities of the cluster members are individually much less severe. Without expert elicitation and Type II risk modelling, the potential of these risks to combine and cluster to create a severe threat level would have remained hidden and not given sufficient attention for mitigation.

Figure 8: The aggregated view of the most expected cluster and its time-to-impact once a risk arises



The next three scenarios have substantial overlap because they share risks. This overlap implies that the panel expects the risks to spread within each of the three clusters and *also between them*. This means that we should manage *Clusters 2, 3 and 4* collectively; we can think of them as a *super-cluster*. Figure 9 shows the shared risks between *Clusters 2, 3 and 4*.

In *Cluster 2*, there are four risks – *Climate change & episodic events, Diminishing biodiversity, Disconnect between long-term / short-term interests* and *Soil degradation & nutrient preservation*. As highlighted in Figure 10, these risks combine to produce the most severe aggregate risk to the industry (beyond the upper bound of *major*) and close to almost

certain likelihood. *Cluster 2* also has an expected velocity of only 44 months. To prevent this scenario from occurring, we must break the expected causal pathways between the risks. We cannot allow one risk to spread to another and it follows that we must address and mitigate each risk within the cluster with purpose and urgency.

Figure 9: The next three most expected clusters and their times-to-impact once a risk arises

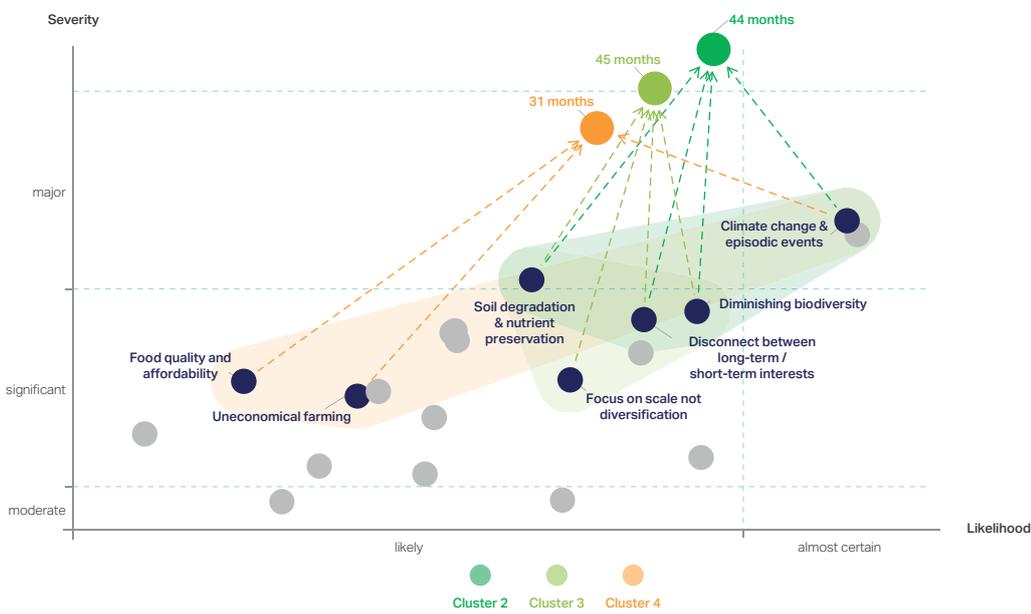
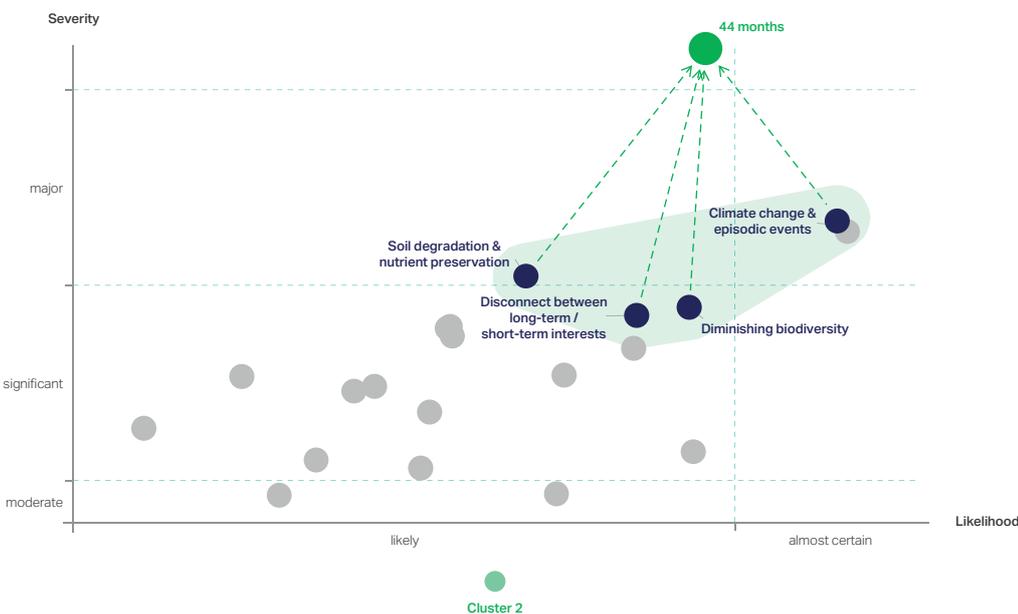


Figure 10: The aggregated view of Cluster 2 and its time-to-impact once a risk arises



Cluster 3 contains *Diminishing biodiversity*, *Disconnect between long-term / short-term interests*, *Focus on scale not diversification* and *Soil degradation & nutrient preservation*. Three of these, *Diminishing biodiversity*, *Disconnect between long-term / short-term interests* and *Soil degradation & nutrient preservation*

are common to Cluster 2, indirectly connecting *Climate change & episodic events* in Cluster 2 with *Focus on scale, not diversification* in this cluster. The aggregate severity of Cluster 3 (depicted in Figure 11) is similar to Cluster 2 (Cluster 3 at USD \$1020m and Cluster 2 at USD \$1290m) and its aggregate velocity is 45 months.

Cluster 4 consists of three risks: *Climate change & episodic events*, *Food quality & affordability* and *Uneconomical farming*. It shares *Climate change & episodic events* with Cluster 2. The aggregate severity of Cluster 4 (USD \$800m) approaches those of Clusters 2 and 3, but its velocity is faster at 31 months.

