

BUSINESS ADAPTATION TO CLIMATE CHANGE AND GLOBAL SUPPLY CHAINS

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Executive Summary

Climate change will likely lead to serious, systemic, and global consequences, posing risks to economic activity and development aspirations across the globe. The biodiversity and ecosystems services that sustain population centers and allow for economic development are at risk. This includes the provisioning services that supply food, water, minerals, medicines, construction materials, energy, and fibers; the regulating services that control climate, irrigation, disease vectors, and waste; the cultural services that interact with human spirituality and provide recreational, artistic, and aesthetic benefits; and the supporting services that aid with nutrient cycles and crop pollination.

The risks to communities and companies may at first appear to exist in parallel worlds; but, look more closely and it becomes clear that the fate of multinational companies and frontline communities are intertwined. For example, the International Labour Office (ILO) calculates that approximately 190 million women work in global supply chain-related jobs in the 40 countries for which estimates were available. In sectors such as consumer products and food the proportion of women in the labor force can be as high as 70 percent in some countries.² Many of the impacts of climate change will disproportionately affect the disadvantaged and marginalized. The world's poor are particularly vulnerable to climate change as they often rely on small scale rain fed farming systems and agricultural labor as their major sources of food, often derive up to two-thirds of their income directly from climate effected natural resources; lack the assets that would enable them to cope with climate related crises and adapt to climate change; and are most exposed to the health risks arising from pollution, poor sanitation and unclean water. In periods of stress they may be forced to sell off their physical assets such as land, fishing boats, livestock or market stalls, thereby undermining the sustainability of their livelihoods over the longer term.

About this paper

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Private companies increasingly recognize the risks that climate change poses to their operations, including through the disruption of global supply chains. However, this awareness is not yet adequately translated into action. Most companies fail to understand the asymmetrical impacts of climate change resulting from social, political, economic, and cultural norms and, consequently, fail to develop meaningful interventions to protect their workers, maintain productivity, and ensure business continuity. A review of disclosure reports from almost two thousand companies concluded that companies underestimate the cost of climate change, misdiagnose climate risk, and pursue strategies for resilience sporadically and inconsistently.³

And yet, the potential of the private sector is enormous, and its capacity to be transformative agents of resilience is immense. Businesses are already responding to climate change by reducing greenhouse gases, enhancing resilience, and mobilizing finance. More than six thousand companies, representing at least US\$36 trillion in revenue, or half the global economy, have made climate commitments.⁴ In most economies, the private sector holds up to 70–85 percent of the investment; and, on an annual basis, the private sector makes over \$80 trillion worth of institutional investments globally. If properly equipped and incentivized, the private sector can enable socio-ecological resilience through its innovations, products, services and finance inside companies, across complex global supply chains and within frontline communities.

Cotton provides a powerful case study of climate risk as well as the steps the private sector is already taking, and should take going forward, to enhance resilience, address private damage, and minimize public harm. Cotton is the most widely produced natural fiber in the world, representing about 31 percent of the world textile market.⁵ More than a quarter of a billion people worldwide derive income from its production and almost 7 percent of the global workforce in developing countries is employed in it.⁶ According to the Food and Agriculture Organization (FAO), over 250 million people are involved in the cotton sector. Cotton also provides additional employment to several million people in related industries such as agricultural inputs, machinery and equipment production, cottonseed crushing and textile manufacturing.

Purpose, Scope and Methodology

The purpose of this paper is to improve understanding of how the private sector is addressing climate risk and enhance collective capacity to develop climate resilience inside individual companies, across complex global supply chains and for the benefit of frontline communities most vulnerable to climate change.

A two-tiered analysis of risk and resilience is offered:

- First, the paper offers an analysis of the material risks of climate change across complex supply chains – surfacing social and human dimensions as well as environmental ones. Many of the material risks to business, and many of the factors that amplify risk, are applicable and evident across sectors, geographies, and both the vertical and horizontal parts of global supply chains.
- Second, the paper offers a more detailed analysis for the agriculture and food supply chain with a specific focus on cotton.

A variety of research methods is used to harvest lessons from the best available climate science: real-world corporate experience in dealing with elevated climate risk; supply chain management practices, particularly as applied across the agriculture and food value chain; and expertise from across the climate resilience community of practice.

- First, a comprehensive literature review was conducted. The scientific basis is provided by the recent assessments from the Intergovernmental Panel on Climate Change (IPCC), starting with the fifth assessment report in 2014 and utilizing the recent 1.5°C Report. A number of recent publications have identified significant shortcomings in the private sector when properly recognizing and diagnosing climate risk. The most recent of these was published in January 2019 and results from assessing 1600 disclosure reports issued through CDP (formerly the Carbon Disclosure Project). The vision for the future is, in part, based on an examination of 23 separate resilience frameworks used by multilateral and bilateral donors, research institutes, and civil society; along with insights from research specific to the agriculture and food value chain.

- Second, semi-structured interviews were conducted with a range of stakeholders including those with expertise on climate risk and resilience; and practitioners across the target audience in the agriculture and food value chain, including representatives from input companies, farmers, traders, food companies and retailers.

Material Risk

Climate impacts are already widespread and consequential. Extreme weather events are increasing in terms of intensity and frequency. There has been an increase in both heavy precipitation and drought. Additional changes include shifts in the availability of fresh water; declines in both terrestrial and marine biodiversity and ecosystem services; sea level rises; and extreme heat.

The impacts of climate change will amplify other stresses. Many natural ecosystems are already subject to urban encroachment, fragmentation, deforestation and pressure on water resources. Moreover, climate change has disproportionate impacts on the vulnerable and marginalized, affecting the development aspirations of women, children, migrants and indigenous peoples, and the urban poor. The most vulnerable people have limited capacity to cope with, and adapt to, the changing weather and climate patterns, and risk being left behind.

In 2016, the World Economic Forum (WEF), identified climate change as the “highest impact risk to business”,⁷ prompting losses and disruptions horizontally across multiple parts of the supply chain; and vertically within various business divisions. Its 2019 annual report amplified the warnings, with environment-related risks now accounting for three of the top five material risks by likelihood, and four of the top five by potential impact. This has prompted WEF to suggest that “of all risks, it is in relation to the environment that the world is most clearly sleepwalking into catastrophe”.⁸

A total of 64 business risk vectors were studied, revealing business susceptibility to climate risk across six categories: strategy, operations, finances, human resources, marketing and sales, and compliance and legal. This has significant implications for the global economy. Analysis by Mercer, the world’s largest human resources consulting firm, estimates the cumulative, global cost of climate change-related impacts on the environment, health, and

food security will reach US\$2–4 trillion by 2030. Research published in the science journal *Nature* suggests the impact of climate change on the market value of global financial assets could be as high as US\$24.2 trillion under worst-case scenarios.

The cotton sector is at risk from temperature increases; changes in the availability and distribution of water; damages to crop quality and yields; shifts in soil fertility; impacts on workers across the supply chain, particularly women; and price volatility for essential commodities.

- Temperature increases of 2°C are expected to reduce crop yields, and adaptive capacity is projected to be exceeded in regions closest to the equator if temperatures increase by 3°C or more.⁹ In sub-Saharan Africa, climate change is expected to reduce land productivity by 14–27 percent by 2080, amplifying existing stresses on water availability and agriculture. Southeast Asia is expected to see decreases in agricultural productivity in the range 18–32 percent by 2080.¹⁰
- In many regions, changing levels and patterns of precipitation, melting snow and ice, and retreating glaciers are altering hydrological systems, affecting water resources and quality. Climate change is projected to reduce renewable surface water and groundwater resources significantly in most dry subtropical regions. Each degree of warming is expected to decrease renewable water resources by at least 20 percent for an additional 7 percent of the global population.¹¹ Shifting and erratic rainfall patterns increase the risk of low germination rates and associated crop failure in rainfed cotton production systems. Reduced total precipitation diminishes yields.
- Cotton is grown in rotation with other crops, as well as in various intercropping combinations. The main issues related to soil management and sustainability in the cotton sector are: soil fertility depletion, soil contamination, and soil erosion. Climate change can exacerbate these issues due to increasing rainfall intensity, mounting drought severity, and oxidation of soil organic matter.
- Climate risk is particularly acute for women as they are often constrained by social and cultural norms that prevent them from acquiring appropriate skill-sets; restrict their access to assets (including land); prevent

them from having adequate access to governance (including access to decision-making and information); place them in inferior social positions; and prevent them from acquiring education and appropriate health-care. The gender dimension of climate risk matters because agriculture generally, and cotton in particular, are heavily dependent on women workers.

State of Adaptation

The IPCC defines resilience as “the ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration, or improvement of its essential basic structures and functions. Investing in six so-called Capital Assets – natural, human, social, physical, financial, and political capital – represent the most effective and comprehensive means for the private sector to build resilience. These are interdependent capacities that, together, address the underlying causes of vulnerability such as poverty, inequality, and environmental degradation.¹² Across the private sector, and within the cotton sector, companies are working to strengthen these assets.

Adaptation efforts must, therefore, focus on the natural capital upon which cotton depends; the human capital of the farmers who work the land and the workers engaged across the supply chain; the social capital that is created when companies and stakeholders in the sector work together; the physical capital and infrastructure that improves the flows of materials, goods, services, and finance through the supply chain; the financial capital that increases both the volume and access to financial instruments in the industry; and the political capital that creates a policy-enabling environment conducive to the success of the sector.

Anecdotal evidence is emerging, tracing the use of these capital assets within the private sector and across the cotton supply chain. For example:

- Companies across the globe are using the Global Organic Textile Standard (GOTS) and Textile Exchange's Organic Content Standard (OCS) to protect, revitalize and enhance natural capital by using cotton that is organic, free of harmful chemicals, and produced using environmentally sustainable practices.

- The Better Cotton Initiative (BCI), the largest cotton sustainability programme in the world, aims to train five million farmers, covering 30 percent of global cotton production, in sustainable farming practices by 2020. Meanwhile, CottonConnect has created the Responsible Environmental Enhanced Livelihoods (REEL), the Farmer Business School, “Women in Cotton”, and REEL Rights & Life Skills Education Programmes to advance women's technical skills related to cotton production and enterprise management. Both make vital contributions to enhancing human capital.
- The Sustainable Apparel Coalition (SAC) is the apparel, footwear, and textile industry's leading alliance for sustainable production and is the steward of the Higg Index, used to measure environmental and social impacts across the supply chain. As of 2017, more than 10,000 customers around the world use the Higg Index to improve sustainability performance and enhance social capital.
- Through tools like the Fairtrade Minimum Price and an additional Fairtrade Premium, Fairtrade is enhancing the financial capital of cotton farmers by offering an alternative route to trade and higher, more stable incomes.

Vision for the Future

Four specific recommendations are offered to enhance resilience across the private sector and throughout the cotton supply chain:

1. **Commit to resilience:** In recent years, companies across the globe have formalized their climate leadership into tangible commitments. The time is ripe to complement these mitigation-focused commitments with a new pledge on climate resilience. A resilience commitment could consist of a publicly disclosed pledge to create a science-based assessment of their climate risks; to follow this by formulating a strategy to build resilience to climate risks based on the six capital assets; to report progress and challenges regularly to shareholders and stakeholders; and, finally, by embracing some of the pioneering collaborative initiatives profiled in this report.

