

ESG Summer Series

How sustainable is your morning coffee?

- ◆ Climate change threatens coffee production as suitable land for coffee cultivation shrinks, and bean quality and yields decline
- ◆ Coffee industry is facing mounting pressure for supply chain transparency; technology to be a key enabler, in our view
- ◆ Investors are waking up to social risks, consumer choices and future developments to improve the industry's sustainability

This is the 4th report in our [ESG Summer Series](#) – looking at sustainability issues in less obvious places. These issues could grow to become bigger trends in the future.

Coffee plantation risks brewing: As many as 125m people depend on coffee production for their livelihood, but rising temperatures and a changing climate have put plantations under threat. Coffee plants are particularly sensitive to temperature changes, risking reduced yields and bean quality. Already we have observed increased pest and disease outbreaks due to temperature changes. With coffee being linked to deforestation and a shift in suitable growing regions, coffee plantations are at risk.

Supply chains in hot water: Pressure is rising for supply chain transparency, and with regulatory developments growing, we think the ability to collect data across the entire coffee supply chain is vital. Social conditions are of increasing concern, especially labour conditions whereby many coffee producing regions in Southern America have seen a 2x increase in working hours lost since 1995 due to heat stress. We believe technology can play a key role in improving coffee traceability, specifically blockchain – linking farmers to roasters to retailers more effectively.

Your coffee choice matters: Once the coffee reaches the shelves, it may be surprising to know a consumer's choice impacts the industry's sustainability. The decision between instant and ground coffee, and how your coffee is made, have variable impacts on emissions, energy usage and waste. Finding alternatives to disposable coffee cups that cannot be recycled, and choosing pods or capsules which do not contribute to landfill, are key to improving the sustainability of the coffee industry.

What's next for cappuccino lovers? Reusable coffee cups are commonplace for many regular coffee drinkers; however, we require more effort to reduce the industry's impact and ensure the reliability of the coffee supply chain. Regenerative agriculture, new species adaptations and technology are opportunities to increase supply chain resilience. Progress in standards and regulations provide certifications for increasingly concerning social risks. And innovative developments in lab-grown coffee and waste recycling create opportunity to reduce environmental impacts – as, demand for the product is likely to triple its production requirements by 2050 (source: World Economic Forum, 2021).

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Starting from the ground

What is brewing: From home to popular coffeehouses, coffee lovers across the globe consume over 400bn cups of coffee every day. Nearly 10bn tonnes of coffee is produced annually, primarily concentrated in regions known as the “Coffee Belt”. Brazil, Vietnam, Colombia, Indonesia and Ethiopia are the top five producers of coffee, accounting for over 70% of global production.

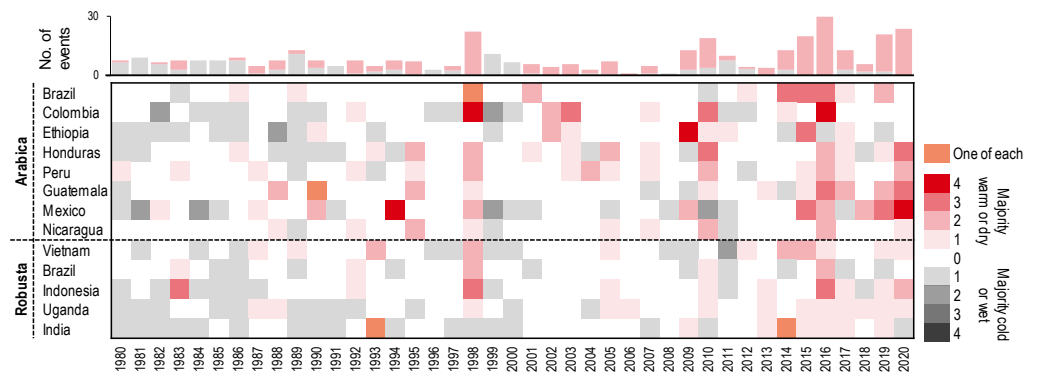
Small-scale farmers produce about 80% of the world’s coffee, and as many as 125m people depend on coffee production for their livelihood. But this popular drink could be at risk. IPCC has predicted a possible reduction in suitable area for coffee cultivation by the year 2050. These findings are supplemented by several studies that have shown rising temperatures encourages coffee plant pests and diseases.

