BREWING RESILIENCE

Coffee, Climate and the Future of India's Value Chain

Overview

Coffee is more than a beverage; it is a cultural anchor and an economic lifeline. Over 2.25 billion cups are consumed daily, making it the second most popular drink after water. Coffeehouses worldwide serve as social and creative hubs, underscoring its unique role in everyday life.

Economically, coffee sustains more than 25 million farming families and contributes up to 5% of GDP in countries like Brazil and Ethiopia, and about 3% in Vietnam and Costa Rica. This dependence makes the sector's stability critical not only to producers, but also to the global economy. Yet climate change, volatile markets, and unsustainable practices are pushing the sector toward systemic risk. The threat extends beyond environmental degradation to the livelihoods of millions in vulnerable regions.

Global demand continues to rise despite price shocks. Consumption is projected to reach a record 169.4 million 60-kg bags in 2025–26, with emerging markets as the key growth engine. China has more than doubled consumption in a decade, while countries like India, Indonesia, and the Philippines are rapidly adopting coffee as a lifestyle product.

In India, consumption has grown at 4% annually, with urbanization, café culture, and the rise of specialty coffee driving change. However, India's 250,000 smallholders who account for 98% of coffee growers face mounting challenges from climate stress, pests, rising labor costs, and compliance with new international regulations like the EU Deforestation Regulation (EUDR).

"Coffee is culture. It's commerce. It's connection. But it's also carbon."

The environmental footprint of coffee also demands attention. A life-cycle assessment shows a single cup of coffee generates five times the CO_2 emissions of tea, with up to 91% of emissions occurring before beans leave the farm. Fertilizer use, deforestation, and processing are the largest hotspots. Sustainable practices like shade-grown systems, organic inputs, integrated pest management, and low-water processing can reduce emissions by up to 77%, offering a pathway for climate-positive coffee.

This whitepaper examines coffee at the intersection of culture, climate, and commerce, with a spotlight on India's evolving role. It explores:

- Global consumption trends and India's expanding market
- The carbon intensity of coffee relative to other beverages
- Farmer livelihoods, financing, and systemic risks in India's coffee sector
- Opportunities in traceability, blended finance, and performance-based models for sustainable growth

By connecting these threads, the paper positions coffee not only as a cherished ritual but also as a test case for building resilient, sustainable value chains where every cup contributes to farmer well-being and planetary health.

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1. The Global Coffee Imperative: Why India Matters Today

Coffee is more than just a beverage; it is a globally significant cultural phenomenon and a vital economic commodity. This widespread consumption underscores its deep integration into daily routines and social interactions across diverse cultures.

Consumed black as an espresso, on the rocks, or in various specialty forms like lattes and cappuccinos, its rich flavour and refreshing benefits have cemented its status as a significant cultural cornerstone. The widespread growth of coffeehouses, which serve as essential public gathering places, is a striking example of coffee's social significance. These venues foster relationships, inspire creativity, and play a crucial role in daily routines worldwide. Think about it next time you're going on a coffee break for the third time in a day at your workplace.

Economically, coffee holds immense importance, particularly for developing countries. It has been a critical export for major countries like Brazil, Ethiopia, Costa Rica and Vietnam. Coffee contributes close to 5% of both Brazilian and Ethiopian GDP, and about 3% of Vietnam and Costa Rica each. The livelihoods of tens of millions of small producers are directly dependent on coffee cultivation globally, with estimates ranging from 25 million families. This vast human dependence means that the stability and health of the coffee sector are intrinsically linked to global socio-economic well-being. When climate change and unsustainable practices threaten coffee production, the ripple effect extends beyond environmental degradation to potential widespread economic instability and poverty in vulnerable communities. Therefore, sustainability in coffee is not merely an environmental consideration but a critical socio-economic imperative that demands urgent attention and investment.

Since 2022, regional coffee consumption has generally diverged, with mature markets experiencing decreased demand and developing markets seeing increased consumption. In the coffee year 2023-24, coffee consumption in Asia & Pacific grew by 2.7%, with the region consuming 45.7 million bags of coffee. Over the longer term (2019-2024), Asia & Oceania's share of global coffee consumption rose by 2.51% to 25.8%. The Asia-Pacific region lacks a dominant country but resembles a market where one is first among equals, with Japan at the forefront. This partly reflects the coffee market development-population matrix.

The coffee market trends have evolved through six waves and are becoming increasingly sophisticated with each wave. We are now in the fifth wave, which focuses on the experiential and business aspects of coffee. This wave integrates technological advancements with traditional brewing techniques. These trends create spaces that are not just for drinking coffee but also serve as social and environmental statements.