2. Improve understanding of risk and resilience: A number of companies are beginning to address climate risks by building on existing business risk assessment activities and integrating adaptation initiatives into enterprise-wide risk management systems. However, the majority of businesses are misdiagnosing climate risk and failing to build comprehensive strategies for resilience. While they understand that climate change is increasing the intensity and frequency of climate hazards; and while they recognize that an increasing proportion of their supply chain is exposed to these hazards; they fail to properly understand the underlying weaknesses or vulnerabilities in their supply chains – that exacerbate risk.
3. Improve investments in capital assets: As the examples in the state of adaptation section of this paper illustrate, companies across sectors are enhancing climate resilience by investing in six so-called capital assets. There is scope to improve private sector understanding of, and investments in, these capital assets, notably by ensuring that all companies consider interventions across the full six rather than siloing in their adaptation strategies in to one or two. In addition, there are options to become more expansive in a number of the asset categories.
4. Empower women workers: Women’s empowerment needs to be concrete and not just rhetorical. Gender sensitive approaches to policymaking that understand gender-based discrimination are a starting point; but, ultimately, gender transformative approaches that promote equality as a priority, and aim to transform unequal relations, power structures, access to and control of resources, and decision-making are critical. Additionally, the strengthening of human rights is central to climate ambition in terms of improving mitigation, adaptation, finance and technology, and is not a parallel but separate sustainability goal. Access rights can ensure that women have a seat at the table when policies are being designed; provide tools for resilience-building; and, with prior-informed consent, ensure that women have agency over their communities and resources.

Approaches to risk and resilience ought to be systemic, meaning addressed across entire companies, supply chains and sectors, rather than siloed within a narrow range of sustainability projects. Moreover, companies ought to utilize the capital assets framework in its entirety, rather than focusing on one or a few of them in a manner that suggests adherence to a corporate comfort zone rather than commitment to systemic change. And, approaches to resilience need to be scaled. Many of the projects outlined in this report are laudable, but often lack sufficient ambition and volume to drive meaningful outcomes and impacts.

1. MATERIAL RISKS AND GLOBAL SUPPLY CHAINS

1.1 The Nature of Global Supply Chains

As much as 80 percent of global trade is embedded in global supply chains, including trade in intermediate goods and services of about US\$12 trillion or about 60 percent of global trade.¹³ According to the World Trade Organization, global merchandise exports surged from US\$7.38 trillion in 2003, to US\$17.93 trillion in 2012.¹⁴ As a result, resilient supply chains are vital to the performance of individual companies, but also to the broader health of national and global economies.

Supply chains create value by being reliable and responsive in matching demand and supply. Reliability is delivering the right product in the right quantity at the right time to the right place at the lowest cost. Responsiveness is the ability to respond quickly to changing market conditions.¹⁵ According to Christopher (1992), leading-edge companies have realized the real competition is not company against company, but rather supply chain against supply chain.¹⁶

Modern supply chains span the globe and involve many suppliers, contract manufacturers, distributors, logistics providers, original equipment manufacturers, wholesalers, and retailers. The supply chain includes the inbound or supply-side elements, featuring all the processes and suppliers responsible for furnishing the company with materials and parts; the internal processes within companies that convert inputs into manufactured goods and services; and the outbound or customer-facing elements that focus on distribution processes and customers.¹⁷ This vast network consists of materials and flows, and depends on the locations of suppliers, sub-suppliers, and service providers.

The parts that go into the company's products are also known as a bill of materials (BOM). Companies create a BOM that lists the quantities of subassemblies, parts, and raw materials required to make one unit of a product. Production planners use the BOM to identify the parts needed, the quantities required, the inventories of parts available, and the time when they should be ordered, so that they will be available for the manufacturing processes.¹⁸ For example, a car may contain up to 50,000 unique parts.¹⁹

Supply chains encompass three essential types of flows: material, information, and money. In general, materials flow downstream from mines and farms to factories that process raw materials, to the factories that make parts and sub-assemblies, to original equipment manufacturers that make finished goods and products, to distributors and to retailers and, finally, to end consumers. At each stage, companies add value to the materials, often differentiating them into many types of parts or products. At the same time that materials flow down the chain, money flows up the chain when consumers pay the retailer, the retailer pays the distributor, and so on.²⁰

The structure of the supply chain for acquiring and moving raw material and parts to final assembly – the so-called upstream supply chain – is determined by the choice of suppliers. Manufacturers may choose to locate production facilities close to raw material supplies, close to sources of labor, close to centers of demand, in some industrial cluster location, or in a location influenced by government. In the downstream part of the process, the supply chain encompasses the distribution function. Distribution determines the location and operations of the company's warehouses and distribution centers. Distribution also usually manages the movement of the finished products to the customers be they retail distribution centers, retail outlets, or e-commerce fulfillment centers.²¹

Rapidly declining costs of communications and growing efficiency of logistics are enabling an explosion in global trade with the resulting lengthening of supply chains. Digital communications mean companies can more readily work with facilities, suppliers, and distribution centers on the other side of the world. Containerization and larger conveyance sizes aid global trade by reducing transportation costs. Global trade, global competition, and the need for differentiation in the marketplace mean that companies now sell more varieties of each product. Many products have become more complex through the addition of embedded information and communications technology. Automobiles now contain between 30 and 100 microprocessors, with each subsystem of the car having its own controller and software. Companies can more readily manufacture complex products using complex supply chains, but the systems are inherently more fragile precisely because modern computers and communications enable tighter coordination and lean, inventory-less operations. While such controls and processes make a company more competitive in normal times, they also make it more fragile to any event that disrupts the finely tuned global network of business machinery.

In addition, complex supply chains mean deep bills of materials and, thus, many tiers in the supply chain. While companies may be able to pressure their direct suppliers to help manage risks, companies have little knowledge of these deep tier suppliers and, in most cases, almost no influence over them to demand more resilience or adherence to a code of conduct.²²

A 2000 study of 861 public companies found that with the announcement of a supply chain malfunction, such as production or shipment delays, the company's stock price tumbled nearly 9 percent on average. Furthermore, that stock lost 20 percent of its value within six months of its announcement.²³ Research conducted on a sample of 519 supply chain disruptions during the period 1989–2000 concluded that such disruptions are associated with an abnormal decrease in shareholder value of 10.28 percent.²⁴ The research further concluded that the announcement of supply chain disruptions will have a negative stock market reaction and that more recent supply chain glitches will be penalized more significantly by the market than earlier glitches.²⁵

1.2 Climate Change and Supply Chains

Climate impacts are already widespread, consequential and expected to increase in intensity and frequency.²⁶ Between Autumn 2017 and Summer 2019, a series of extreme events across the globe illustrated that climate change is a crisis of today and not tomorrow. In California, the Mendocino Complex Fire in 2018 spread to more than 300,000 acres, becoming the largest fire ever recorded in California; while the Camp Fire of the same year was the deadliest in State history with 100 deaths. Over the same period, more than US\$3 billion of damage was inflicted across five mid-western US states due to flooding. In Nebraska alone, the flooding has already caused more than US\$1 billion in damages, with more than 2,000 homes and 340 businesses lost. In 2018, Hurricanes Florence and Michael were just two of 14 “billion-dollar disasters” in the US; while the 2017 Atlantic hurricane season was the costliest on record with over US\$290 billion in damages from Harvey and Irma alone, and the tragic loss of 3,000 US citizens in Puerto Rico due to premature death associated with these hurricanes. In Spring of 2019, Cyclone Idai swept through the southern African countries of Mozambique, Zimbabwe, and Malawi on March 15. The storm is believed to have killed more than 750 people across the three countries. More than 100,000 people were forced to live in shelters, and the coastal city of Beira, Mozambique, has been all but destroyed. In India, drought and resultant crop failures in India's Madhya Pradesh state led to significant migration; and in August 2018, Kerala experienced heavy rainfall and one of the worst floods on record, leading to hundreds of deaths. Weather fluctuations in Japan during 2018, resulted in 22,000 people being hospitalized with heat stroke, record-high rainfall and extensive flooding and mudslides, and thousands of houses damaged and at least 122 lives lost.²⁷

The recently published Intergovernmental Panel on Climate Change (IPCC) Special Report on Global Warming of 1.5°C provides a comprehensive, scientifically robust, and specific overview of the potential impacts and associated risks. Chief among these are the rapid increase in global mean temperature; increase in intensity, frequency and uncertainty of extreme weather events; an increase in both heavy precipitation and drought; changes in the availability of fresh water; dramatic changes in both land and

marine biodiversity and ecosystem services; an increase in vector- and water-borne diseases; growth in the numbers of invasive species and pests; sea level rises; and extreme heat.²⁸

Climate change is a material risk to the global economy and to the private sector with impacts inside individual companies, across complex supply chains, and within frontline communities. Analysis by Mercer, the world's largest human resources consulting firm, estimates the cumulative, global cost of climate change-related impacts on the environment, health, and food security will reach US\$2–4 trillion by 2030.²⁹ More recent research published in the science journal *Nature* suggests these numbers may lean toward the lower end of the spectrum. The project team calculated the impact of climate change on the market value of global financial assets to be US\$2.5 trillion but estimated that it could be as high as US\$24.2 trillion under worst-case scenarios.³⁰

According to the World Economic Forum (WEF) climate change is the highest impact risk to business.³¹ Companies right across complex supply chains experience climate risk, from those cultivating natural resources or extracting raw materials, to those producing manufactured goods, transporting products, or ultimately selling finished articles to consumers.