Headed for trouble? Rising temperature and changing rainfall patterns pose several threats to coffee plantation. Consider the following impacts:

- ◆ **Reduced crop yields:** Coffee plants are sensitive to temperature changes, and prolonged heatwaves can hinder their growth and productivity. Arabica and Robusta are the two primary species of coffee cultivated globally. While Robusta is relatively less sensitive to heat (but more susceptible to drought), temperature plays a crucial role in the development and maturation of Arabica coffee. Arabica plants thrive in the temperature range of 18-21°C, and continuous exposure to temperatures above 30°C can damage them, resulting in reduced yields and compromised bean quality.

The temperature in several leading producers of coffee has already been increasing. For instance, Brazil, which is the top producer of Arabica, has witnessed an increase of 1.16°C in annual mean temperature between 1971 and 2021. A recent study, published in the journal PLOS Climate, found that the sub-optimal conditions that reduce coffee yield have increased since 1980 (figure 1). The last decade was found to be more acute with five of the six most hazardous years occurring since 2010.

1: Regional events for all sub-optimal climatic conditions, 1980-2020



Source: PLOS Climate, “Synchronous climate hazards pose an increasing challenge to global coffee production”, 8 March 2023, HSBC
Note: Climate variables considered are vapour pressure deficit, temperature and precipitation.

- ◆ **Shifts in suitable growing regions:** IPCC projects a decline of 38-89% in the Central American coffee-growing area by 2050 due to changing temperature and rainfall patterns, as well as the minimum altitude for cultivation to raise from 2,000 feet above sea level to 3,300 feet¹. A study published in the journal PLOS One modelled how growing conditions for three popular foods—coffee, cashews and avocados—will change by 2050, and found

Climate change is impacting both Arabica and Robusta production

50% of land suitable for coffee cultivation could be lost by 2050

¹¹ 'Climate & Coffee', National Oceanic and Atmospheric Administration (NOAA), 19 June 2015

coffee to be hit the hardest with the number of regions most highly suited for coffee cultivation declining by 50%².

- ◆ **Increased pest and disease outbreaks:** Warmer temperatures create a more favourable environment for pests and diseases that can ravage coffee plants. Coffee leaf rust, a devastating fungal disease, has already led to significant damage in Central and South America. The coffee rust epidemic in Colombia, from 2008 to 2011, reduced production by 31% on average, compared to 2007³.

Coffee leads to clearing of forests to meet the growing demand and beat the heat as it migrates upslope

The bitter notes: While rising temperature is known to brew trouble for coffee production, its cultivation is linked to deforestation which steams up the planet even more. Vast areas of tropical forests are often cleared to meet the growing demand for coffee and to meet the optimum temperatures for growth. Per the World Resources Institute (WRI), nearly 2Mha of forest was replaced by coffee plantation between 2001 and 2015. There are two methods of coffee cultivation: shade-grown (agroforestry system) which is environmentally sustainable, and sun-grown which requires **clearing of forests** and causes **depletion of soil nutrients**.



The coffee industry in many countries has already transitioned to full-sun production to meet the growing demand. This shift in the cultivation method is partly driven by the commonly held assumption that fungal infections are limited by sun exposure, as well as by the financial appeal. Additionally, leguminous tree species providing shade have been found to cause soil and water competition during severe drought, resulting in mortality of coffee plantation. Stuck in a vicious cycle, deforestation due to coffee plantations not only reduces carbon sinks but also eliminates critical habitats for several species, exacerbating **biodiversity loss** and climate change.

Water and energy consumption: Coffee production also requires substantial amounts of water across its lifecycle, affecting local communities and ecosystems in water-stressed regions. According to the Food and Agriculture Organization (FAO), a cup of coffee requires 140 litres of water to grow⁴. From roasting to brewing, the coffee supply chain guzzles energy, adding to its carbon footprint.



Regenerative agriculture and adoption of more resistant varieties might be the solution for coffee farmers

To overcome these pressing issues, various adaptation measures and sustainable solutions are being taken. For instance, **regenerative agriculture** through intercropping helps improve the quality and biodiversity of soil which is beneficial for coffee yield and quality. It also aids in long-term security for farmers who are among the most vulnerable to climate risk, by diversifying outputs and income. A study analysing intercropping between Macadamia and coffee, conducted over a seven-year period, found a 10% increase in coffee yield under rain-fed conditions, and the greatest profitability after the first five harvests in the irrigated coffee plantation regime⁵. Regenerative agriculture also aids in the reduction of the water footprint of coffee by increasing the soil's filtration and retention capacity.