Development Wave	1	2	3	4	5	6
Focus	The Coffee Commodity	The Coffee Experience	The Specialty Movement	The Science of Coffee	The Business of Coffee	The Circular Economy
Key Driver	Mass production & convenience	Social culture & "third place" cafés	Artisanal sourcing & single-origin craft	Precision & technology	Scaling excellence with efficiency	Sustainability & ethics
Defining Traits	Instant coffee, vacuum-sealed cans, affordability	Starbucks era, espresso-based drinks, branded chains	Single-origin beans, pour-overs, roaster expertise	Water chemistry, data, advanced equipment	Brand + tech + operational consistency, refined experience	Waste upcycling, carbon footprint cuts, circular supply chains
Period	Mid 19th Century -1960s	1970s - 1990s	2000s	2010s	2015s - Present	Present - Future

Figure 1. Decoding half a century of Dramatic Growth

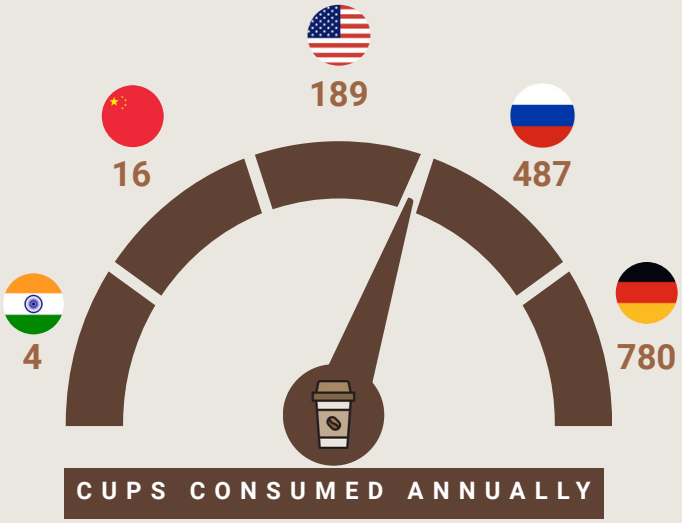


Figure 2. The One Cup Coffee Alchemy

You see a demonstration of the frequency of cups consumed annually.
It's important to note that these figures reflect the number of cups consumed, not the actual volume of coffee consumed in liters. Cup sizes and brewing styles vary wildly. What counts as a cup in the US (typically 250–350 ml of brewed drip coffee) is very different from a 30 ml espresso shot in Europe or a 100 ml cup of filter coffee in southern India.

"Even so, India's relatively small share in global coffee consumption clearly leaves ample room for market expansion. Moreover, the average cost per cup of coffee $1.83 in India is significantly lower than most countries."

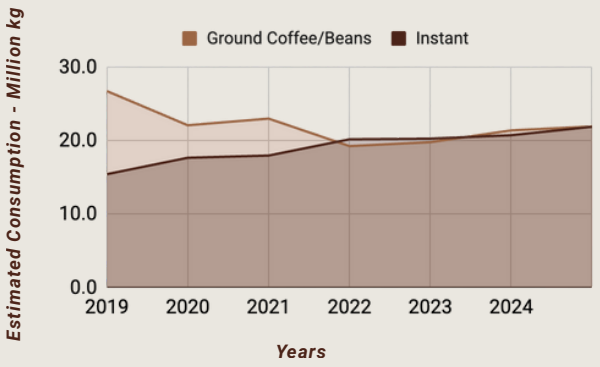
2.The Distinct Taste of India: Culture, Market, and Consumption

2.1 Coffee's "Situationship" with India- A Maturing Market

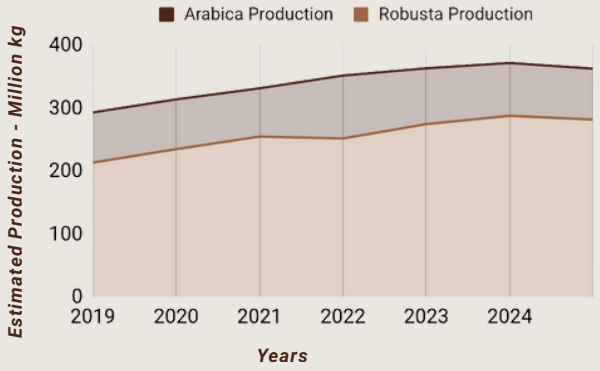
Traditionally a tea-drinking country, India's coffee consumption has grown steadily due to urbanization, exposure to global café culture, and a younger population shifting toward coffee-centric lifestyles.