Companies may experience operational disruptions from damage to vital infrastructure caused by climate hazards; production shortfalls and procurement problems when the workers, communities and resources that serve the supply chain are adversely impacted; and logistics failures when transport routes are shut down by extreme weather.³²

Compliance and legal issues risks arise when companies fail to adhere to laws and regulations designed to enhance adaptive capacity; from liability arising from climate-related lawsuits; and from failure to fully disclose climate risks through mandatory reporting mechanisms. Climate activists are increasingly turning to the courts to drive the climate ambition they see as being absent from boardrooms. In recent years, a variety of laws including those dealing with environmental damage, human rights violations, and breach of fiduciary or transparency have been used in an attempt to bring polluters to account for climate change. In the past 15 years, 64 such cases have been brought in countries other than America. Around 20 are being filed each year in the United States alone.³³ In November 2017,

a German court allowed a lawsuit to proceed against RWE, a German utility company. The lawsuit was brought by a farmer in Peru who claimed RWE's contributions to carbon dioxide (CO₂) emissions negatively affected his crops.³⁴

The key concern for companies is that climate change will turn assets and liabilities; increase supply chain disruption, thus undermining competitive advantage; and ultimately lead to financial losses. Financial risk can be exacerbated by climate change in a number of ways:

- Company profits could fall as vulnerability and exposure to climate risk becomes known – possibly through an increased focus on the content of disclosure reports or resulting from unfavorable media coverage of a supply chain disruption.
- Profitability could also be hit due to diminished capital availability and higher credit risk, as investors and lenders refuse to make capital available to companies seen to be exposed and vulnerable to climate impacts or not managing them adequately. The Global Investor Coalition on Climate Change, which represents US\$24 trillion in assets, expects companies to have climate change strategies in place. The California Public Employees' Retirement System, or CalPERS, for instance, requires from corporations it invests in that board members have climate expertise.³⁵ BlackRock, the largest asset manager in the world – with its US\$5.1 trillion under management, equivalent to 4.3 percent of the world's gross domestic product (GDP) – announced that it would expect companies to provide assessments of how climate change would affect their business.³⁶
- Large accounts may be at risk if significant procurers of goods and services begin to focus their purchasing on climate-friendly suppliers.³⁷
- Risks related to asset and commodity prices are particularly strong because of the impact of climate change on ecosystems services, food production and real estate. High variability in the price of raw materials driven by vulnerability and exposure to climate hazards may dramatically change inputs vital to production.³⁸
- Reputational damage may result from a perceived failure to account for climate risk with implications for revenue, as customers and suppliers become hesitant to associate with a discredited brand. According to

research by Morgan Stanley, millennials purchased from a sustainable brand twice as often as the total individual investor population. Millennials were three times more likely to have sought employment with a sustainably minded company and invested in companies targeting social/environmental goals twice as much as the total individual investor population. This is important as millennials are expected to make up 75 percent of the American workforce by 2025, and 90 percent of them have expressed an interest in pursuing sustainable investments as part of their retirement savings. Millennials also showed the greatest interest in pursuing investment supportive of climate action, with 82 percent of those surveyed expressing an interest in thematic investments designed to reduce emissions and enhance resilience.³⁹

These risks are no longer merely projected in climate models. In recent years, they have become all too familiar in the experiences of some of the world's leading companies.

In October 1998, Hurricane Mitch, a category five storm, made landfall in Honduras resulting in the loss of 7,000 lives, destroying up to 80 percent of the country's transportation infrastructure, and causing more than US\$4 billion in damage. In addition, Honduras lost 80 percent of its banana crop. Other banana producing countries in the region such as Nicaragua and Guatemala were also affected. In total, Hurricane Mitch destroyed 10 percent of the world's banana crop. Both Dole and Chiquita relied on the tropical climate of central American plantations for banana supplies. Dole lost 25 percent of its global banana supply, while Chiquita lost 15 percent of its capacity.⁴⁰

In 2011, the worst floods in more than 50 years struck Thailand, causing millions to become displaced or homeless, and activity at businesses, schools, and hospitals ground to a halt. Seventy-seven of Thailand's 84 provinces were affected, resulting in economic losses of more than US\$45.7 billion or 13 percent of that year's GDP.⁴¹ The industrial parks in central Thailand had become a cluster for making hard disks and their components. Four of the five top suppliers of drives all had facilities or key suppliers in Thailand. At the time, Thailand provided 45 percent of worldwide hard drive production. When the floods inundated 877 factories, halting 30 percent of global hard disk manufacturing, the personal computer (PC) industry faced a 35 percent shortfall in disk supplies in the fourth

quarter of 2011.⁴² Hewlett-Packard Technology, at the time the world's leading PC manufacturer, suffered in excess of US\$4 billion in lost revenue as a consequence of the floods, as it was a supplier of components vital for the production of hard disk drives.⁴³

Of all the lingering reminders of 2012's cataclysmic Hurricane Sandy, a line on a wall at Verizon Wireless' Lower Manhattan offices represents the high-water mark from the massive storm. Before October 2012, Verizon's telephone infrastructure depended on copper-based systems to support its landlines nationally, including in New York and New Jersey. But when the hurricane sent a surge of saltwater sweeping through the company's facilities, the 90,000 cubic foot cable vault suffered a catastrophic failure and the copper wiring dissolved. As a result, thousands of Verizon customers lost service; the company suffered reputational and operational damage; and, ultimately, the company lost approximately US\$1 billion.⁴⁴ Verizon suffered these consequences because although it's modeling recognized the likelihood of increased intensity and frequency of extreme weather events due to climate change, and understood the company's exposure to these extreme weather events, it failed to address its underlying weaknesses or vulnerability, namely its dependence on physical capital and infrastructure that were incompatible with a changing climate.

Hurricane Maria slammed into Puerto Rico on September 20, 2017, leveling homes, flooding vast swaths of the island, and – because the impact of climate change sometimes follows a circuitous path – affecting the health of people thousands of miles away. Pharmaceuticals and medical devices constitute Puerto Rico's leading exports, and drug companies and device makers represent a US\$15 billion stake there. Baxter International manufactures intravenous (IV) bags on the island – in fact, the Fortune 500 healthcare company constitutes more than 40 percent of the United States' IV solution market. When Hurricane Maria forced the shutdown of Puerto Rican plants, hospitals that relied on these products were unable to resupply. When an unusually severe flu season swept across the United States, hospitals were left scrambling for IV bags to care for dehydrated flu patients. In some cases, clinics nowhere near the storm suddenly found themselves paying up to a 600 percent markup.

1.3 Climate Risk and Cotton

Assuming a linear model of the supply chain for the sake of illustration, the transformation of the raw material of cotton into a final product involves picking the cotton boll; ginning, or separating the lint from stems and other materials; spinning the lint into yarn; knitting or weaving the yarn into fabric; designing a product and converting the fabric into the final product; distributing and selling the product; and, ultimately, using the product.

Once it is picked and harvested, seed cotton is sent to the gin for cleaning and pressing. A gin may receive cotton from multiple growers, which it will clean and separate from detritus and other trash. The clean raw cotton is then pressed into bales of cotton lint. In the next step, spinning, cotton lint is transformed into yarn. This is mostly dry processing with comparatively few environmental side effects. Next, through weaving and knitting, cotton yarn becomes textile. Starch can be added in this process. Next, this raw fabric is processed, washed, dyed, and sometimes even bleached. Finally, the processed fabric is sent to manufacturing sites to be transformed into products for retail.

In fact, the cotton supply chain is far more complex than this model suggests. For instance, a gin receives cotton from multiple growers; traders buy cotton from all over the world and sell it through global markets; spinners use a mixture of cotton that ranges in origin, quality, and cost to produce yarn; fabric mills take a similar approach to produce a final fabric; garment manufacturers may have subcontractors dye, launder, or embellish their product; retailers may source the same product from a variety of garment manufacturers. What is more, the different players in this supply chain have varying profiles too. The cotton yarn spinning industry is highly capital intensive, faces acute cyclicalities, has extremely fragmented capacities, and is intensely competitive on account of the commoditized nature of the product. In contrast, garment manufacturing is not as capital intensive but is fragmented, resulting in lower economies of scale.

Cotton is the most widely produced natural fiber in the world and represents about 31 percent of the world textile market.⁴⁵ More than a quarter of a billion people worldwide derive income from its production and almost 7 percent of the global workforce in developing countries is employed in it.⁴⁶ About 100 countries produce cotton and 150 are involved in its trade, with cotton crossing international borders at every point of the supply chain. Set in a context

of globalized trade, the cotton supply chain is in reality a hypercomplex web of players, diverse in size, power, and stakes, as well as embedded in very local economies and with very specific economic profiles.

In 2013/14, cotton was harvested on about 2.3 percent of the world's arable land. About 80 percent of all cotton is produced in six countries. China is the world's leading producer, followed by India, the United States, Pakistan, Brazil, and Uzbekistan. In 2014, China and India accounted for slightly more than half of world cotton production, while the United States, Pakistan, Brazil and Uzbekistan accounted for an additional 29 percent.⁴⁷

According to the Food and Agriculture Organization (FAO), over 250 million people are involved in the cotton sector. Cotton also provides additional employment to several million people in related industries such as agricultural inputs, machinery and equipment production, cottonseed crushing and textile manufacturing. The value of the 25.6 million tons of cotton production in 2013/14 amounts to about US\$51.4 billion.⁴⁸

In the countries of sub-Saharan Africa, cotton is grown almost exclusively by smallholders, while it tends to be grown at commercial scale in other regions. The typical size of cotton farms in West Africa is under three hectares, and cotton production ranks highly as the source of employment in top-producing countries; in Benin, some estimates put employment in the cotton sector at nearly 30 percent of total employment; while Zambia has about 300,000 smallholder cotton farmers; and cotton provides around 7 percent of employment in Burkina Faso and 17 percent of employment in Mali.⁴⁹ Hence, disruptions to the supply of cotton has the potential to undermine livelihoods and broader economic development.

Like other agricultural commodities, cotton is susceptible to changes in temperature, water, and the quality of soil; can be damaged by extreme weather events and pests; and the full supply chain can be adversely affected by climate hazards disrupting vital transport infrastructure, and facilities; and undermining the wellbeing of workers.

According to the IPCC, human activities are estimated to have already caused approximately 1°C of global warming above preindustrial levels and are likely to lead to warming of 1.5°C between 2030 and 2052 in the absence of aggressive greenhouse gas emissions reductions.⁵⁰ Temperature increases of 2°C are expected to reduce crop yields and

adaptive capacity is projected to be exceeded in regions closest to the equator if temperatures increase by 3°C or more.⁵¹ These projected impacts will occur as demand for crops is expected to increase by about 14 percent per decade until 2050.⁵² Africa and Asia are likely to be hardest hit. In the countries of sub-Saharan Africa, climate change is expected to reduce land productivity by 14–27 percent by 2080, amplifying existing stresses on water availability and agriculture. Southeast Asia is expected to see decreases in agricultural productivity in the range 18–32 percent by 2080.⁵³ Temperature increases may be detrimental to cotton yields in countries where production is already occurring at the upper range of growing temperatures, such as in India and Pakistan.⁵⁴

In many regions, changing levels and patterns of precipitation, melting snow and ice, and retreating glaciers are altering hydrological systems, affecting water resources and quality. Climate change is projected to reduce renewable surface water and groundwater resources significantly in most dry subtropical regions. Each degree of warming is expected to decrease renewable water resources by at least 20 percent for an additional 7 percent of the global population.⁵⁵ Shifting and erratic rainfall patterns increase the risk of low germination rates and associated crop failure in rainfed cotton production systems. Reduced total precipitation diminishes yields, especially when below 700 millimeters of annual precipitation or a total of 105 days of sufficient soil moisture in tropical conditions.⁵⁶ The importance of water availability, both in quantity and right timing, varies with the technology use for the culture of cotton (whether it is rainfed or irrigated). In both cases, cotton yields are reduced by drought and the scarcity of water. In Australia, the 2014 droughts resulted in the reduction of the country's cotton production estimates by as much as 35 percent⁵⁷ and a 2013 drought in Texas saw cotton yields reduced by 18 percent.⁵⁸ Drought in western Turkmenistan and Uzbekistan is predicted to reduce cotton production, increase water demand for irrigation, and exacerbate desertification.⁵⁹

Cotton is grown in rotation with other crops, as well as in various intercropping combinations. The main issues related to soil management and sustainability in the cotton sector are soil fertility depletion, soil contamination and soil erosion. Climate change can exacerbate these issues due to increasing rainfall intensity, mounting drought severity and oxidation of soil organic matter. In some of the top cotton-producing countries, cotton is grown in very

large holdings with intensive use of synthetic or chemical agricultural inputs. These farming system practices might lead to the depletion of soil nutrients and deterioration of soil structure if proactive measures for rebuilding soil health are not implemented.