Figure 11: The aggregated view of Cluster 3 and its time-to-impact once a risk arises

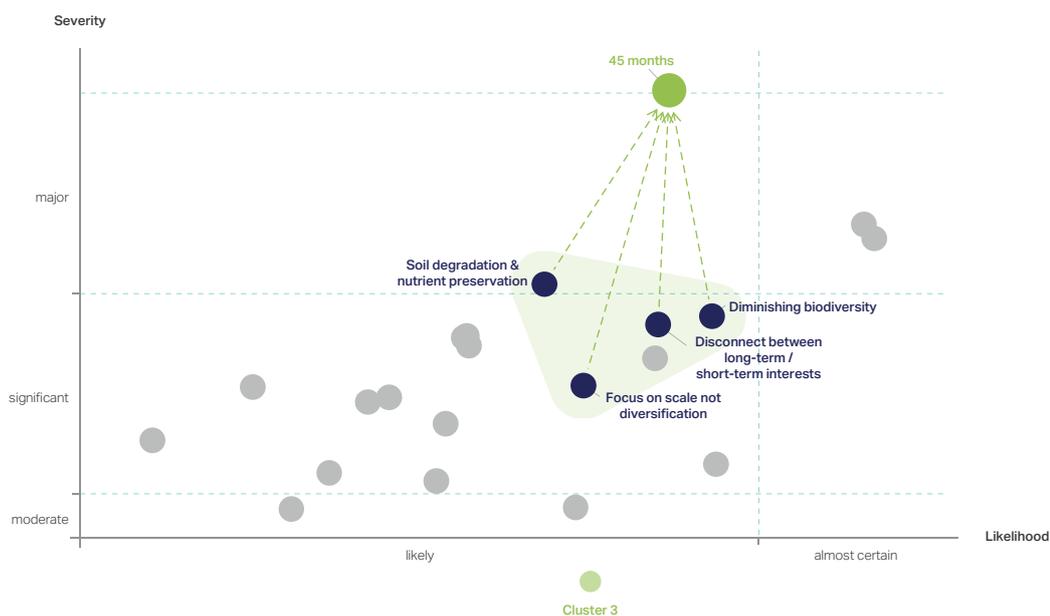
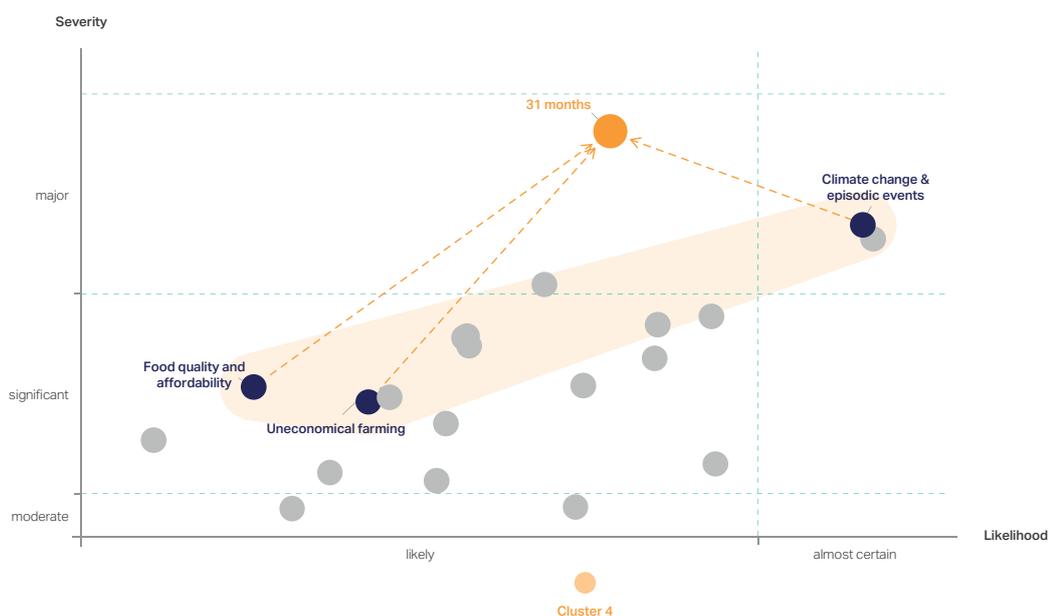


Figure 12: The aggregated view of Cluster 4 and its time-to-impact once a risk arises



In Figure 13, we examine the profile of the four clusters on the heatmap. It is noteworthy that the risk profile appears markedly different to the traditional depiction of only the individual risks' discrete threat levels, as re-presented in Figure 14.

Figure 13: The aggregate view of the most expected scenarios and their times-to-impact once a risk arises