As of 2024, India's coffee consumption in crop terms stands at approximately 78 million kilograms, with a year-on-year growth rate of +4% and a CAGR of +3.3% (2021-2024). Out of this, +49% of crop is utilized to produce Instant/Soluble Coffee (including coffee mixtures), and rest +51% is consumed as roasted coffee beans or ground coffee (including Chicory based filter coffee, drip bags, and coffee pods).

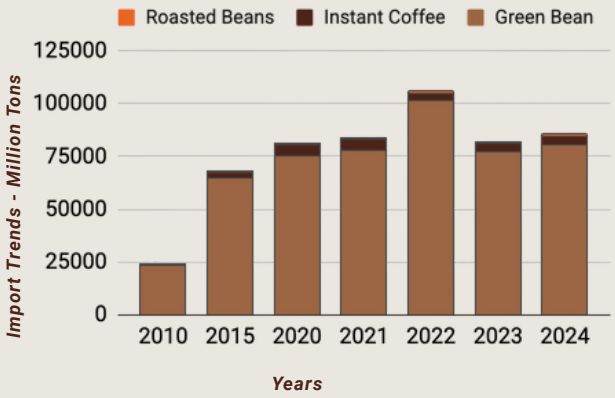
In 2024, the per capita consumption of coffee in India is approximately 0.07kg which places us on the 65th rank in this index. The global average per capita coffee consumption is 1.3kg, whereas that of North America and Europe are 5.1 kg and 4.5kg respectively.



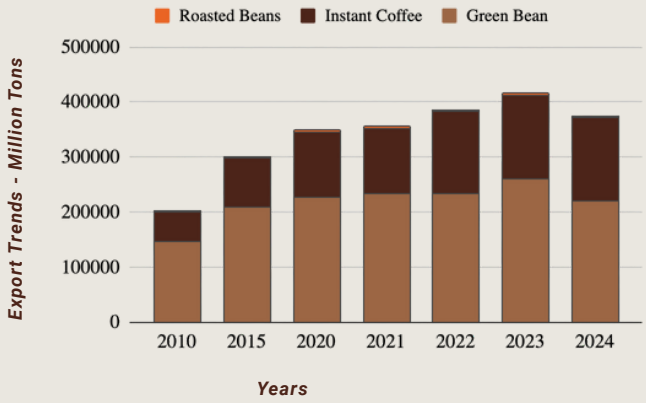
Graph 1. Coffee Clash:
Ground Beans vs. Instant



Graph 2. Bean Battle:
Arabica vs. Robusta Trends



Graph 3. Bean Boom:
Coffee Imports Over Time



Graph 4. Global Buzz:
Coffee Exports on the Rise

Coming to retail consumption (packaged coffee), instant coffee accounts for 65-70% of the market, with the rest being ground and filter coffee. Another significant consumption trend is the increase in chicory-mixed coffee, which has seen an uptake almost 2.5 times higher than pure coffee. The total consumption of chicory-mixed coffee (both instant and fresh) has risen from 25% in 2010 to 70% in 2024, indicating a growing preference for chicory in coffee blends. Chicory, known for its earthy flavor, serves as a cost-effective alternative to coffee. It has been a staple in coffee consumed in India and has gained popularity in coffee blends. Coffee companies often incorporate chicory into their blends to create a strong profile and give a nostalgic feel of Southern region of India.

2.2 Experience as Ritual, Not just a Drink

The Indian specialty coffee market is evolving led by micro-roasters, direct-to-consumer brands, coffee chains outlets in urban centers. Single-origin beans, cold brews, and hand-pour techniques are driving new interest, especially among millennials and Gen Z. Specialty coffee centers in Tier 1 cities and economically well-placed Tier-2 cities have reported a roughly ~25% spike in revenue in Q1 2025 compared to Q1 2024.

2.3 Shifting trends in at-Home Coffee Consumption

Access, knowledge, and work from home lifestyles have had both direct and indirect impact on Indian consumers as they have been adapting coffee brewing formats and specialty coffee beans in their lifestyle. On the other hand, instant coffee and mixes (3in1, cappuccino/mocha blends) are gaining popularity stating the USP of easy, quick and tastier brewing. These trends are driven mostly by younger consumers who want to recreate coffee shop-style drinks at home.

A new sub-segment, the ready-to-drink (RTD) coffee has come as a solution and is also gaining traction, with Supermarkets, Hypermarkets and E-commerce being the go-to channels of major sales. It is a niche product in the Indian ecosystem at present, but based on consistent growth, a CAGR of around +4% from 2025 to 2033 indicates a viable offering for major companies in the long term.