Some pest outbreaks are attributed to climate change. Rising land temperatures, changes in precipitation patterns, and increased frequency and intensity of extreme heat undermine the natural regulation of pests and diseases, while increasing the ranges of various pests. This, in turn, can lead to losses of important ecosystem services and facilitate the increased dominance of damaging invasive organisms. Expected increases in crop damage by pests are projected to affect food production further and raise the cost of key commodities.⁶⁰ Moreover, higher CO₂ levels will tend to favor weeds, making weed control more critical to achieving optimal cotton plant development and yield.

These climate impacts contribute to price volatility for agricultural commodities.⁶¹ Weather-related fluctuations in food production often lead to price spikes. Price rises of 37 percent (rice), 55 percent (maize), and 11 percent (wheat) are projected by 2050 from the additional stress of climate impacts. Increased volatility has negative implications for business as it heightens uncertainty, potentially increases the costs of production, and impedes access to vital commodities. From a development standpoint, climate-related price rises have a disproportionate impact on the welfare of the urban and rural poor. The 2010/2011 food price spike is estimated to have pushed 44 million people below the basic-needs poverty line across 28 countries.⁶² The variability in quality and quantity of cotton contributes to its price volatility. The price of cotton can vary as much as 50 percent in one year, and poses particular risk in the most fragmented parts of the supply chain, where smallholders cannot mitigate these fluctuations with large orders.⁶³

Ultimately, these impacts undermine livelihoods and lives. People who are socially, economically, culturally, politically, institutionally, or otherwise marginalized are especially vulnerable to climate change as well as to some adaptation and mitigation responses. This heightened vulnerability is rarely due to a single cause. Rather, it is the product of intersecting social processes that result in inequalities in socioeconomic status and income, as well as in exposure. Such social processes include discrimination on the basis of gender, class, ethnicity, age, and (dis)ability.

1.3.1 Gendered dimensions of climate risk and the cotton industry

Climate risk is particularly acute for women as they are often constrained by social and cultural norms that prevent them from acquiring appropriate skill-sets; restrict their access to assets (including land); prevent them from having adequate access to governance (including access to decision-making and information); place them in inferior social positions; and prevent them from acquiring education and appropriate healthcare. They are most exposed to the health risks arising from pollution, poor sanitation and unclean water. And they also rely most on natural resources, often deriving up to two-thirds of their income directly from these resources and spending up to three-quarters of their household incomes on food and other basic needs. In periods of stress they may be forced to sell off their physical assets such household items, livestock with lower cultural importance, and jewelry (often kept and used in an emergency). This is often after taking loans from family/friends and possibly before or after high-risk borrowing from loan sharks. Ultimately, women might be forced to sell their land, thereby undermining the sustainability of their livelihoods over the longer term.

When natural disasters strike, often as a result of climate change, women and girls frequently bear the brunt and longer term consequences. A 2007 study of 141 natural disasters found that when the socioeconomic status of women is low, more women died as a result of a natural disaster; and, post-disaster, women and girls suffered a disproportionate lack of access to food and economic resources.⁶⁴ The 1991 cyclone in Bangladesh illustrates many of these issues. More than 90 percent of the estimated 140,000 fatalities were women – their limited mobility, skills, and social status exacerbated their vulnerability to this extreme weather event.⁶⁵

Some of the reasons for this are similar across these countries: women died because they stayed behind to look for their children and other relatives. Women in these areas often can't swim or climb trees, which meant that they couldn't escape. Some cultural differences between men and women also contributed to the disproportionate death toll. Recurring natural disasters also lead to further violations of women's rights and dignity, such as human trafficking, child marriage, sexual exploitation and forced labor. While the emphasis is often on natural disasters such as floods, cyclones and earthquakes that strike quickly, slow

onset disasters such as prolonged droughts in parts of South Asia, notably India, are resulting in growing numbers of farmer suicides that are placing women in vulnerable positions due to being saddled with crippling debt and having to provide for the family.

The gender dimension of climate change matters because agriculture generally, and cotton in particular, are heavily dependent on women workers. The International Labour Office calculates that approximately 190 million women work in global supply chain-related jobs in the 40 countries for which estimates were available. In sectors such as consumer products and food, the proportion of women in the labor force can be as high as 70–90 percent in some countries. Women farmers currently account for 45–80 percent of all food production in developing countries depending on the region, with about two-thirds of the female labor force in developing countries, and more than 90 percent in many African countries, engaged in agricultural work.⁶⁶ Gender disparities in ownership and access to resources (such as land, credit and technology), coupled with sociocultural barriers, impoverish and isolate women; lower their adaptive capacity; and increase their vulnerability to climatic risk. Since women's livelihoods tend to be climate-sensitive, climate change imperils their lives more than it does men's. Increasing natural disasters caused by climate change also disproportionately affect women due to their role as mothers, carers, and workers in the informal sector, among other roles.

The impact of damages to the cotton supply chain on women is significant, given the role of women in the production of cotton. In India, the second largest producer of cotton in the world, 70 percent of the planters and 90 percent of the harvesters are women. Women are traditionally also the custodians of locally adapted seed varieties – an important climate adaptation measure that is being undermined by large multinational seed companies. Chetna Organic Farmers Association supports and promotes women-managed and controlled seed enterprises in Odisha, India, through its Seed Guardians program, supported by Textile Exchange and Inditex.⁶⁷ These seedbanks have given food security to 600 families, and are particularly important for organic farmers who do not use the genetically modified seed or chemical inputs that dominate the market.

Further downstream in the supply chain of cotton, women are prominent stakeholders in the manufacturing of garments out of cotton fiber.



2. STATE OF ADAPTATION

The IPCC defines resilience as “the ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration, or improvement of its essential basic structures and functions.”⁶⁸

A resilient business must be able to anticipate, absorb, accommodate and rapidly recover from climate events. Business continuity requires these abilities to be present within own operations, throughout the supply chain, and within frontline communities. A complex, global and interconnected business cannot be resilient if it focuses exclusively on efforts within its own four walls. It needs to reach out to moderate harm to socioecological systems and enable people, the economy and natural systems to rebound quickly in the face of adversity. Businesses can be agents of climate resilience, benefitting from the availability of resources; the security of supply chains and transport routes; the protection of workers and infrastructure; and the rising prosperity of consumers and shareholders.⁶⁹

Investing in six so-called Capital Assets represents the most effective and comprehensive means for the private sector to build resilience. These are interdependent capacities that, together, address the underlying causes of vulnerability such as poverty, inequality, and environmental degradation.⁷⁰ The capital assets can also reduce exposure to climate risk, notably by improving poor planning and construction practices that currently place infrastructure, population centers, and utilities in the path of climate hazards, and often without sufficient regard for how these hazards are increasing in intensity and frequency.

2.1 Natural Capital

Natural capital refers to the full range of services provided by biodiversity and ecosystem services, including land and water. For example, wetlands are vital to climate resilience because they protect upland areas – including valuable residential and commercial property – from flooding due to sea-level rise and storms; and help to regulate water tables. They further prevent coastline erosion due to their ability to absorb the energy created by ocean currents. According to research published by the Royal Swedish Academy of Sciences, coastal wetlands reduce the damaging effects of hurricanes on coastal communities with significant financial benefits. A regression model using 34 major US hurricanes since 1980 determined that coastal wetlands in the US currently provide over US\$23 billion per year in storm protection services as these wetlands function as self-maintaining “horizontal levees”.⁷¹

Companies might work to enhance natural capital by maintaining wetlands and urban green spaces; expanding forested areas, which help to regulate micro-climates and groundwater, and can reduce peaks in intense rain runoff, reducing flash flooding downstream; reducing other stressors on ecosystems and habitat fragmentation; changing cropping, livestock, and aquaculture practices; and investing in green infrastructure.

Natural capital could be enhanced in the cotton supply chain by:

- Acting to avoid, reduce and reverse land degradation as this can increase food and water security, and contribute to broader resilience.⁷²
- Diversifying water resources, enhancing watershed and reservoir management, and improving integrated water management. Adaptive water management techniques include enhancing storage and access to

irrigation water, more efficient water delivery systems, and agronomy that improves soil water retention. Drip-irrigation installations can be installed to reduce the amount of water used to supplement rainfall in regions where it is needed; while other technologies can detect where in a field the soil is dry and where it isn't, concentrating delivery to areas where water is required. Furthermore, improved transportation and storage can reduce the amount of water wasted. Further down the supply chain, manufacturing processes use a lot of water – in particular, the dyeing process both uses a large amount of water and causes significant water pollution. The water that runs off the fabric and down the drain into sewage systems pours chemicals into the groundwater as well as rivers, lakes and other water sources. Companies with significant water footprints for processing can put in place technologies and innovations to maximize efficiencies.

- Improving tolerance of crops to high temperature, changing crop rotation systems, breeding additional drought-tolerant crop varieties, and maintaining genetic diversity. There is increasing evidence that farmers in some regions are altering cultivation and sowing times to deal with changing local conditions. Warming may extend the growing season, so changing planting dates is a frequently identified option for cereals and oilseeds, provided there is not an increase in drought at the end of the growing season. Changing planting dates may increase yields by a median of 3–17 percent.⁷³ Early sowing is being facilitated by improvements in machinery, and through the use of techniques such as dry sowing, seedling transplanting and seed priming. The optimization of crop varieties and planting schedules is an effective approach to adaptation, increasing yields by up to 23 percent compared with current practices.⁷⁴ High temperatures reduce crop yield and quality; and, consequently, improving heat tolerance is a frequently identified adaptation for almost all crops. Improving gene conservation and access to extensive gene banks could facilitate the development of better-adapted crop varieties.
- Soil conservation and restoration. High quality cotton comes from high quality soil and so soil health practices are vital to yields and quality. Soil health is the continued capacity of a soil to function as a

vital, living ecosystem. This is achieved by cycling nutrients; absorbing, draining and retaining rainwater; filtering water to remove pollutants; and increasing the diversity of soil animals and microorganisms.⁷⁵

- Reducing pesticides use. Practices that reduce the overall use of pesticides and steer farmers towards organic agriculture are favorable, as is reducing the cloud application of pesticides in favor of ground-level application in specific areas.
- Pest management. Insects are major limiting factors in producing cotton, and hundreds of species of insects may be found in cotton, some of which are important economically.