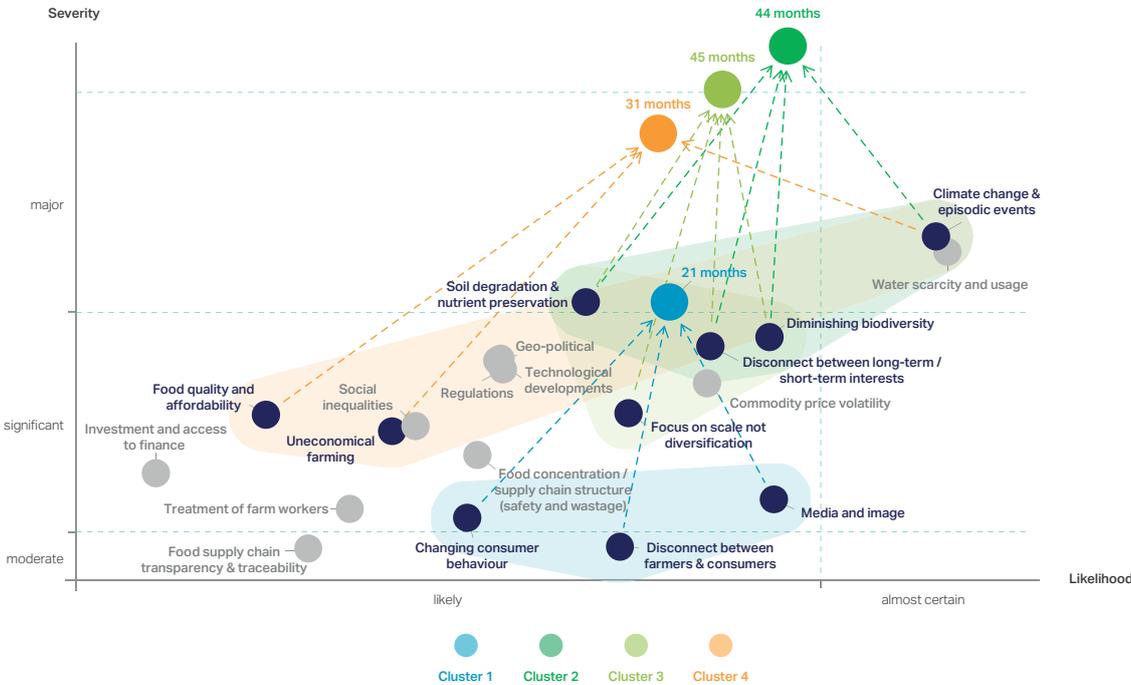
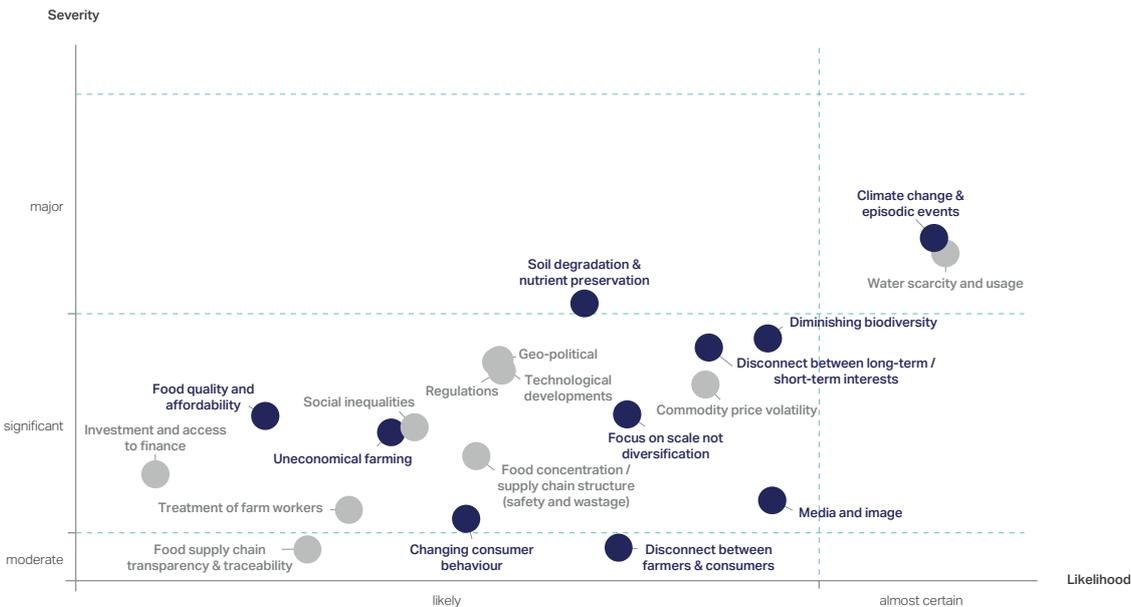


Figure 14: The traditional view of risks - assessed discretely



5.7.2 Insight 2 - The longer-term risk pathway we are now heading towards

In Section 5.6, we commented that the network in Figure 5 is not symmetric; the risks have varying severity and influence on each other. Additionally, the strength of the connections between the risks varies. This asymmetry, like loaded dice, biases the system to produce a longer-term outcome, which we can calculate. Using graph theory algorithms on the network data,

we can describe the pathway the experts predict we are now heading towards. We chart this pathway in Figure 15.

If any risk in the network triggers and we do not intervene, contagion can flow freely. Under this assumption, network asymmetry will unavoidably increase the ways to trigger red-arrowed risks. The network structure is strongly biased to cause these risks. This makes them much harder to mitigate; they

are the most vulnerable in terms of receiving contagion from every other risk. Of these, *Uneconomical farming* is the most connected – both directly and indirectly – to every other risk in the network.

If any risk in the network is triggered, it increases the likelihood of the red-arrowed risks also being triggered. These end-state risks are always at risk, even when it is not immediately apparent.