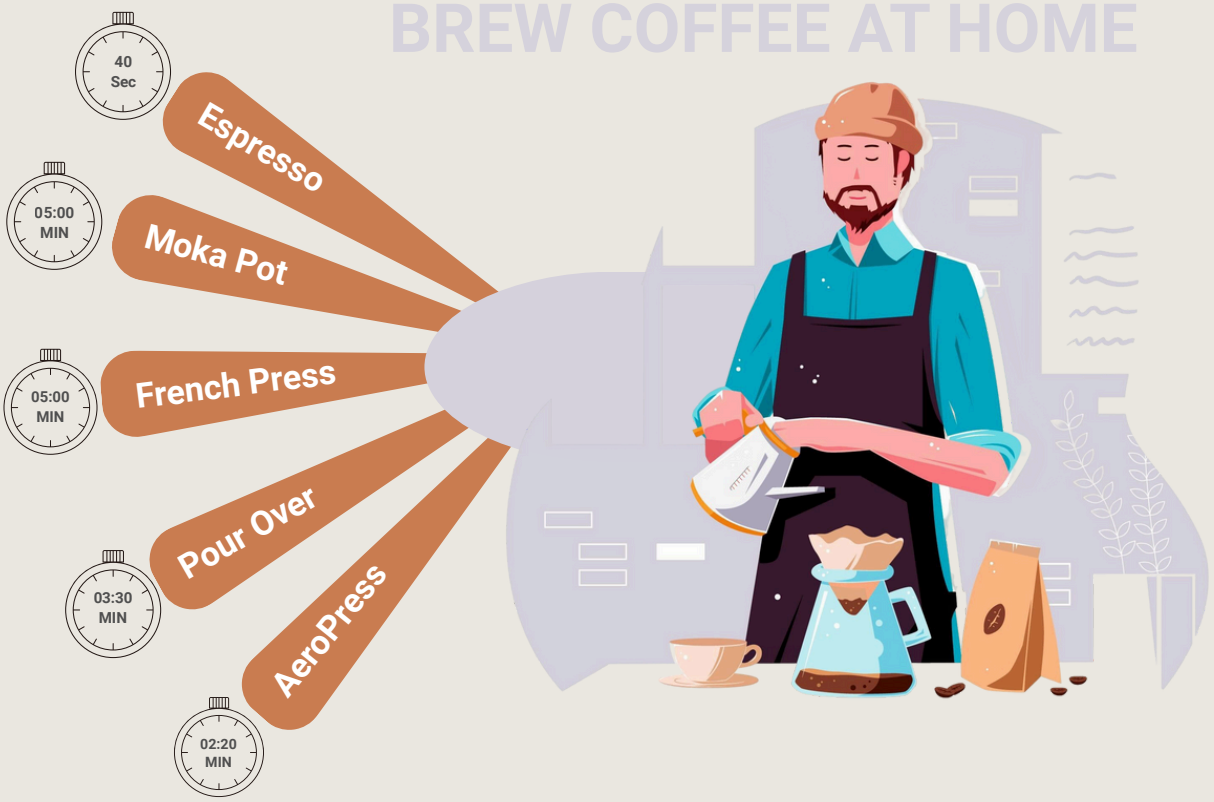


Figure 3. Coffee Countdown: Race Against the Clock for Your Perfect Home Coffee!

2.4 Decoding the Crave: Caffeine kick vs Cherished drink

Black coffee is more popular in urban areas, with 22% of consumers opting for it compared to just 2% in rural regions. Milk remains the most used add-on in both areas, consumed by roughly 70% of urban and 95% of rural drinkers. Natural sweeteners (forms of sugar) are widely used with Indian Coffee, with 65% of urban and 59% of rural consumers including them in their coffee. While milk and sweeteners are common across the board, rural regions remain far behind in adopting black coffee and other non-traditional additions.

2.5 Kaapi, Kaafi or Coffee? Regional Diversity

Figure 4. Coffee Growing Areas & Consumption Centres

Karnataka leads in coffee consumption among South Indian states, where coffee is a traditional drink, followed by Kerala, Tamil Nadu, Telangana and Andhra Pradesh. While South India continues to dominate in filter coffee consumption, Northern and Western India have seen significant upticks in instant, RTD, and café-style coffee purchases. Apart from major cities like Bangaluru, Hyderabad, Delhi and Mumbai, Tier-II cities like Surat, Jaipur, Indore, Lucknow, and Coimbatore have seen double-digit growth in consumption.

As far as coffee cultivation is concerned, it is predominantly concentrated in the hill tracts of the South Indian states. The top three states collectively contribute nearly 96% of India's coffee production.