Adoption of different varieties of coffee, such as the first generation (F1) Arabica hybrids⁶ and *Coffea stenophylla*⁷ which are more heat, drought and disease resistant, is also a promising adaptation strategy. Varieties such as Liberica and Excelsa also present the opportunity for commercially viable coffee that can be grown at lower elevations and warmer conditions compared to Arabica, and which exhibit better climate resiliency compared to Robusta.

² PLOS One, Expected global suitability of coffee, cashew and avocado due to climate change, 26 June 2022

³ 'The coffee rust crises in Colombia and Central America (2008–2013): impacts, plausible causes and proposed solutions', J. Avelino et al., Food Sec, 2015

⁴ 'Your morning cup of coffee contains 140 litres of water', World Economic Forum, 22 March 2019

⁵ Agronomy Journal, Irrigation and intercropping with macadamia increase initial Arabica coffee yield and profitability, 1 March 2015

⁶ 'New coffee varieties as a climate adaptation strategy: Empirical evidence from Costa Rica', G. Abraha Kahsay et al., World Development Sustainability, June 2023

⁷ 'Arabica-like flavour in a heat-tolerant wild coffee species', A. P. Davis et al., Nature Plants, 2021

Supply chain developments brewing

Sustainability regulations driving traceability

The desire for transparency across consumer goods is growing, and this includes the daily coffee we drink. Pressure from regulators, investors, retailers and consumers is driving the demand for greater traceability in the coffee industry, fuelled by both social and environmental concerns. Considering the environmental impacts of coffee plantations previously discussed, mapping the supply chain allows for greater transparency and collection of ESG metrics such as emissions, water usage and deforestation. With regulatory developments such as the EU Deforestation Law, the ability to gather this information across the whole value chain is vital.



Looking to workers across the supply chain, we believe **heat stress** is a growing concern and agriculture is particularly impacted. Southern America has seen a 2x increase in working hours lost since 1995 due to heat stress, which includes countries that are key coffee producers. This presents a key health & safety (H&S) risk to workers in coffee agriculture and a threat to global coffee production if precautions are not properly taken.



Technology plays a role in improving transparency and simplifying increasingly complex and dynamic supply chains. In our report, *Retail and supply chains* (January 2022), we identify key disruptive technologies that we believe are important in the transition to traceable supply chains: element analysis, blockchain, artificial intelligence (AI), internet of things (IoT), drones and virtual reality. Many of these technologies are applicable to the food sector and, specifically, coffee. **Blockchain** is expected to be especially useful for coffee traceability – this is a distributed database that allows for record-keeping, key for tracking the movement of coffee through the supply chain from farmers to roasters to retailers. The data included within blockchain technology are ‘tamper resistant’ meaning they can be used for regulatory purposes; giving stakeholders the ability to certify their products, provide quality assurance and ESG metrics, as well as making sure farmers get fair prices⁸. However, challenges remain with the vast amount of small-holder farms, with limited digitalisation and technological knowledge gaps⁹.

Standards and regulations



Alongside regional food safety requirements, the coffee market is increasingly observing sustainability standards develop. In the European Union, mandatory requirements include food safety/containments, pesticides and pathogens, among others, as well as additional sustainability certifications. These certifications are third-party-curated and aim to show compliance with social criteria – commonly known certifications include Fairtrade, Rainforest Alliance and Fair for Life¹⁰. **Fairtrade** aims to make a positive impact on producers and workers across the globe in a range of products, including coffee. *Fairtrade Minimum Price* safeguards against volatile markets with a set minimum price to be paid for products, and *Fairtrade Premium* provides additional funds for farmers and workers to invest in infrastructure, healthcare and social projects. Currently, Fairtrade coffee accounts for around 25% of total coffee sales in the UK¹¹.