Figure 15: Risks boosted by network asymmetry

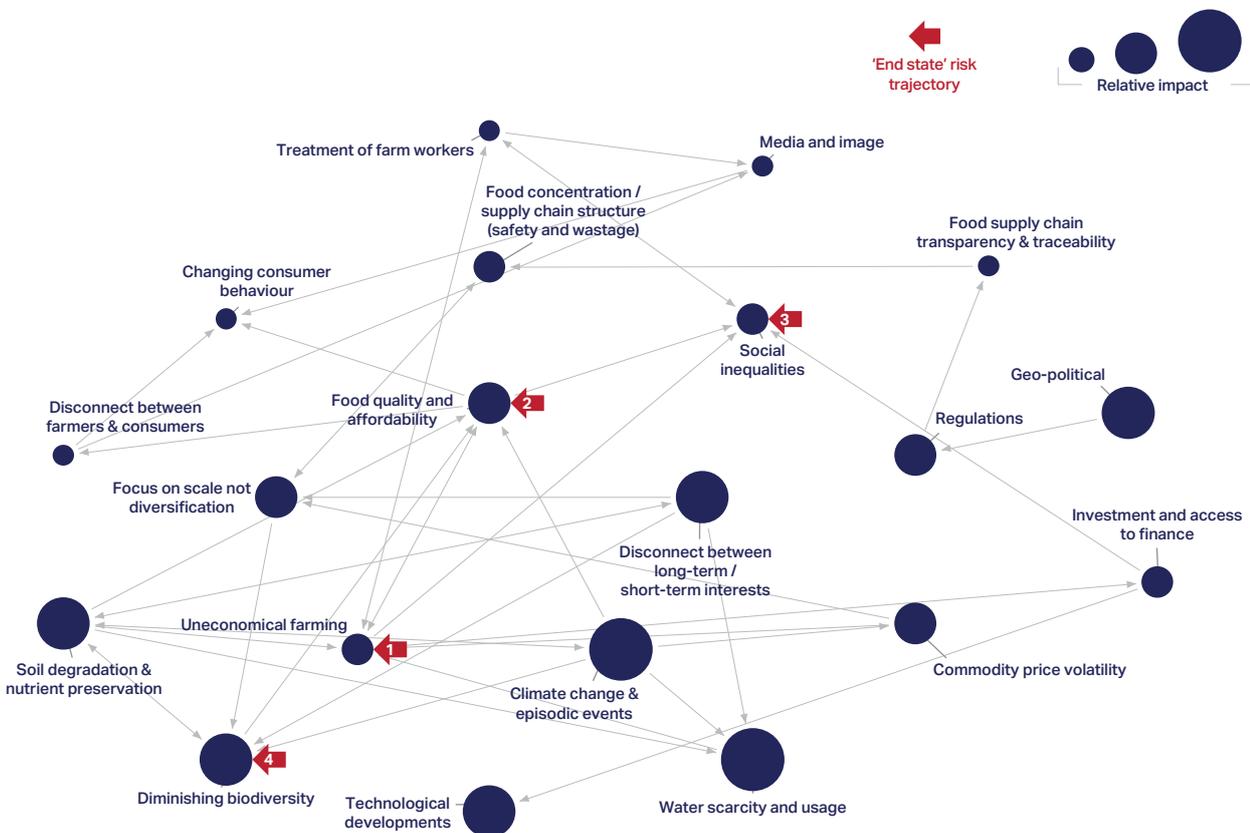


Figure 16: Rank order of the network's most affected risks

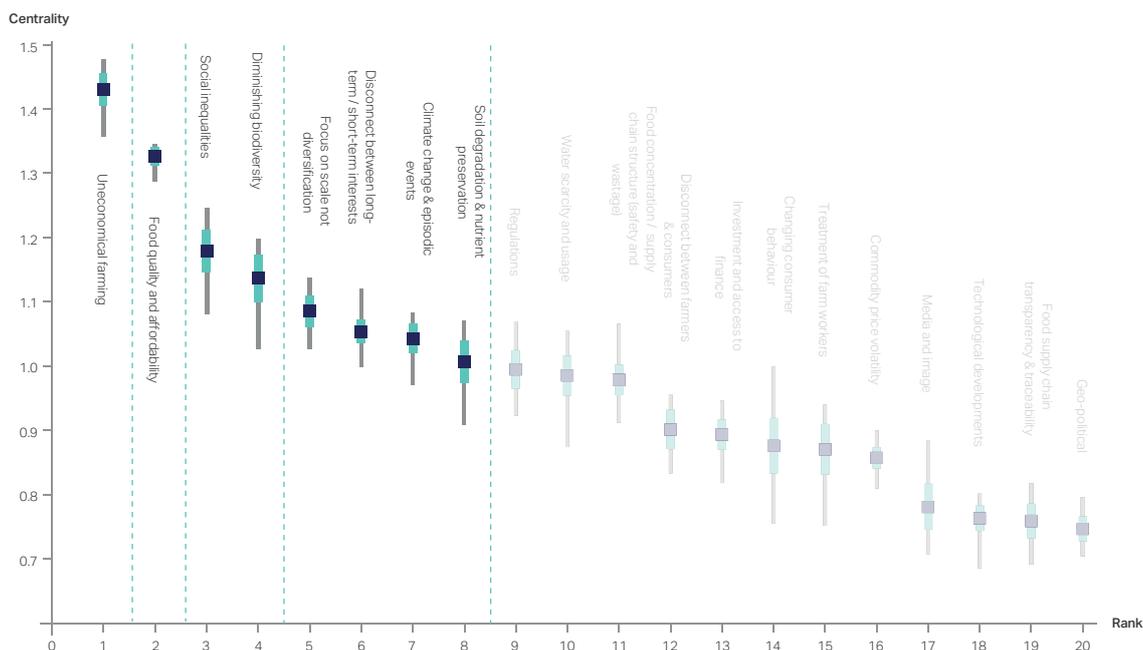


Figure 16 shows the rank order of exposure of the red-arrowed end-state risks to the network.

We note in Figure 16 that:

- *Diminishing biodiversity* ranks fourth in vulnerability in the network. Its inbound connections are the fourth most integrated into the network structure.
- *Social inequalities* rank third; the strength and number of inbound connections make it even more integrated. The vertical centrality scale measures how much more intertwined these risks are into the network, compared to each other. Note that there is a 'step up' and an increase in the curvature of this graph. These are the signs of a *phase transition* in vulnerability. As we compare the fifth ranked risk, *Focus on scale not diversification*

(which is partially faded), to the fourth ranked risk, the network vulnerability has jumped.

- The transition from third to second rank shows a large step up in vulnerability to the network of *Food quality and affordability* relative to *Social inequalities*. The inbound paths to this risk and the strengths of those indirect paths are an order of magnitude more interlinked than those of *Social inequalities*.
- An even bigger step up occurs to *Uneconomical farming*. These inbound paths are like a plant's root system and this risk has the most integrated root system of any risk. The analysis highlights that *Uneconomical farming* feeds off every other risk, even indirectly. It is this risk that is the most difficult to mitigate by acting on it alone - it is simply too integrated into the whole.

Collectively, the end-state risks describe the longer-term causal pathway of the network. If we allow the network to function freely, it will put in motion (in order of increasing systemic importance) the indirect triggering of *Diminishing biodiversity*, *Social inequality*, *Food quality and affordability* and *Uneconomical farming*. This inbound contagion sequence provides the basis for the primary "loaded bias" or asymmetry of the network.

The positioning of the four risks on the vertical scale in Figure 16 shows that the pathway to these inbound risks is not linear. Phase transitions imply a downward spiral with increasing momentum, each stage harder to remedy than the last. The more individual risks in the network occur, the further the system cascades the rapid path of *Diminishing biodiversity*, *Social inequality*, *Food quality and affordability* and, ultimately, *Uneconomical farming*.

Another way to interpret the results is by using the idea of cumulative exposure. The occurrence of the fifth ranked risk, *Focus on scale not diversification*, makes the risk of *Diminishing biodiversity* more probable. This makes intuitive sense as scale favors the selection of fewer alternatives. As more providers of alternatives are disenfranchised (thereby *diminishing biodiversity*), the greater the chances of *Social inequality*, leading to *Food quality and affordability*. Ultimately, the result is that *Uneconomical Farming* will become a reality for many.