2.6 Point of view- The Final Stakeholder

India's coffee drinker is quietly but steadily evolving. While taste and affordability remain the main factors driving consumption, an increasing number of consumers are beginning to explore coffee beyond just drinking it, seeking stories of origin, brewing methods, and the people behind the beans. This change is most noticeable in urban areas, where specialty cafés, home brewers, and artisanal roasters are introducing consumers to new flavor profiles and brewing techniques. Curiosity is rising, along with an appreciation for freshness, quality, and traceability.

Sustainability and ethical sourcing are still developing considerations, but they are no longer entirely niche. Younger consumers are interested in how their coffee is grown, who grows it, and its impact on the environment and communities. The Indian coffee drinker is not static; they are learning, experimenting, and evolving. As awareness increases, so does the potential for a more conscious and connected coffee culture.

Mishthi Aggarwal (hereafter to be referred as Mishthi), notes that approximately 5% of customers actively ask about sustainable practices. "This indicates a broader lack of awareness rather than a lack of interest." Many consumers believe that terms such as "specialty coffee" or just "coffee beans" automatically mean sustainability. This misunderstanding highlights a significant knowledge gap in the coffee ecosystem and offers a valuable opportunity for the industry to educate and engage consumers more effectively.

This sentiment is echoed by Rajeshwari Nilawar (hereafter to be referred as Rajeshwari), an SCA CSP Barista and Roaster, who observed that customers are more focused on the flavor profile than on whether a product is organic or fair-trade. There's also a clear preference for international beans, with consumers willing to pay more for them, often unaware of the high quality of Indian-grown coffee.

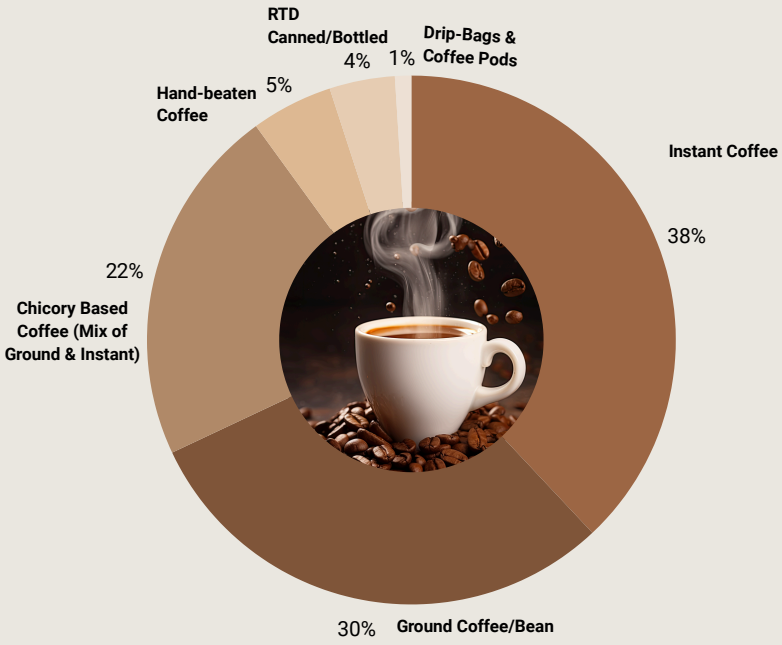


Figure 5. Brewing Impact:
The Carbon Footprint Showdown – Coffee vs. Tea

Lynn Mascarenhas (hereafter referred to as Lynn) a wildlife biologist and coffee producer from St. Margaret Estate, pointed out that many consumers tend to connect with a coffee's story only when it aligns with their lifestyle or values. While concepts like sustainability and traceability are important within the industry, they often don't yet hold significant meaning for the broader market. In fact, many people may not even recognize the difference between naturally ground coffee and flavored or processed alternatives, which reflects not apathy, but how new and evolving this space still is for many. However, there is a growing sense of optimism. A small but steadily expanding group of curious and conscious consumers is starting to ask deeper questions. With the ongoing efforts of roasters, baristas, and producers who are passionate about sharing knowledge, there is a real opportunity to build a more informed and mindful coffee culture in India.

While consumer choices, such as milk additions and brewing methods, contribute to the overall footprint, the disproportionate number of emissions stems from land use change, deforestation, fertilizer use, and processing methods. This means that efforts to reduce emissions must primarily target the agricultural stage, through practices like precision agriculture, biochar application, organic farming, and promoting shade-grown systems, to achieve significant, systemic impact. Focusing solely on consumer-end solutions, while important for individual impact, would be insufficient given the overwhelming emissions generated at the source. This understanding provides a clear strategic direction for policy and investment in sustainability.

My coffee has higher flavor notes than your wine!!