The South African retailer Woolworths developed the Farming for the Future Initiative in response to declining crop yields and quality in the region. Changes in water distribution throughout southern Africa pose a threat to the entire agriculture sector. In 2014, Woolworths lost an estimated US\$2 million in sales due to extreme weather affecting some of their fresh fruit suppliers.⁷⁶ Woolworths developed an initiative designed to help agricultural producers conserve water and maintain the soil. The premise is that healthy soil is better able to retain water, reducing irrigation and water usage, while soil erosion and loss of topsoil are reduced. Healthy soil also requires fewer chemical interventions, meaning less dependence on pesticides and less damage to biodiversity and ecosystems services. The initiative focuses on:

- Soil management, including soil chemical composition, soil nutrient status, fertilization practices, soil carbon content, and soil cover.
- Irrigation water management, including the measurement of soil moisture, water use efficiency, water chemical composition, and water health.
- Biodiversity management, including the conservation of endangered species, and alien invasive plant management.⁵²
- Pest and plant management, including chemical usage, integrated pest and disease management, and integrated weed management.⁷⁷

This has enabled Woolworths to set ambitious targets for sustainable cotton. Woolworths currently uses sustainable cotton across 60 percent of its fashion items but plans to source all of its cotton from sustainable sources by 2020, ensuring that all supplies are certified organic or to the Better Cotton Initiative (BCI) criteria.⁷⁸

Producing cotton organically is increasingly recognized as a promising adaptation measure to support sustainable livelihoods under a changing climate. The high organic matter of soils farmed organically results in greater resilience to droughts and excessive rainfall compared to soils farmed under conventional practices.⁷⁹ A study in north-west Benin found that the practices used in organic cotton production directly reduced the most frequent climatic risks faced by households, and indirectly contributed to reducing economic risks and empowering women.⁸⁰

In North America, two of the world's largest clothing and apparel companies are working to reduce water use further downstream. Nike has developed a ColorDry process that eliminates water from fabric dyeing. Whereas 30 liters of water are needed to dye a T-shirt using traditional dyeing methods, ColorDry technology removes water from the dyeing process by using recycled CO₂ to infuse fabric with intense, saturated color. The result is a product that dyes fabric with zero water, and also “reduces energy consumption by around 60 percent compared to traditional dyeing and eliminates the use of process chemicals.”⁸¹

Many companies are now turning to the Global Organic Textile Standard (GOTS) and Textile Exchange's Organic Content Standard (OCS) to guarantee farm-level chain of custody, and ensure that the cotton they source and sell is organic, free of harmful chemicals, and uses these environmentally sustainable practices to preserve and restore natural capital. GOTS is recognized as the world's leading processing standard for textiles made from organic fibers as it defines high-level environmental criteria covering the processing, manufacturing, packaging, labelling, trading and distribution of all textiles made from at least 70 percent certified organic natural fibers. Williams–Sonoma, Nike, Patagonia and Adidas are among the leading multinationals turning to this certification system. Williams–Sonoma is working towards a goal of 100 percent responsibly sourced cotton by 2021 using GOTS as a standard.⁸²

2.2 Human Capital

Human capital refers to the skills and knowledge of available human resources, particularly in the workforce. A company might enhance human capital by investing in skills and training for the workforce to cultivate agents of broader workplace, household and community resilience. It might lead on technology development, transfer, and diffusion; conduct hazard, exposure, and vulnerability mapping focused on its workforce; work with government to produce early-warning and early action to an impending severe weather event for their communities; and undertake participatory scenario development to prepare workers for climate impacts. Similarly, businesses set standards for their contingent workforce and workers in global supply chains. Businesses decide who has access to their jobs through their diversity and inclusion programs that seek to bring marginalized groups such as refugees, the homeless, or the formerly incarcerated into the workplace. Businesses also decide who has access to employment with them through their choice of whether to locate their facilities near public transportation or in regions of a country with high unemployment.⁸³

Increasingly, investments in human capital involve advancing gender equality. Women possess significant knowledge and skills that can contribute to effective responses to climate change, including building community resilience. Their unique knowledge of community dynamics and skills in the use and management of natural resources enhances the efficiency and sustainability of climate change response efforts.

One leading proponent of human capital advancement in the cotton sector is the BCI – the largest cotton sustainability program in the world. Established by WWF (formerly the World Wildlife Fund) and supported by leading companies such as H&M (formerly Hennes & Mauritz), Adidas, and Ikea, BCI aims to train five million farmers, covering 30 percent of global cotton production, in sustainable farming practices by 2020. In 2016–17, Better Cotton was grown in 21 countries by 1.3 million licensed BCI farmers and accounted for 14 percent of global cotton production.

BCI works through Implementing Partners (IPs) – including non-governmental organizations (NGOs) and companies – to help farmers acquire the social and environmental

knowledge they need to cultivate Better Cotton. Each IP supports more than 4,000 Field Facilitators who, in turn, run Learning Groups across communities and regions to master best practice techniques in line with the Better Cotton Principles and Criteria, which define sustainable cotton through seven key standards:

- Crop protection – to restrict the use of hazardous pesticides.
- Water stewardship – to encourage collective action towards sustainable use of water at a local level.
- Biodiversity management – to identify and map biodiversity resources.
- High Conservation Value Assessment – to safeguard against any negative environmental or social impacts that may result from land conversion.
- Soil management – to encourage better nutrient management through mandatory soil testing.
- Climate change – to focus attention on enhancing adaptive capacity and reducing greenhouse gas emissions from land use associated with cotton production.
- Gender equality – to offer improved guidance on various topics such as child labor, sanitation facilities and equal payment for women.⁸⁴

CottonConnect was established in 2010 to increase transparency by connecting brands and retailers with their supply chains; to empower farmers to be more resilient and productive; and to enhance the livelihoods of smallholder farmers and their communities. The goals of the organization include building more resilient supply chains that manage risk better, provide security and stability of supply, increase productivity, improve livelihoods, and have reputational benefits for brands. Since 2014, CottonConnect has worked with 135,000 farmers globally and increased the land under sustainable cultivation by almost 500,000 acres.

Women in the cotton supply chain generally report having little or no training in agricultural best practice. CottonConnect observes that engagement is often targeted towards men, effectively excluding women from acquiring the skills necessary to build resilience for their

farms and their communities. Engaging women needs to be culturally sensitive to overcome these barriers. CottonConnect reports that without specific outreach efforts only 4 percent of women join any form of training that can assist them in their roles as farmers and champions within their communities.⁸⁵ Where women are more marginalized, supporting their ability to take on higher-value roles by providing technical training along with better awareness of their literacy, health, and rights helps them to earn higher incomes and have greater influence over cotton production.

It is in this spirit that CottonConnect established a series of initiatives for women. These programs address the challenges women face at home and on the farm and are comprised of complementary initiatives: Responsible Environmental Enhanced Livelihoods (REEL); the Farmer Business School; “Women in Cotton”; and REEL Rights & Life Skills Education Programme. The programs’ objectives are to build knowledge on basic education and rights; advance women’s technical skills related to cotton production and enterprise management; and connect markets by increasing demand for sustainable cotton and improved supply chains.

“Women in Cotton” focuses on women as key drivers of change in the cotton sector. The program provides training including education in literacy, numeracy, rights and health to enable women to take advantage of increased livelihood opportunities, both within cotton and through supplemental income by running their own enterprises.

The REEL Rights & Life Skills Education Programme includes education on water, hygiene and sanitation, sexual and reproductive health as well as occupational health and safety to improve the wellbeing of women and their families. It also delivers rights training with information on child labor and women’s rights, improving women’s ability to reduce child labor while enhancing their own working conditions and status in the community. Finally, it offers training on enterprise development, which consists of business skills and micro-enterprise training to give women supplementary income during the cotton off-season.

Results from a group of 500 women and 150 adolescent girls indicated that 84 percent are using soap for hand washing, up from 9 percent; 72 percent are aware of anaemia, up from 4 percent; 47 percent are taking iron

/ folic acid; and 27 percent are using a sanitary napkin, up from 1 percent.⁸⁶ It is critical to engage women so that they see themselves as agents of change. If they do not join conversations that focus on safe, sustainable and profitable agriculture, their transformative potential remains unlocked.

Investments in human capital are vital, even for the largest actors in the cotton industry. Olam International is one of the world's largest suppliers of cotton, with over twenty thousand customers worldwide. Its notable investments in human capital include partnerships in the Ivory Coast and India. In the Ivory Coast, Olam's subsidiary Société d'Exploitation Cotonnière Olam (SECO) provides technical training to more than 16,800 smallholder cotton farmers on issues ranging from finance, literacy, education, healthcare and, of course, farming practices. Initially dedicated to smallholder cotton growers, the SECO literacy program has evolved to include farming communities. SECO engages groups of volunteers to teach the local youth and women who are unable to go to school, reaching over 3,000 people since 2011. In India, Olam is working with IDH (the Sustainable Trade Initiative) to deliver training on gender awareness to 2,000 field facilitators. These facilitators will, in turn, reach over 1 million cotton, spice and grape farmers across India and design the farmers' training so that they can input to further gender-balanced interventions and trainings across the country.⁸⁷

2.3 Social Capital

Social capital refers to strong relationships, collaborations, and bonds of mutual support and cooperation that are essential for addressing a systematic global challenge such as climate change. When reciprocal claims for support can be made within communities in times of stress, this adds considerably to adaptive capacity. Activities and businesses that strengthen social bonds and aid the spread of ideas and resources are considered extremely important elements of social capital. A company might enhance social capital by establishing planning boards designed to evaluate risk and create strategies for resilience. These boards should include worker representatives. Social media and technology companies might work to enhance virtual social networks that can provide support in times of crisis.⁸⁸ Companies that help to build social networks are also contributing to

social capital. Finally, collaborative initiatives that build cooperative relationships across supply chains, amongst peer companies and with other stakeholder groups, also contribute to social capital.

The Sustainable Apparel Coalition (SAC) is the apparel, footwear, and textile industry's leading alliance for sustainable production and is the steward of the Higg Index, used to measure environmental and social impacts across the supply chain. As of 2017, More than 10,000 customers around the world use the Higg Index to improve sustainability performance. Higg Index data spotlights areas that require improvement and delivers a functional roadmap to sustainable design choices. Companies across the supply chain use the Index to engage with each other, developing partnerships as they streamline the process of measuring, guiding, tracking, verifying, and sharing sustainability performance. By joining forces in the Coalition, brands and retailers not only share best practices and gain invaluable insights for their own businesses, they help to accelerate the pace of innovation across the entire industry. They also establish a credible collective voice with policymakers on regulations that affect everyone's future. Small- and medium-sized businesses also can gain large benefits. They can make cost-effective progress on sustainability, forge new business opportunities, and improve sourcing practices by finding reliable supply chain partners with robust sustainability credentials. With accurate and verifiable sustainability data in hand, brands and retailers can demonstrate their sustainability performance to consumers and investors, which strengthens credibility and reputation.

PVH (formerly the Phillips-Van Heusen Corporation) is one of the largest apparel companies in the world, operating in over 40 countries and with annual revenues in excess of US\$9 billion.⁸⁹ In 2017, PVH implemented the Higg Index to better understand and report its environmental and social supply chain impacts. It had already applied the Index to 530 facilities across the supply chain, including approximately 80 that involve wet processors (e.g., mills, laundries and dye-houses).⁹⁰ One of the most important appeals of the Higg Index is that it is a standardized tool with cross-industry appeal and uptake. This means that assessment and verification results can be shared and contrasted with peers across the industry, and it further minimizes the danger of audit fatigue and assessment costs – a major problem in the private sector when companies are faced with competing assessment tools.