In the end, it is the systemic, inbound and interconnected nature of the risks that is of concern. Subsidies, food stamps, housing and other forms of direct aid can be used to offer immediate relief to *Social inequality* and *Food quality and affordability*. However, the financial payoff will be negligible

as these actions do not remedy the network effect. These risks will continue to occur, driven by risks far upstream in the contagion pathway. Complex issues like this are at risk of populism and geo-political risk – conditions that slow the required system-wide response at a time when cooperation and alignment are vital.

Avoiding this outcome requires a 'whole-of-system' response. Fortunately, the asymmetry of the network also creates several *leverage points* – influential points where intervening can create positive cascading effects. As before, graph theory algorithms allow us to find these key points which we show next in Section 5.7.3.

5.7.3 Insight 3 - The highest payoff mitigation points to change the longer-term risk pathway

Asymmetry in the network means that risks do not exert an equal influence on the outcome of the network. Some risks have more 'impact' due to: their position in the network; their number of first, second, third and higher-order outbound connections; connections to other 'impact' risks; and the strengths of these connections. In effect, 'impact' risks have characteristics like 'influencers' on social media.

The most efficient approach to changing the longer-term risk pathway in Section 5.7.2 is to focus on the influencers. These risks will optimally push the network because their outbound 'root system' of network connections reach further, are stronger and influence more broadly than other risks. As before, we find the most influential risks using graph algorithms.

Figure 17: Most influential network intervention points

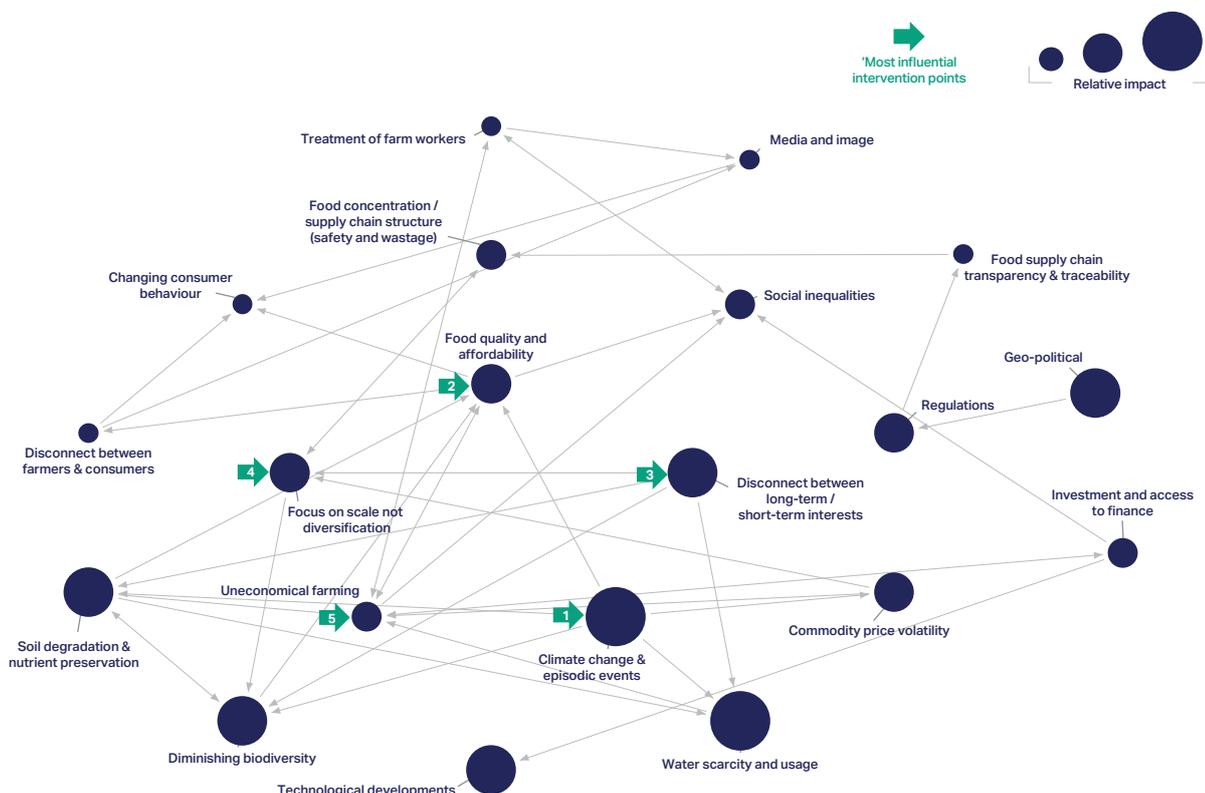


Figure 18: Rank order of network-wide influence of individual risks

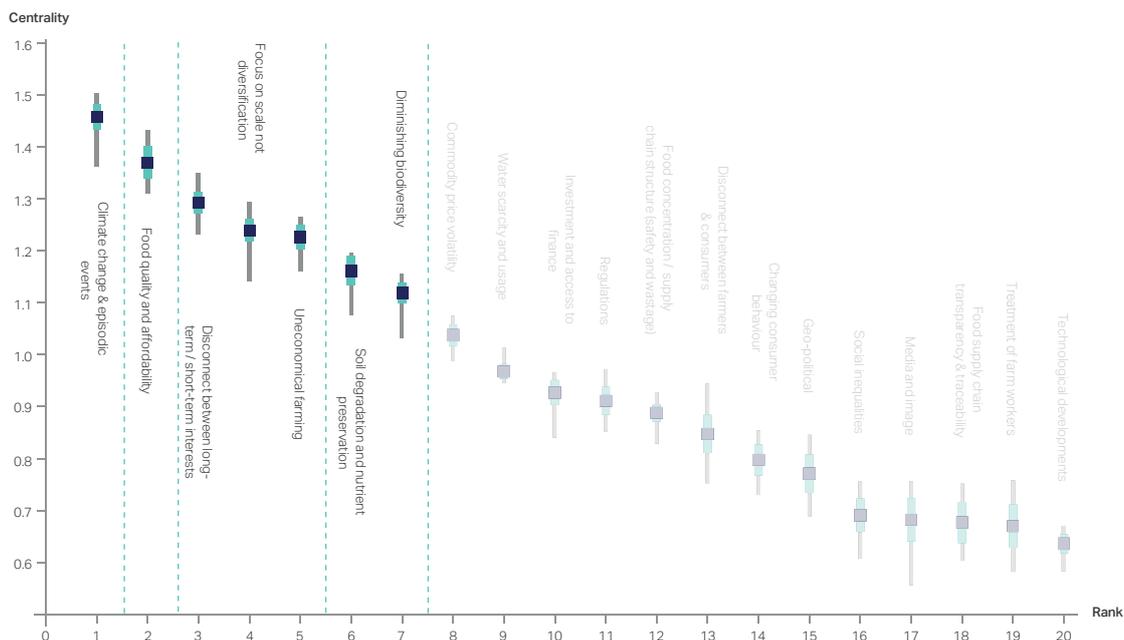


Figure 17 and Figure 18 show the results of those calculations. The risks marked with green arrows above individually and collectively force the out-workings of the network.