Pin the thought?
What steps are we taking as individuals to lead a sustainable life?
Do we want to put the onus of sustainability to the coffee sellers and not having that as a criterion while selection?
If so, then the discussion about creating a sustainable value chain for coffee would be irrelevant!

3.The Emissions Equation: Quantifying Coffee's Environmental Cost

3.1 Emissions Showdown: Where Coffee Stands

To characterize coffee's environmental burden, a comparative analysis is essential, to help us understand the impact of our morning cuppa. The paper aims to highlight major emission hotspots throughout the lifecycle of coffee. A life cycle assessment (LCA) offers convincing evidence that coffee drinks generate about five times more kilograms of CO_2 equivalent (kg CO_2e) over their entire lifecycle than a single cup of tea. The most substantial environmental impacts for coffee mainly stem from growing the beans and processing them before they reach the roasters!!

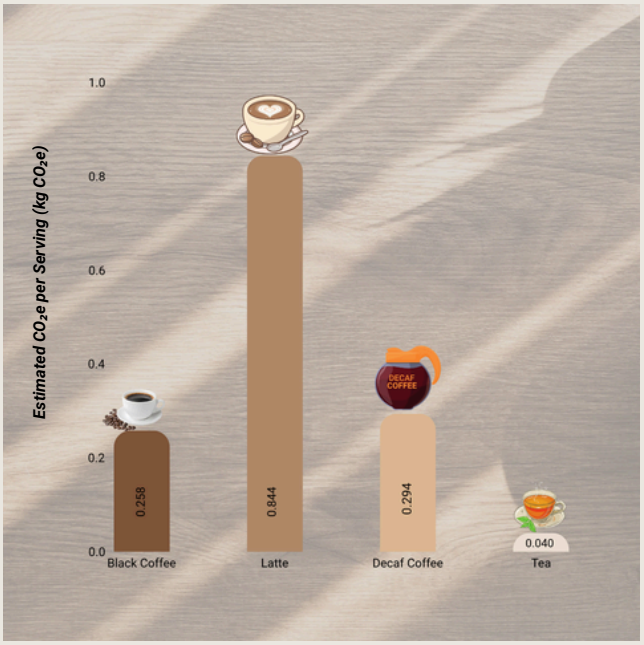


Figure 6. Brewing Impact: The Carbon Footprint Showdown – Coffee vs. Tea

3.2 The butterfly effect (Small choices can have large, far-reaching consequences)

Even the methods of brewing and choices of consumption contribute to the overall environmental footprint. Heavy duty coffee machines, single-serve pods or capsules often produce significantly more waste compared to traditional brewing methods. Promoting reusable cup options and encouraging methods.

The sheer volume of waste generated by disposable coffee cups is staggering. Transitioning coffee grounds to reusable coffee mugs is identified as an effective strategy to close the loop on coffee waste if implemented on a large scale to achieve economies of scale.

The significantly higher carbon footprint of coffee compared to tea, compounded by the added emissions from decaffeination and dairy, reveals a disproportionate environmental burden with substantial hidden costs embedded in specific processing and consumption choices. This situation extends the environmental responsibility beyond just the farm. The consistent finding that coffee's footprint is "roughly five times more kilograms of CO_2" than tea, with the largest impacts from "raw material acquisition and manufacturing," indicates that coffee's production model is inherently more resource-intensive.

The additional data on decaffeinated coffee's higher CO_2e and water footprint, and the dramatic increase in emissions from dairy milk, demonstrate that the environmental cost is not static. This highlights that the problem encompasses not just coffee itself, but the entire ecosystem of its production, processing, and consumption, pushing the responsibility to manufacturers and consumers alike.
The growth of Indian Coffee is propelled by urbanization, rising disposable incomes, the expansion of global coffee chains, and an increasing preference for premium and specialty coffee, particularly among younger consumers. Notably, approximately 70% of the total coffee produced in India is exported.

The carbon footprint embedded in coffee production is substantial, with the majority of emissions occurring before the beans even leave the farm. Studies indicate that growing a single kilogram of Arabica coffee using conventional methods in regions like Brazil or Vietnam, and exporting it to the UK, produces greenhouse gas emissions equivalent to 15.33 kg of carbon dioxide.10 In stark contrast, sustainable coffee production can reduce this footprint by 77%, down to 3.51 kg CO_2e per kg of green coffee.