When taken together, the countries of sub-Saharan Africa are the fifth largest cotton exporter worldwide and employ about 3.4 million smallholder farmers. Consequently, it is estimated that more than 20 million people in the region are directly or indirectly living off cotton. Improving the working conditions of smallholder cotton farmers holds a significant potential for impact. Cotton made in Africa (CmiA) works towards the continuous improvement of cotton production in Africa, from the environmental and social spheres, by building up a strong alliance of retailers and brands that rely on CmiA certified cotton. The guiding principle of CmiA is to help people through trade, and one of the key elements of CmiA's theory of change is collaboration across different types of stakeholders. Specifically, it has established an alliance of around 30 retailers and fashion brands and more than 60 spinning mills, including Cargill, Louis Dreyfus Company, ASOS, and Armani.⁹¹ These companies purchase CmiA cotton and pay a licensing fee to use the seal. The proceeds from licensing fees are reinvested in the project regions within community projects, such as improving school infrastructure or building maternity wards.

The collaboration between private companies and public- or mission-driven groups is the key to success for CmiA. For instance, the Deutsche Investitions- und Entwicklungsgesellschaft and the Aid by Trade Foundation come together with philanthropic organizations such as the Bill & Melinda Gates Foundation and the C&A Foundation, as well as implementation partners such as WWF, to catalyze the transformation of the entire cotton value chain in Africa. This model of collaboration has delivered positive impact to more than one million smallholder farmers across Africa.⁹²

2.4 Physical Capital

Physical capital refers to infrastructure, equipment, facilities, logistics, communications, utilities, and even genetic agricultural resources. Physical capital is vital in securing communities against extreme weather events that are increasing in intensity and frequency. Flood defenses are increasingly common in low-lying states and coastal regions, and climate-proofing of infrastructure is recommended in locations experiencing stronger storms. Investments in roads, bridges, and stronger protections

for utility services are vital for ensuring continued links across supply chains and between workers, employers, and consumers in the aftermath of climate-related events. Early warning systems along with hazard, exposure, and vulnerability mapping provide companies with tools to aid disaster preparedness and enterprise risk management.

Allianz Re was critical to the development of a multi-stakeholder partnership to provide governments and NGOs with better information on rice crop growth to support the development of more robust food security policies in addition to new and enhanced crop insurance programs in Southeast Asia. The Remote Sensing-based Information and Insurance for Crops in Emerging Economies (RIICE) initiative increases the availability and quality of information on rice yields to help improve management of domestic rice production and distribution, especially after extreme events. It also provides access to insurance solutions to alleviate the financial effects on farmers that stem from natural catastrophes such as flood and drought. Radar images are used to determine how much rice grows in each area, each season, ultimately arriving at a total national yield estimate. By analyzing time series, RIICE determines the extent of rice cropping, monitors rice growth, and identifies crop damages and losses caused by droughts and floods. The data captured by the satellites is processed and then translated into readable maps.⁹³ A similar technology could be used for cotton crops.

General Mills is an American multinational manufacturer and marketer of branded consumer foods sold through retail stores. In 2015, the company committed to two important climate targets. First, an absolute reduction of greenhouse gas emissions of 28 percent by 2025 across its value chain; and, second, a commitment to actively build and support adaptation efforts across key commodities and sourcing regions, including efforts to improve the ability of its growers and other suppliers to adapt to climate change. The adaptation commitments include investments in proprietary plant breeding programs with the goal of providing farmers with seeds that deliver high-yield, high-quality crops despite climate variability; and the development of tools and systems that monitor climate change at the regional and farm levels with the goal of enabling more rapid adaptation to changes in weather. Investments in adaptation are projected to amount to close to US\$100 million.⁹⁴

Vale is a Brazilian-based metal and mining company, ranking as one of the largest producers of iron ore and nickel in the world. The company invested more than US\$18.6 million to implement a short-term forecasting program at a weather monitoring center to issue weather warnings to prepare its port facility for extreme weather events. The data gathered from this early warning is used for forecasting and nowcasting (forecasts for the next 30 minutes to 3 hours), enabling Vale to closely monitor weather conditions; and, when shared with the local authorities, helps municipalities prepare for extreme weather events.⁹⁵

2.5 Financial Capital

Financial capital refers to the volume of available financial resources and access to financial goods and services. Financial capital concerns both the mobilization of increased financial flows in support of resilience and the critical expansion of financial services to frontline sectors, companies, and communities. Companies can enhance financial capital through the provision of insurance schemes; income, asset, and livelihood diversification; the provision of catastrophe bonds; the development of microfinance products; and the facilitation of cash transfers to frontline communities. Improved employment practices can also enhance financial capital, as businesses can set the wage and working conditions for individuals impacted by climate change. Companies make strategic choices around whether to pay a living wage to their frontline workers, as well as whether these workers will receive the same benefits in insurance, paid leaves, and predictable and flexible working hours that the white-collar workforce receives. This has implications for the financial resources individuals can call upon when faced with climate hazards.⁹⁶

The transformations required to build the resilience of the cotton supply chain require investments as well as financial stability for farmers. By improving access to finance and, in particular, financial products suited to the needs of smallholder farmers, stakeholders can contribute to increased yields, healthier farmer households, and increased knowledge and practice by farmers to improve management of their production, even in cases of disruption.

The provision of microfinance has become a key means to channel funding to the upstream agricultural supply chain. With support from the Canadian International Development Agency, the International Finance Corporation developed a cotton advisory services project in southern Tajikistan in 2010. It has helped Tojiksofirot Bank and First MicroFinance Bank to introduce a new form of cotton lending, and between them lend nearly US\$5 million to local small-scale farmers. More than 96 percent of the loans have been repaid, which is a much higher than average repayment rate for the industry. This has increased confidence in financial institutions and particularly in these products, which has improved the financial health of farmer households. The project also provided training for farmers to improve understanding of productivity and gender issues, with results in yield increase at participating cotton farms 37 percent higher than at farms that did not take part – with direct impacts on profitability. One of the main benefits from these new financial products has been the fact that farmers receive monthly salaries, shielding them from price volatility and variations in demand.

Weather index insurance has also become an important product to drive investments and safeguard against climate losses. The Centenary Bank, a private commercial bank in Uganda, was established with an objective of serving the rural poor and contributing to the country's economic development. The bank provides financial services to over 1.4 million clients, with a focus on microfinance. The savings and credit services offered by the bank already provide benefits that enable climate risk management by value chain actors within the local rice industry. For example, credit has facilitated diversification of income sources by some of the actors and savings have provided a buffer when farmers have experienced financial losses. The bank is also looking at the development of weather index insurance, and the provision of complementary services, such as dissemination of climate and weather information through existing communication systems used by financial service providers. In 2010, Sompoo Japan Nipponkoa observed that farmers in northeast Thailand were suffering significant revenue losses as a result of extreme weather events and other climate impacts. Very few insurance products were available to protect them against these risks; and, as a result, extreme weather events – such as flooding and drought – posed serious threats to their ability to support themselves and their families. To address this

problem, Sompo launched a new weather index insurance product, which also responded to increased demand for financial and insurance products to cover the revenue losses caused by extreme weather events. Weather index insurance products (weather derivatives) provide compensation and/or insurance payments to farmers when temperatures and rainfall breach certain thresholds or when other extreme weather events occur.⁹⁷

Cash injections are also important in the immediate aftermath of climate events to resuscitate small businesses and revitalize the supply chain. The Coca-Cola Company realized this soon after Typhoon Haiyan devastated the Philippines in early November 2013. The strongest tropical storm to ever make landfall, Haiyan was responsible for more than 6,000 deaths and more than US\$4 billion in economic losses. Coca-Cola and its local bottling partner contributed more than US\$2.5 million in cash and in-kind contributions to community rehabilitation. This was with the goal of having small traders and shops reopened as soon as possible, realizing that this was vital to drive local economic recovery, but also necessary in ensuring that Coke was quickly on sale once more.

In the cotton sector, the organization Fairtrade has established a Minimum Price and additional Premium for seed cotton farmers and producers to invest in strengthening their organizations, developing their businesses and improving the infrastructure of their communities. Set by region and variety, the price ranges from European Union euro (€) 0.66/kg in Kyrgyzstan to €0.39/kg in South Asia. The Fairtrade Minimum Price aims to cover average costs of sustainable production and provides a safety net when market prices fall below a sustainable level. When the market price is higher than the Fairtrade Minimum Price, the buyer must pay the higher price. Producers and traders can also negotiate higher prices based on quality and other attributes. Producer organizations are paid an additional Fairtrade Premium of €0.05/kg to invest in business development as well as community and environmental projects chosen by their members. Through Fairtrade, thousands of cotton farmers have already improved their lives; cotton cooperatives have become better organized; farmers are more productive; and women farmers are receiving the same rewards as male farmers, from voting rights to equal pay.⁹⁸

2.6 Political Capital

Political capital refers to access to decision-making that shapes policy environments to enable resilience. Just as climate change undermines the realization of human rights, the strengthening of human rights is arguably the most important intervention to enhance resilience. Access to information helps vulnerable populations anticipate climate-related events and take preventative action. Being more considered in decision-making enables marginalized communities to help shape public policy in a manner that accounts for their specific vulnerabilities. And access to justice enables communities to hold both the public- and private-sector accountable for failures to build resilience in a manner that is proportional. Political capital is also critical to addressing the social, cultural, and economic inequalities that exacerbate risk to climate change. These inequalities include the differentiated vulnerability faced by women, indigenous peoples, and the urban poor. Companies can enhance political capital by advocating for reduced gender inequality and marginalization in all its forms; the extension of social safety nets and protection to women; and improved access to information, decision-making, justice, education, health, energy, and housing.



3. VISION FOR THE FUTURE

The work of building climate adaptation across global supply chains has begun. The private sector is investing in natural, human, social, physical, financial and political capital to enhance resilience inside individual companies, across complex global supply chains and within frontline communities. However, the work of adaptation needs to be deepened and accelerated. This section provides a vision, consisting of four recommendations, on how to improve private-sector leadership on adaptation over the coming years.

3.1 Commit to Resilience

According to research conducted by Yale University and the NewClimate Institute, 6,225 companies and investors from 120 countries, representing at least US\$36.5 trillion in revenue, have pledged at least one climate commitment.⁹⁹ These commitments are housed within a range of initiatives including the setting of science-based emissions reductions targets; purchasing one hundred percent of energy needs from renewable sources; ending all commodity-driven deforestation in supply chains; and reducing short-lived climate pollutants.

The sheer scale of these commitments is remarkable. The World Bank estimated the global economy as being worth US\$74 trillion in 2017, meaning corporate climate commitments now represent half of the global economy.¹⁰⁰

In recent years, companies across the globe have formalized their climate leadership into tangible commitments. For example, the We Mean Business Coalition invites companies to make emissions reductions pledges across 11 commitment areas including science-based targets, renewable energy procurement, and ending commodity-driven deforestation. To date, close to 900 companies, with market capitalization close to US\$17 trillion, have made over 1400 commitments. The time is ripe to complement these mitigation-focused commitments with a new pledge on climate resilience.

A resilience commitment should have a clearly stated business rationale / purpose for focusing on resilience as well as goals among employees and supply chain partners, which can serve as guiding principles in the event

of breakdowns in systems with unexpected events. Most companies have failed to analyze the full impact of climate risk on business risk factors including strategic, financial, operational, human resources, compliance and legal risks. As a result, they do not have a full understanding of the business rationale for action. The business case can be strengthened by equipping companies with a methodology to build climate resilience backed up by documented new practices, processes, and/or investments made – highlighting opportunity as well as risk and the intended multidimensional Return on Investment.