Figure 18 shows how much each risk influences the network:

- *Climate change & episodic events* is the risk that most determines the overall outcome of the network. The vertical axis measures its comparative influence over every other risk in the network.
- Second in network-wide influence is *Food quality and affordability* – food prices not reflecting nutritional value or the true social, environmental and health impacts of production. This creates price distortions which allow the third most influential risk to occur -

Disconnect between long-term / short-term interests.

- Price does not give the industry and consumers an incentive to act for longer-term interest and drives the *Focus on scale, not diversification*. Scale leads to other forms of agronomy becoming *Uneconomical farming*, which results in *Soil degradation & nutrient preservation*. This results in an increase in the risk of *Diminishing biodiversity*.

Note that these influential risks affect more than just immediately adjacent risks in Figure 18; every *downstream* risk is affected. The smaller the influence rank, the further the risk appears to the left in Figure 18 and the greater it influences other network risks. It follows that these risks have a greater sway on changing the outcomes in Section 5.7.2.

Even so, a more desirable outcome may not follow if we mitigate the seven risks highlighted in Figures 17 and 18. Some risks are more vulnerable to the network than they influence it. In other words, risks' overall influencing power must also consider how vulnerable they are in Figures 15 and 16.

Our objective is to find those risks that are '*net influence positive*' in that they affect the network more than the network affects them. Where this net influence is poor, we should spend mitigation resources on addressing more systemically net influence positive risks. The points at which we can do so, we term *net accretive intervention points* – i.e. the points of intervention where mitigating actions will lead to positive overall network outcomes.

5.7.4 Insight 4 - The most net accretive intervention points

We find the net accretive intervention points starting with the list of influential risks in Section 5.7.3 and removing those risks that have a higher vulnerability rank.

Table 7: Identifying the net accretive leverage points

Rank Order	Most Influential Risks	Rank order	Most Affected (Entangled) Risks
1	Climate change & episodic events	1	Uneconomical farming
2	Food quality and affordability	2	Food quality and affordability
3	Disconnect between long-term / short-term interests	3	Social inequalities
4	Focus on scale not diversification	4	Diminishing biodiversity
5	Uneconomical farming	5	Focus on scale not diversification
6	Soil degradation & nutrient preservation	6	Disconnect between long-term / short-term interests
7	Diminishing biodiversity	7	Climate change & episodic events
8	Commodity price volatility	8	Soil degradation & nutrient preservation
9	Water scarcity and usage	9	Regulations
10	Investment and access to finance	10	Water scarcity and usage
11	Regulations	11	Food concentration / supply chain structure (safety and wastage)
12	Food concentration / supply chain structure (safety and wastage)	12	Disconnect between farmers & consumers
13	Disconnect between farmers & consumers	13	Investment and access to finance
14	Changing consumer behavior	14	Changing consumer behavior
15	Geo-political	15	Treatment of farm workers
16	Social inequalities	16	Commodity price volatility
17	Media and image	17	Media and image
18	Food supply chain transparency & traceability	18	Technological developments
19	Treatment of farm workers	19	Food supply chain transparency & traceability
20	Technological developments	20	Geo-political

Table 7 repeats the influence rank in the left column and the vulnerability rank on the right. For example, *Climate change & episodic events* is most influential, ranking first on the left. It is less vulnerable to other risks as its ranks lower – seventh – on the right. This makes its system influence net accretive. Other risks that are net accretive points are:

- *Disconnect between long-term / short-term interests*
- *Focus on scale not diversification*
- *Soil degradation & nutrient preservation*
- *Commodity price volatility*
- *Water scarcity and usage*
- *Investment and access to finance*
- *Geo-political and,*
- *Food supply chain transparency and traceability.*

These risks in this order offer the highest payoff opportunities to avoid the pathway in Section 5.7.2. They are a key finding of this report.

5.7.5 Insight 5 – Implications

1. We cannot overstate the siren call on *Climate change & episodic events*. Our expert panel found it to be the most influential factor in determining the quality of the food and agriculture future we can expect to pass on to future generations. *Climate change & episodic events* must continue to be escalated in importance as the key principle guiding every decision by organizations across the global food system as well as every other industry, public entity and private household. Relevant knowledge and information are critical to enable this to happen so that consumers, regulators and businesses

can make informed decisions and change their behaviors. Consistent, mandatory labelling of environmental impact to appropriately inform choices is one of the most impactful actions the industry could take.

2. While embedding climate as a guiding principle in every decision, specific consideration should be given to the *Disconnect between long-term / short-term interests*. For example, in addition to buying carbon offsets, a worthy but short-term solution, we should consider longer-term solutions like sequestering carbon back into the soil or investing in technologies that remove carbon from the air.
3. This raises the need for audits of the decision-making architecture to detect and address instances of rewarding short-term returns at the expense of longer-term benefits within the industry and beyond. Examples extend to political election cycles that favor short-term 'vote-buying' promises over inconvenience in the short term to serve longer-term interests, and corporate reporting cycles where quantification of results does not include the costs of climate change. These out-workings translate into downstream food and agriculture policy and finance choices. If election platforms and business cases do not align to longer-term interests, the management and attitude of institutions and organizations who set policy, invest in and provide finance for the food and agriculture industry will be similarly short-term minded.
4. *Announcing long-term goals without clear transition pathways is unhelpful* – these might be interpreted as buying moral ground while

permitting an acting status quo. Stewardship, accountability and due diligence require measurable component goals that support announced aspirations. Only then will we reach a threshold of credible governance.