GHG emission	Kg of CO2e per kg of green coffee	Difference in practices
Sustainable production method	3.51	Sun grown, higher water consumption, high fertiliser use, unavailability of soil and water conservation measures
Conventional method	15.33	Shade grown, soil and water conservation techniques, use of organic fertilisers, waste recycling

Figure 7. Eco Beans: Emissions in Every Sip

For Indian coffee specifically, conventional Robusta coffee production has a Global Warming Potential over 100 years (GWP100) of approximately 1.4 kg CO_2-eq. per kg of green coffee beans and 1.8 kg CO_2-eq. per kg of roasted coffee beans. However, organic Indian coffee significantly reduces this to about 0.3 kg CO_2-eq. per kg of green coffee beans and 0.5 kg CO_2-eq. per kg of roasted coffee beans. A significant portion approximately 70% of CO_2 emissions in conventional Indian coffee cultivation is attributed to field emissions related to urea and limestone applications. While India's traditional shade-grown coffee plantations possess the potential to sequester carbon and mitigate climate impact, the increasing demand and reliance on conventional practices pose a growing emissions challenge.

India presents a particularly unique and rapidly evolving coffee landscape. The nation is currently the seventh-largest coffee producer globally, contributing significantly to the international market.

3.3 Breaking Down the Barrel of Emissions

A detailed analysis of the Indian coffee value chain reveals distinct emission hotspots at each stage, from cultivation to the final cup, highlighting where interventions can yield the most significant environmental benefits. The most substantial environmental impacts for coffee mainly stem from growing the beans and processing them before they reach the roasters!!

Cultivation (The Primary Hotspot):

The majority of coffee's carbon footprint between 75% and 91% is generated before the coffee beans even leave the farm.

- **Land Use Change & Deforestation:** Clearing forests for new coffee plantations releases vast amounts of stored carbon into the atmosphere, contributing significantly to greenhouse gas emissions. Historically, coffee cultivation often involves shade-grown methods, but the transition to sun-grown plantations demands increased water usage and can lead to environmental degradation due to deforestation.

- **Fertilizer Use:** The excessive application of nitrogen-based fertilizers is a major contributor to greenhouse gas emissions, particularly nitrous oxide (N_2O), which is 273 times more potent than CO_2 in trapping heat.4 In conventional coffee farming, fertilizers frequently represent the largest source of emissions during the growing phase.

- **Pesticide Use:** The application of pesticides and weedicides also contributes to overall emissions and can lead to water pollution.

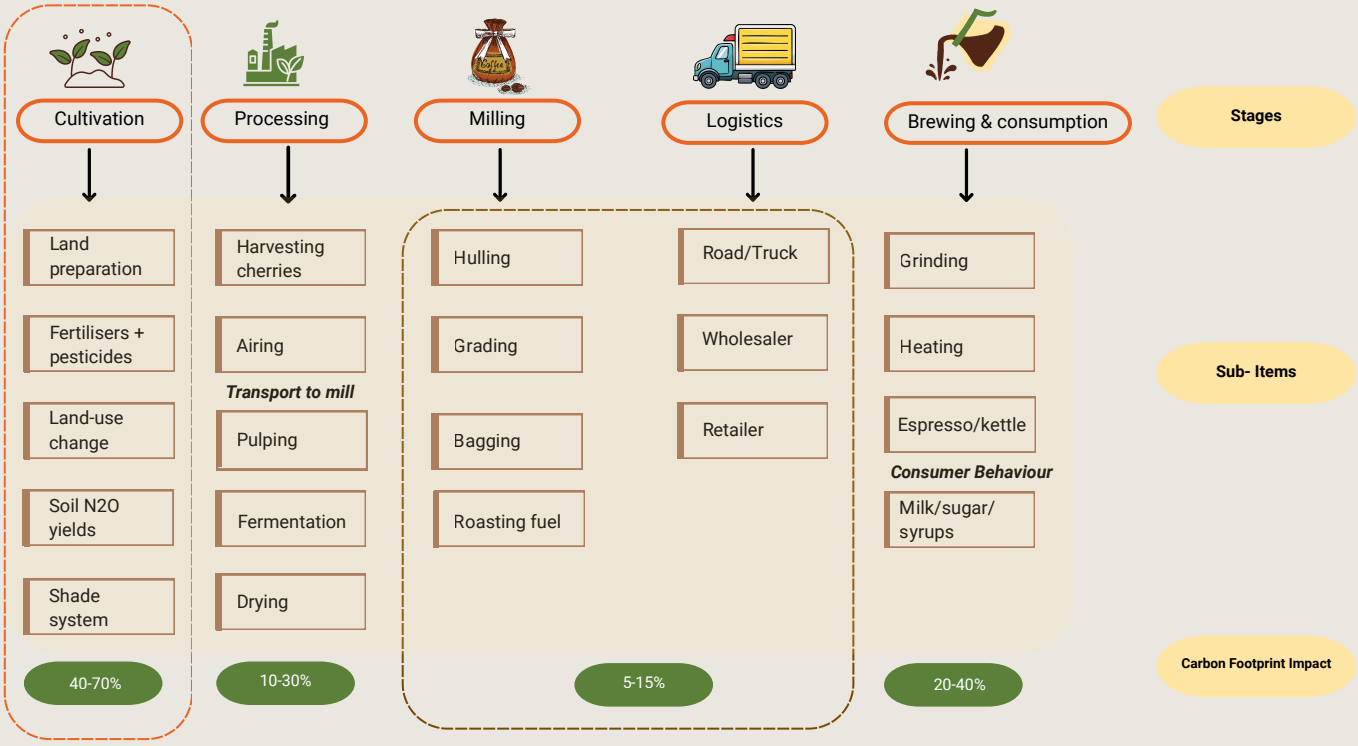
- **Farm Equipment & Energy:** The operation of vehicular movement, power sprayers, power diggers, and other heavy machinery on coffee plantations consumes fossil fuels and electricity, resulting in both direct and indirect emissions.