Just as leadership on greenhouse gas emissions reductions is increasingly viewed through the prism of science-based targets, leadership on climate risk and resilience needs to be aligned with scientifically robust assessments of risk and resilience. This means commitments that accept the IPCC definition of climate risk (consisting of hazard, exposure and vulnerability) rather than following an antiquated approach to risk, based merely on exposure to a climate event. In addition, approaches to resilience need to be aligned with IPCC scenarios and framed around mobilizing resources in support of the six capital assets essential to adaptive capacity (natural, human, physical, social, political, and financial capital).

To succeed, businesses rely upon the availability of resources; the security of supply chains and transport routes; the availability of a reliable workforce and infrastructure; and the rising prosperity of consumers and shareholders. Consequently, an approach to risk and resilience that isolates these issues inside one company

- **Conduct a science-based assessment of their climate risks:** The IPCC defines climate risk as determined by the existence of physical hazards, exposure to those hazards, and underlying vulnerability. With this commitment companies pledge to undertake an assessment of climate risk grounded in this definition to properly understand:
 - Projected increases in the intensity and frequency of climate hazards, including hurricanes, cyclones, changing precipitation patterns, extreme temperatures, droughts, floods, storm surges, sea-swells, salt-water intrusion, acidification of the oceans, landslides, and the spread of waterborne, vector-borne and airborne diseases as well as the spread of pests.
 - Exposure to these hazards right across the supply chain, including impacts on raw materials extraction, workforce wellbeing, manufacturing, distribution, and retail.
 - Underlying vulnerabilities inside the company, across the supply chain and within frontline communities. This means assessing the propensity of exposed elements whether people, ecosystems, biodiversity, economic sectors, complex supply chains or individual companies to suffer adverse effects when exposed to climate-related physical hazards.
- **Formulate a strategy to build resilience to climate risks based on six capital assets:** The IPCC defines resilience as “the ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner”. A resilient business will, therefore, be able to anticipate, absorb, accommodate and rapidly recover from climate events in its own operations and throughout its value chain. It will further contribute to resilient societies, which means moderating harm to socioecological systems and enabling people, the economy and natural systems to rebound quickly in the face of adversity. With this commitment companies pledge to formulate a strategy for resilience drawing on the six capital assets – the interdependent capacities that together address the underlying causes of vulnerability. They consist of human, financial, social, natural, physical, and political capital and are considered to be the key building blocks of resilience.
- **Report climate risks and strategy to build resilience:** The company will produce and use information related to climate risk and resilience in mainstream corporate reports out of a sense of fiduciary and social responsibility, in order to support the development of sound corporate strategies and the efficient allocation of capital.
- **Commit to collaboration:** Research conducted by Business for Social Responsibility (BSR) reveals that precompetitive collaboration allows companies to invest their resources in the sustainable development of their organization, market, and greater ecosystem. Working together to address sustainability challenges allows companies to coinvest in new market opportunities; build resilient, sustainable supply chains; overcome regulatory barriers; share the risk of new approaches with peer organizations; access donor funding to support innovation; shape industry standards; and build legitimacy and support for a preferred approach.¹⁰¹ In the cotton sector, an increasing number of collaborative initiatives are providing guidance on why sourcing sustainable cotton is good for business; the types of sourcing options available to companies; how to source sustainable cotton; and are reducing the time, financial and labor burden on individual companies associated with understanding and acting on sustainable cotton. Many of the pioneer collaborations are also improving the uptake and traceability of sustainable cotton; and equipping farmers with the skills, practices and enabling structures to adapt, increase levels of independence and grow cotton sustainably. Companies should commit to working with one of the industry pioneers profiled in this report, including Fairtrade, BCI, CmiA, and SAC.

is unlikely to have much impact. Too few companies have mapped the full spectrum of risks across their full supply chain and are therefore working with flawed approaches to risk management. Commitments should, therefore, include a process of building knowledge and internal capability to understand the full implications of risk and resilience across the full value chain.

Article 4 of the Paris Agreement provides the basis for commitments that are sequenced, provided the sequencing represents a progression over time and reflects the highest possible level of ambition based on circumstances and capabilities. On the mitigation side of the equation, the sequence has three steps – peaking of greenhouse gas emissions; followed by rapid reductions; and, eventually, landing at net-zero emissions in the second half of the century. A similar approach to sequencing could be applied to resilience commitments. Sequencing essentially provides an on-ramp for ambition, allowing those making the commitments to begin with a goal that is balanced between ambition and pragmatism, is achievable, provides confidence that goals can be met, but also offers a stretch goal and a roadmap for how to ultimately get there.

Conditionality is also a useful element to include in a commitment as the attainment of climate goals is often dependent on a complex ecosystem comprising governments, peers, suppliers, and consumers. Designing a goal that has elements of conditionality to it is a means for making an offer on ambition while also protecting those making the offer from being isolated and operating without a conducive enabling environment. Often, it provides a basis to balance the offer with specific asks, notably aimed at government.

3.2 Improve Understanding of Risk and Resilience

Some companies are beginning to address climate risks by building on existing business risk assessment activities and integrating adaptation initiatives into enterprise-wide risk management systems.¹⁰² However, most businesses are misdiagnosing climate risk and failing to build comprehensive strategies for resilience.

Research conducted by BSR and CDP, revealed that 72 percent of suppliers accept that climate risks could significantly impact their business operations, revenue or expenditure; yet only half of these are currently managing this risk.¹⁰³

A third team of researchers reviewed more than 1,600 corporate adaptation strategies and found significant blind spots in companies' assessments of climate change impacts; their approaches to resilience; and in their development of strategies for managing climate impacts. In 2016, CDP collected voluntary public disclosures on physical climate change risks from 1,959 companies, representing 69 percent of global market capitalization. Among the respondents, 1,630 companies disclosed the physical climate change risks they faced in the reporting year as well as the potential business impacts of those risks; the estimated financial implications; the management method implemented to deal with risks and the cost of that adaptation. More than half of reporting companies expect that climate change will increase their operational costs (56 percent) and/or reduce or disrupt production capacity (52 percent); while 17 percent report that at least one identified climate risk could result in an inability to do business for a particular geography or period of time. However, these companies appeared to be underestimating and misunderstanding the various pathways through which climate change can manifest in business impacts, from lost consumer purchasing power to employee absenteeism to raw material shortages. The authors highlight that most global estimates predict that the cost of climate impacts will run into trillions of dollars and yet the aggregate financial risk reported through corporate disclosures runs only in the tens of billions – a discrepancy of at least two orders of magnitude. The researchers conclude that companies report the costs of both physical climate change impacts and the strategies required to manage them sporadically and inconsistently, while the overall strategies themselves reflect a narrow view of risk that underestimates supply chain and broader societal impacts. The study concluded by suggesting a wider view of climate risk management in the private sector with new partnership models.¹⁰⁴

Efforts are underway to build a three-dimensional understanding of climate risk within the private sector; and, thus, improve the state of adaptation across complex

global supply chains. Climate risk is determined by the existence of physical hazards, exposure to those hazards and underlying vulnerability. Although most companies are aware of the existence of climate-related hazards, such as extreme weather events, and are often well-informed about their potential exposure to these hazards, they lack a fundamental understanding of vulnerability, the underlying weaknesses in their own systems that exacerbate risk.

Climate hazard refers to the possible, future occurrence of natural or human-induced physical events that may have adverse effects on vulnerable and exposed elements.¹⁰⁵

Exposure refers to the inventory of elements in an area in which hazard events may occur.¹⁰⁶ In other words, a hurricane moving slowly through the mid-Atlantic may be influenced by climate change, but it does little physical damage to human populations unless it makes landfall and passes through population centers. It is the presence of people; livelihoods; environmental services and resources; infrastructure; or economic, social, or cultural assets that turns a hazard into a risk.

A growing number of population centers are exposed to climate-related hazards. Rapid development over the past forty years means that South and East Asia are heavily exposed to hazards because of their large coastal populations in low-lying areas; populations that form the customer and employee base of the world; and many of the workers in global supply chains. A report prepared by the New Economics Foundation predicts that the “human drama of climate change will largely be played out in Asia, where over 60 percent of the world’s population lives, over half of those live near the coast, making them directly vulnerable to sea-level rise.”¹⁰⁷ Considering that in 2014, East Asia accounted for 60 percent of the container volume among the 100 largest ports in the world – equivalent to 4 times the volume of European ports and 6 times U.S. ports – the implications of climate-related hazards in the region for global value chains cannot be underestimated.¹⁰⁸

Vulnerability is the propensity of exposed elements whether people, ecosystems, biodiversity, economic sectors, complex supply chains or individual companies to suffer adverse effects when climate-related hazards occur.¹⁰⁹ It is the underlying weaknesses in their own systems that exacerbate risk.

The first step for any company is to apply due diligence criteria to climate hazards, exposure and vulnerability, as they would with other risk factors such as financial, economic and political circumstances. This should be considered an essential element of the social contract between companies and communities.

Conducting appropriate due diligence can be used to improve understanding of climate vulnerability. In the context of climate change, this involves a four-step process to identify risks; determine potential outcome severity; clarify the scope of responsibility; and recommend actions to build resilience to the identified threats.¹¹⁰

All companies are connected to climate-vulnerable communities in some capacity, although often not in their direct operations. To determine the scope of responsibility and appropriate remedy, a company must first map its operations and the operations of significant business partners to identify where the company operates in known high-risk climate-vulnerable communities. Companies should determine whether they are causing or contributing to increasing the vulnerability of high-risk communities, or whether they are directly linked to a business partner that is increasing the vulnerability of an at-risk community. Put differently, companies should ask whether their operations (or significant business partners’) cause or contribute to weakening the realization of human rights that would protect vulnerable communities from the negative impacts of climate change. For example, a food and agriculture company with a significant operational footprint in a high-risk community should take corrective measures if it learns that its business partners have acquired land without contracts, making the proper enforcement of land rights after an adverse weather event more difficult, thus weakening rights realization. Similarly, a consumer goods company should be aware of heightened risk if it is manufacturing in a region with significant levels of discrimination against women in the workplace. This would place its own operations in jeopardy in the event of a significant adverse weather occurrence, should the women be forced to stay home. It would also reinforce local social norms that may deprioritize responses to women.¹¹¹

Risk mitigation can take many forms. Where due diligence reveals increased vulnerability caused by a company's own operations, the remedy should include a focus on strengthening capital assets in those communities to provide a forward-looking remedy that strengthens the community's resilience to adverse climate events. The company may also need to consider changing certain aspects of its operations, including diversifying water sources, mitigating risk in the workforce, updating land-acquisition methods, and incorporating ways to build capacity on preventing gender discrimination in the workforce.

3.3 Improve Investments in Capital Assets

As the examples in Chapter 2 (State of Adaptation) of this paper illustrate, companies across sectors are enhancing climate resilience by investing in six so-called capital assets. There is scope to improve private-sector understanding of, and investments in, these capital assets; notably by ensuring that all companies consider interventions across the full six, rather than siloing their adaptation strategies within one or two. In addition, there are options to become more expansive in a number of the asset categories.