5. In addition to lifting long-term thinking and action, the analysis also suggests there is a need to address the decision architecture that favors scale over the longer-term benefits of diversification. Behavioral economics can be helpful here; actions could take the form of subsidies, tax incentives and penalties, awareness campaigns, consumer drives and other behavioral and policy 'nudges' to create incentives to maintain or, in many cases, restore biological and food system diversity.
6. We must mitigate *Soil degradation and preserve nutrients*, beginning with sharing clear reasonable, science-based information. This will need to be followed with incentive structures that reward the improvement of soil quality, carbon sequestration and nutrient preservation. We can reward farmers who put carbon back into the soil and those adopting sustainable practices. Disincentives for poor behaviors and practices could include market access restrictions, levies for soil degradation and, ultimately, removal of a farmer's license to operate.
7. A new emerging reporting trend is *Planetary Zero Disclosure*. In addition to carbon zero reporting, this highlights how much an organization or farmer is contributing to, or costing, nature. We recommend this as a framework that can be used to report on *Soil degradation & nutrient preservation*.

8. During interviews, experts frequently described *Commodity price volatility* (and *Climate change & episodic events*) as a “one season destroyer” of small farmers. Interviewees frequently voiced the need for upper and lower bounds on commodity prices to provide certainty for planning and confidence for investment. They were not concerned by the method. For example, public or private institutions could underwrite this risk or financial products could be created linking with implication 2 above.
9. We must reduce the risk of *Water scarcity and usage*. Appropriate pricing for clean water and penalties and prosecution for negligent pollution is a good start and there should also be disincentives for wastage. Information on water footprints will be helpful. Information campaigns on how and when to irrigate, advice on using less water, investment in water management innovation, incentive schemes to reward efficient users among cohorts, advice on crops and cultivars, and water consumption product labelling should all form part of the response.
10. This risk is not only critical to the food and agriculture sector. The COVID-19 pandemic is putting pressure on national budgets and adversely impacting economies. While the consequences of climate change (floods, droughts, fires) wreak unprecedented damage, we are also losing jobs. At the same time, many countries across the world share water basins and water sources. In addition to the already challenging conditions, increased water scarcity risks escalating tensions and threatens trade and peace, further impacting food systems.
11. The global financial crisis demonstrated beyond question that the objective of financial institutions cannot solely be profit optimization. Many opportunities exist to increase *Investment and access to finance* for food and agriculture. This risk links up with longer-term objectives and commodity price volatility – areas where we sorely need financial innovation.
12. Three risks, *Food quality and affordability*, *Changing consumer behavior* and *Media and image* balance influence and vulnerability. These risks do not change the path of the network and reinforce whatever momentum it has. They are force multipliers, supporting whatever direction the network is taking. It is important to recognize that these factors must be carefully observed and managed to ensure the force of their impact supports improvements in our food systems globally, rather than detracting from progress or slowing or halting the momentum needed.

5.8 IN SUMMARY

Food and agriculture is recognized as a critical infrastructure sector, central to the survival, quality and wellbeing of our planet and global society.

For it to flourish in a safe and sustainable way, every economic sector, governmental and regulatory institution, and all consumers at large must build into every decision, investment and purchase the consequences of *Climate change*. They must ask whether it is in the longer-term interest to go ahead with a purchase or action if it supports scale or threatens more marginal products and practices. There are opportunities for better disclosures of *Soil degradation & nutrient preservation*, and for financial and other innovations to install collars around commodity prices. Water management, investment opportunities and access to finance all offer opportunities for improvement.



⑥ Key themes and possible actions



6 Key themes and possible actions

Founded on the analysis of KPMG’s DRA, we present key themes and possible actions below. Whilst the profile of the participant companies may not fully represent the entire sector, the themes and actions highlight WBCSD’s perspectives of potential areas of focus for all companies operating in the sector along with sector-level actions.

The themes and possible actions fall under three main thematic areas that reflect the potential type of response:

- **Evolution of the risk landscape and risk priorities** – how the sector view of key system risks has evolved over the past two years.
- **The focus of company risk management activities** – steps a company may take to positively address system risk and mitigate risk contagion and aggregated impacts.
- **Sector or pre-competitive collaboration** – driving change via collective initiatives, cross-industry alignment and coordinated sector approaches.

EVOLUTION OF THE RISK LANDSCAPE AND KEY PRIORITIES

In comparison to the findings of the DRA reported in 2020, we noted modified perspectives in participants’ assessment of critical system risks and the construct of the risk network. In particular, the updated analysis highlights:

- Increased concern about the levels and likelihood of the impact of climate change and climate-related events;
- A lowering in the prioritization of regulation as a key risk factor, likely in part to recognition of urgent need to act rather than waiting for regulatory leadership and policy to drive change;
- Increased recognition that *Uneconomical farming* is an inevitable, longer-term outcome if there is limited response and the network dynamics are unmitigated; and

- Identification of the primary cluster as comprising *Changing consumer behavior* linked to *Disconnect between farmers & consumers* and *Media and image* – reinforcing the findings of the 2020 report of the importance of consumers understanding agricultural practices and the need for organizations to inform and educate consumers. Social media is likely to be an amplifier, accelerator and multiplier of impacts, whether positive or negative.

THE FOCUS OF COMPANY RISK MANAGEMENT ACTIVITIES

- Companies should focus on clusters of risks and manage these as connected groups rather than as individual risks. In particular, companies should consider strategic approaches to managing and mitigating each of the risks comprising the following clusters:

1	<ul style="list-style-type: none"> • Changing consumer behavior • Disconnect between farmers & consumers • Media & image
2	<ul style="list-style-type: none"> • Climate change & episodic events • Diminishing biodiversity • Disconnect between long-term / short-term interests • Soil degradation & nutrient preservation
3	<ul style="list-style-type: none"> • Diminishing biodiversity • Disconnect between long-term / short-term interests • Focus on scale not diversification • Soil degradation & nutrient preservation
4	<ul style="list-style-type: none"> • Climate change & episodic events • Food quality & affordability • Uneconomical farming