Your coffee decisions matter



On an individual level, decisions regarding consumption impact emissions, waste and pollutants. Alongside the environmental effect, differences between bean type – Arabica or Robusta – and the consumer’s decision to purchase ground or instant coffee have

Variations in coffee type energy consumption

⁸ ‘Blockchain traceability model in the coffee industry’, A. Alamsyah et al., Journal of Open Innovation: Technology, Market, and Complexity, Volume 9, Issue 1, 2023

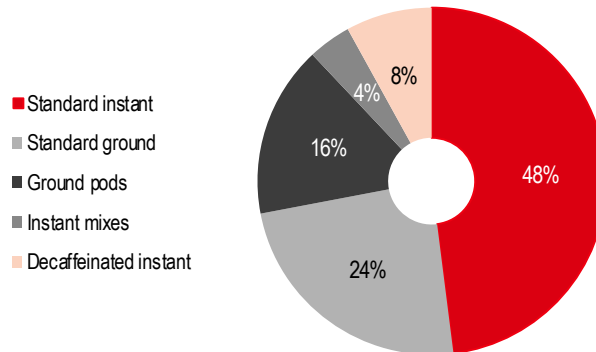
⁹ ‘Blockchain is not a silver bullet for agro-food supply chain sustainability: Insights from a coffee case study’, S.L. Bager, C. Singh, U. M. Persson, Current Research in Environmental Sustainability, 2022

¹⁰ ‘What requirements must coffee comply with to be allowed on the European market?’, CBI, 14 December 2022

¹¹ Fairtrade Foundation

just as different costs. Studies show that with respect to the lifecycle of both instant and ground coffee, instant has higher environmental costs than ground as it requires 7-11x more energy¹². Globally, instant coffee accounts for more than 34% of retail brewed coffee¹³.

2: Coffee volume sales in the United Kingdom



Source: 'An environmental and economic sustainability assessment of coffee production in the UK', P. Gosaltvir et al., Chemical Engineering Journal, 2023. Note: 2017 data.

End-of-life choices affecting landfill contributions and emissions



Ground pods represent 16% of UK coffee sales (figure 2), and although they provide the consumer the opportunity to create barista-style coffee at home, the sustainability of the product has come under investigation. In addition to emissions from preparation, post-consumer waste using pods and capsules disposed of represent a secondary share of emissions and landfill contribution¹⁴. We have observed retailers switching to aluminium pods and recycling schemes, as well as compostable pods (such as Grind Coffee) to help alleviate risks.

Consumer behaviour and sustainability

Disposable coffee cups present an additional environmental risk as the majority are unable to be recycled due to plastic linings and, thus, end up in landfill – in the UK alone, 2.5bn coffee cups are disposed of each year¹⁵. Presenting consumers with environmentally friendly alternatives and providing monetary incentives for reusable cups have proven to be effective solutions. Studies find that just under 93% of consumers are willing to bring a reusable cup if discounts exceed a certain value (USD0.265)¹⁶.

A time for coffee innovation



Seeking sustainable coffee has led to innovations such as **lab-grown coffee** and **energy production** from waste. Cellular agriculture application to coffee provides an opportunity to create coffee cells in a lab. This can be of great use to coffee-flavoured products; however, adoption into mainstream coffee drinking remains a social question for consumers. Additionally, taking demand away from small-holder farms in developing regions risks livelihoods¹⁷. Utilising coffee ground waste is a promising area to alleviate landfill contributions. Combining the grounds with polymers creates a material that can be used in the garment industry, and converting grounds into logs provides an alternative to wood for burning¹⁸. Additionally, opportunities lie in bioenergy production and building material from coffee cups.

¹² 'An environmental and economic sustainability assessment of coffee production in the UK', P. Gosaltvir et al., Chemical Engineering Journal, 2023

¹³ Euromonitor

¹⁴ 'Carbon footprint of different methods of coffee preparation', M. Cibelli et al., Sustainable Production and Consumption, 2021

¹⁵ 'Coffee waste: Companies offer up new solutions', BBC, 22 April 2021

¹⁶ 'Explaining the willingness of consumers to bring their own reusable coffee cups under the condition of monetary incentives', J. L. Nicolau et al., Journal of Retailing and Consumer Services, 2022

¹⁷ 'Where can you find the world's most sustainable coffee? In a lab in Finland, of course...', World Economic Forum, 20 October 2021

¹⁸ 'Coffee waste: Companies offer up new solutions', BBC, 22 April 2021

Global demand for coffee is likely to triple its production by 2050¹⁹. In our view, improving the sustainability of this vast industry will be key to limiting its social and environmental impacts across the entire value chain.

ESG Summer Series

[*The menu: An exclusive edible insect excursion*](#), 20 July 2023

[*Dead or alive – the worth of a tree*](#), 13 July 2023

[*Ice cream: deliciously sustainable?*](#), 06 July 2023

¹⁹ 'Where can you find the world's most sustainable coffee? In a lab in Finland, of course...', World Economic Forum, 20 October 2021

Disclosure appendix

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