For example, there is a great deal of scope to enhance financial capital to support adaptation in supply chains.

Supply chain decisions ultimately drive raw material extraction; all mechanical, chemical or thermal conversion in manufacturing; and all packaging and delivery from source to end consumer. This applies to food, clothing, medicine and machinery as well as all human infrastructure in our communities.¹¹² Therefore, procurement decisions are an impactful way to drive change towards climate adaptation by specifically buying climate adapted products or buying from suppliers having adapted their operations to a changing climate. Companies rolling out this approach on a larger scale often reflect adaptation considerations in their procurement manuals, guidelines and scoring tools, etc., and use specific tools to channel finance to their supply chain.

Another area where companies can leverage supply chain engagement to strengthen climate adaptation is by providing suppliers with access to carbon markets. Marks and Spencer, for instance, has supported its small-scale suppliers to access carbon finance and sell carbon credits, thus diversifying their income and participating in responsible reforestation programs. Marks and Spencer has set up a reforestation program as part of its own commitment to becoming carbon neutral that includes farmers that are part of its own supply chain for tea and green beans in Kenya. The virtuous circle created by the company, which invests in reforestation projects through the Meru and Nanyuki Community Reforestation project in the country, hence supports some of its suppliers in developing activities that allow them to sell back carbon credits to the company; contributes to strengthening the human, social, financial, and natural capital of these communities; while also contributing to mitigation activities.¹¹³

Deepening agricultural markets and improving the predictability and reliability of the world trading system through reform, could reduce market volatility and help manage shortages. Moreover, economic instruments can foster adaptation by providing incentives for anticipating and reducing impacts. These instruments include risk sharing and transfer mechanisms, loans, public-private finance partnerships, payments to farmers for conserving ecological services, improved resource pricing (e.g., water markets), charges and subsidies. Taken together, these approaches could improve yields by about 15–18 percent. While these approaches can contribute to effective adaptation at temperature increases less than 2°C above pre-industrial levels, they are likely to be insufficient for warming above 4°C when combined with population-driven demand.

Beyond financial capital, there is also scope to improve social capital, particularly as it relates to collaboration.

A common response to supply chain disruption is to search for, acquire, and prolong materials vital for production. The capacity to acquire materials rapidly is improved with the use of prequalified suppliers. When a company has prequalified suppliers, it can ask them to increase the allocation of materials relative to potential rivals and competitors.

Increasingly, collaboration across sectors will also be required. The production of cotton, especially at the farming level, is interconnected with other areas of crop culture. Those other sectors are also vulnerable to the impacts of climate change, and are taking measures to reduce that vulnerability. It is very likely that synergies will emerge by analyzing what measures are being taken or need to be taken. Specifically, these could be measures around agricultural technology, skills and capacity building, as well as improving the relationships between buyers and sellers via robust codes of conduct and certifications.

Agricultural supply chains are vulnerable to climate change, and they are also characterized with other potential issues. Working conditions, transparency and traceability are particularly salient at once for agriculture and for the regions where cotton is produced. Measures and initiatives led by business already exist in these areas and leveraging those will ensure better engagement with stakeholders and, ultimately, better results. Specifically, this could include developing technologies that plug in to already existing platforms. It will also take the form of including climate considerations more explicitly in worker training programs.

3.4 Empower Women Workers

Physical capital refers to infrastructure, equipment, Women are vital to the cotton sector and to the broader goal of socioecological resilience. A growing body of evidence suggests that women's full and equal participation and empowerment, and their access to and control of spaces and resources, allows for multifold benefits to the global community.¹¹⁴ These include:

- Raising healthier, more educated families: Educating girls, often referred to as the single best investment for development, leads to better employment opportunities for those girls in adulthood, and to those adults raising healthier, more educated children. Moreover, "A study using data from 219 countries from 1970 to 2009 found that, for every one additional year of education for women of reproductive age, child mortality decreased by 9.5 percent".¹¹⁵

- Translating equitable land tenure into wellbeing: Countries where women lack any right to own land have on average 60 percent more malnourished children, while a lower proportion of the population has access to safe drinking water.¹¹⁶
- Guaranteeing inclusive decision-making benefits the community as a whole: Ensuring women are involved in community-level decision-making processes tends to produce increased focus on public goods, such as education as well as water and sanitation services.¹¹⁷
- Dramatically reducing food insecurity: "Closing the gender gap in agriculture would generate significant gains for the agriculture sector and for society. If women had the same access to productive resources as men, they could increase yields on their farms by 20–30 percent. This could raise total agricultural output in developing countries by 2.5–4 percent, which could in turn reduce the number of hungry people in the world by 12–17 percent".¹¹⁸
- Growing the economy: Over the last decade, the increased employment of women in developed economies has contributed significantly more to global economic growth than China.¹¹⁹ When women are able to develop their full labor market potential, there can be significant macroeconomic gains. Raising the female labor force participation rate to country-specific male levels would, for instance, raise GDP in the U.S. by 5 percent, in Japan by 9 percent, in the United Arab Emirates by 12 percent, and in Egypt by 34 percent.¹²⁰
- Making smart sustainable development decisions: Countries with higher parliamentary representation of women are more likely to ratify environmental agreements and more likely to set aside protected land areas.¹²¹
- Improving the business bottom line: Having women in leadership positions, such as on boards, councils or governing bodies, has shown to be directly linked to higher business performance. Among a multitude of research leading to similar conclusions, one study revealed that of Fortune-500 companies ranked according to the number of women directors on their boards, those in the highest quartile in 2009 reported a 42 percent greater return on sales and a 53 percent higher return on equity than the rest.¹²²

There are a number of steps that can be taken to empower women and reap these rewards:

- Policy processes need to be democratized by increasing women's participation in decision-making and the design of public policies. Women – particularly those on the frontlines of climate change – can contribute to the enhanced understanding of risk; and, by speaking to their own disproportionate vulnerability, can ensure that policy responses are more comprehensive and effective. Women are often excluded from policy processes and are, therefore, underserved by the policy responses.
- Women's empowerment needs to be concrete and not just rhetorical. Gender sensitive approaches to policymaking that understand gender-based discrimination are a starting point; but, ultimately, gender transformative approaches that promote equality as a priority, and aim to transform unequal relations, power structures, access to and control of resources, and decision-making are critical. The Swedish government's decision to create a feminist foreign policy was presented as a benchmark to aspire to.
- Women need to be promoted to leadership positions within both the public- and private-sector, and these need to be in meaningful positions.
- The strengthening of human rights is central to climate ambition in terms of improving mitigation, adaptation, finance, and technology, and not a parallel but separate sustainability goal. Access rights can ensure that women have a seat at the table when policies are being designed; provide tools for resilience-building; and, with prior-informed consent, ensure that women have agency over their communities and resources.
- We need to connect the dots from the local level to national and global policymaking. Grassroots and community organizations are underrepresented at the national and global levels, leading to top-down decision-making that often ignores local contexts and experiences. Improving financial flows from the global to the local level to ensure that more climate finance reaches the most vulnerable communities is particularly important.

- We need to address structural problems that are non-climate in nature. For example, a failure to provide healthcare, parental leave, equal pay, secure labor contracts, land rights, and access to financial services amplify climate risk for women. Governments and companies should address these social, cultural, political, and economic inequalities and not focus exclusively on climate policy responses.

At minimum, corporate actions should be gender sensitive – companies should understand and take into consideration sociocultural factors underlying sex-based discrimination that amplify risk. In application, 'gender sensitive' has come to mean 'do no harm'. Beyond this, companies should work towards interventions that are gender responsive - identifying, understanding, and implementing interventions to address gender gaps and overcome historical gender biases in policies and interventions. More than 'doing no harm', a gender-responsive policy, program, plan or project aims to 'do better'. Ultimately, companies should aspire to climate resilience practices that are gender transformative – whereby gender is central and promoting gender equality is a priority that aims to transform unequal relations, power structures, access to and control of resources, and decision-making spheres.



4. CONCLUSION

Climate change is one of the defining challenges of the twenty-first century, threatening biodiversity and natural systems; undermining the realization of human rights; impeding efforts to advance the Sustainable Development Goals; and posing a material risk to companies across complex, interconnected and global supply chains.

The private sector is responding to the climate challenge by elevating and accelerating its leadership; notably through initiatives to reduce greenhouse gas emissions. More than six thousand companies, representing over US\$36 trillion or half the global economy, have made commitments related to *inter alia* energy use, transportation, and land use. A growing number of companies are beginning to pursue adaptation measures designed to anticipate, avoid, absorb and recover from climate impacts. These include investments in human, natural, social, physical, financial and political capital assets – the essential building blocks of climate resilience. These efforts are important foundations, but they remain siloed and are often two-dimensional, representing an understanding of exposure to climate hazards, but missing the critical importance of vulnerability, or the underlying weaknesses that can amplify risk.

The story of climate risk and resilience is evident across the cotton supply chain. Cotton is the world's oldest commercial crop and one of the most important fiber crops in the global textile industry. Cotton is grown in more than 100 countries and an estimated 350 million people work in the cotton sector, with 100 million households directly engaged in cotton production through family labor, farm labor and workers in ancillary services such as transportation, ginning, baling and storage.¹²³ Climate change is an additional stress for the cotton industry. Rising costs of production, fluctuating market prices, decreasing yields, the notorious complexity of the cotton and textile supply chain, and the need to compete in global markets distorted by subsidies are already challenging producers in developing countries. In this context, understanding climate risk and enhancing resilience right across the supply chain becomes critical to the viability as well as the sustainability of this sector.

This paper offers a vision, consisting of four recommendations, on how to improve private sector leadership on adaptation over the coming years.

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ABOUT THE GLOBAL COMMISSION ON ADAPTATION

The Global Commission on Adaptation seeks to accelerate adaptation action and support by elevating the political visibility of adaptation and focusing on concrete solutions. It is convened by 19 countries and guided by more than 30 Commissioners, and co-managed by the Global Center on Adaptation and World Resources Institute.

GLOSSARY

| | | | |
|-----------------------|--|--------------|--|
| BCI | Better Cotton Initiative | IPCC | Intergovernmental Panel on Climate Change |
| BOM | Bill of Materials | IPs | Implementing Partners |
| BSR | Business for Social Responsibility | IV | Intravenous |
| CDP | formerly the Carbon Disclosure Project | NGOs | Non-governmental organizations |
| CmiA | Cotton made in Africa | OCS | Organic Cotton Standard |
| CO₂ | Carbon dioxide | PC | Personal computer |
| € | European Union euro | PVH | formerly the Phillips-Van Heusen Corporation |
| FAO | Food and Agricultural Organization | REEL | Responsible Environmental Enhanced Livelihoods |
| GDP | Gross Domestic Product | RIICE | Remote Sensing-based Information and Insurance for Crops in Emerging Economies |
| GOTS | Global Organic Textile Standard | SAC | Sustainable Apparel Coalition |
| H&M | formerly Hennes & Mauritz | SECO | Société d'Exploitation Cotonnière Olam |
| IDH | the Sustainable Trade Initiative | WEF | World Economic Forum |
| ILO | International Labour Office | WWF | formerly the World Wildlife Fund |