- Focus company risk mitigation activities on the *net accretive intervention points* – i.e., those risks that influence the network more than the network influences them. Specifically, the analysis highlights that, in addition to *Climate change & episodic events*, there are positive network impacts and opportunities that can be gained through the company focusing mitigation on the following risks:
 - *Disconnect between long-term / short-term interests*
 - *Focus on scale not diversification*
 - *Soil degradation & nutrient preservation*
 - *Commodity price volatility*
 - *Water scarcity and usage*
 - *Investment and access to finance*
 - *Geo-political*
 - *Food supply chain transparency and traceability.*
- Companies should identify and clearly represent their corporate purpose and focus on value creation and value management. For example, building and implementing strategic approaches and capabilities to:
 - Measure the impacts generated by their conduct of business; developing their understanding of dependencies on natural, social and human capital; and using this information to better assess risks to and opportunities for business models;
- Provide transparency on costs and benefits necessary to assess the true value of food;
- Support of system initiatives to measure and value impacts and dependencies to deliver true value accounting and business models; and
- Balance and assess short-term and long-term consequences of business decisions.
- Be clear on the approach to addressing *Uneconomical Farming, Social inequalities and Diminishing biodiversity* risks. The analysis highlights that these risks are more affected by the network than they influence the network – they are net dilutive. This means that mitigation of more influential, connected risks will drive more relatively positive outcomes and be relatively more effective than directly mitigating net dilutive risks. For example:
 - Driving initiatives to positively influence *Food quality & affordability* and *Disconnect between long-term / short-term interests* will have a positive influence on *Uneconomical farming, Social inequalities and Diminishing Biodiversity*.
- Improve stakeholder engagement (e.g., with farmers and consumers) to develop stronger understanding of food and agricultural business practices and consumer preferences.

SECTOR OR PRE-COMPETITIVE COLLABORATION

- Increase sector-wide focus and action to incentivize and strengthen the focus on long-term performance such as climate consequences, diversification of products, scale of production, and measuring and capturing the true value of food in pricing.
- Critically focus on implementing mitigating approaches to reduce the manifestation of risks related to *Uneconomical farming, Food quality and affordability, Social inequalities and Diminishing biodiversity*.
- Consider cross-industry alignment opportunities and sector-level initiatives that can be leveraged to manage or mitigate individual or clustered risks – e.g., land use, deforestation, regulatory engagement, and more sustainable, effective production techniques, etc.
- Consider the system-wide impacts of potential solutions to recognize and assess downside effects on other parts of the system.

7 Conclusion



7 Conclusion

This report reinforces the diversity and interconnectedness of risks faced by the food and agriculture system, its participants and consumers of its outputs.

The analysis clearly highlights that:

- Climate change mitigation must remain a top priority for all participants in the food and agriculture sector. Climate change-related factors and events are the most influential drivers of all risks and will significantly impact the long-term performance and sustainability of the system.
- Farming systems and farmers have a critical impact on the performance of the overall food system. As a result of other system practices – e.g., focus on short-term interests and production at scale rather than long-term goals and diversification in production – farming is under significantly increasing financial strain and is becoming, ultimately, uneconomic.
- When the financials are not sustainable, the ability is lost to invest in the steps that are needed to address the impact food production has on climate, biodiversity and water, to pay people a living wage, or to adopt new digital technology innovation. This could create catastrophic outcomes for our food system in a remarkably short period of time.

We need to push harder to innovate and, more importantly, to incentivize, accelerate and ensure global adoption of innovations that will help balance environmental, social and economic outcomes and meet the expectations and needs of society.

The analysis tells us that doing nothing is not an option. It also shows that, if we do focus on the big challenges that the system faces, we can build solutions that reflect the interconnectedness of risks and create a food system that is economically sustainable and meets essential environmental and social goals.



Useful resources

1. Applying enterprise risk management to environmental, social and governance-related risks, WBCSD, 2018 - <https://www.wbcsd.org/erm>
2. True Value of Food: A powerful aid to business decision-making, WBCSD, 2021 - <https://www.wbcsd.org/zqmg4>
3. CEO Guide to Food System Transformation, WBCSD, 2019 - <https://www.wbcsd.org/ceogfan>
4. Food and Agriculture Roadmap - <https://www.wbcsd.org/Programs/Food-and-Nature/Food-Land-Use/Food-Agriculture-Roadmap>
5. Staple crop diversification: Why and how to diversify from the big five crops (wheat, rice, maize, potato & soy), WBCSD, 2021 - <https://www.wbcsd.org/hxgz5>
6. Food Labeling: Principles to support the uptake of healthy and sustainable diets, WBCSD, 2021 - <https://www.wbcsd.org/q4zau>



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- ¹¹ WBCSD (2021), The impact of COVID-19 on food supply chains: challenges and opportunities for the private sector, available at <https://www.wbcd.org/WBCSD-COVID-19-Response-Program/Vital-Supply-Chains/News/The-impact-of-COVID-19-on-food-supply-chains-challenges-and-opportunities-for-the-private-sector>
- ¹² WBCSD, (2018), Action Brief 2.1: Evolving rural livelihoods and the role of agribusiness, available at <https://www.wbcd.org/Programs/Food-and-Nature/Food-Land-Use/Global-Agribusiness-Action-on-Equitable-Livelihoods/Resources/Action-Brief-2.1-Evolving-rural-livelihoods-and-the-role-of-agribusiness>
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WBCSD is the premier global, CEO-led community of over 200 of the world's leading sustainable businesses working collectively to accelerate the system transformations needed for a net zero, nature positive, and more equitable future.

We do this by engaging executives and sustainability leaders from business and elsewhere to share practical insights on the obstacles and opportunities we currently face in tackling the integrated climate, nature and inequality sustainability challenge; by co-developing "how-to" CEO-guides from these insights; by providing science-based target guidance including standards and protocols; and by developing tools and platforms to help leading businesses in sustainability drive integrated actions to tackle climate, nature and inequality challenges across sectors and geographical regions.

Our member companies come from all business sectors and all major economies, representing a combined revenue of more than USD \$8.5 trillion and 19 million employees. Our global network of almost 70 national business councils gives our members unparalleled reach across the globe. Since 1995, WBCSD has been uniquely positioned to work with member companies along and across value chains to deliver impactful business solutions to the most challenging sustainability issues.

Together, we are the leading voice of business for sustainability, united by our vision of a world in which 9+ billion people are living well, within planetary boundaries, by mid-century.

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