Processing Methods:

Steps in order- Harvesting, Washing, Peeling, Processing, Curling, Roasting, grinding/Instant coffee processing, Packaging)

- **Wet Milling:** A common method for processing Arabica beans, wet milling generates wastewater rich in organic matter. If this wastewater is left untreated, it can emit methane, a potent greenhouse gas.
- **Roasting:** The roasting of coffee beans is an energy-intensive process, consuming a significant amount of energy and adding to the overall environmental footprint of coffee production.

Decaffeination: The decaffeination process introduces an additional, resource-intensive manufacturing stage. This process requires more energy and water, adding nearly 48% more CO_2 emissions to the regular coffee manufacturing process and often necessitates extra transportation to specialized decaffeination facilities.



**Approx. ranges from LCA literature - depends on assumptions and scope*

Figure 8. Life-cycle Assessment for Coffee: Indicative Emission Ranges across Key Stages

4.The Shifting Shade: Mapping Climate Risk to India's Coffee Habitats

4.1 Robusta's Edge: The Role of Hardier Species in Indian Climate Adaptation

Robusta has maintained its dominance over the years with nearly 70% of total output supporting climate resilience due to its higher yield and disease resistance. On the global stage, India maintains a strong export presence with 3.7 million Kilograms shipped in FY 2024–25, (222.4 MKg of coffee beans, 150 MKg of instant coffee). The premium Arabica and unique Monsoon Malabar beans continue to command niche appeal in markets like Europe, Japan, and the Middle East.

In Indian coffee's long tale, Robusta plays the quiet hero, outshone by the star billing of Arabica. Quietly but decisively, Indian Robusta is becoming the foundation of a more resilient, flavor-driven coffee world.

The industry itself often conflates Arabica and Robusta, perpetuating a misconception that the latter is inherently inferior. Lynn candidly highlights the historical oversight: coffee growers in India haven't even tasted their own Robusta, and global research into its nuances remains surprisingly limited. She also points out that while Arabica thrives in cooler, high-altitude regions requiring dense, multi-tiered shade and a rich biodiversity (attracting birds and wildlife), Robusta is a hardier crop, flourishing in lower elevations with less demanding shade requirements. The challenge, she believes, lies in overcoming negative marketing and truly understanding Robusta's unique flavour profile, which is often overshadowed by Arabica's established superiority. Even practical aspects like grading Robusta are deemed not cost-effective, further hindering its recognition.

Navin Rajes (hereafter referred to as Navin) Director, MSP Coffee, offers a compelling counter-narrative, echoing Lynn 's sentiments on past neglect while asserting that India is now leading the charge in showcasing Robusta's true potential. He pointed out that Indian farmers are increasingly fine-tuning processing techniques for Robusta, unlocking exclusive and fantastic flavor profiles. He firmly believes that Indian Robustas are "the best in the world," requiring only further refinement to solidify their global standing. He challenges the long-held belief that Robusta is inferior, arguing that it can often be "equal, I would say, even better at times." This resilience is particularly pertinent in the face of changing climate patterns, as Robusta's hardiness makes it a more reliable crop. Furthermore, Navin passionately advocates for Robusta's crucial role in espresso, providing the essential crema and body often missing in 100% Arabica blends, a misconception he believes was unfortunately promoted by early cafes. The market is adapting, with a growing "uptrend in Robustas" as consumers, both domestically and internationally, discover its robust flavor and adaptability, especially in India's milk and sugar-dominant coffee culture. The future, according to him, is undeniably bright for Indian Robusta, poised to claim its rightful place as a high-quality, resilient, and indispensable bean.

Flipping to the other side of the story, coffee's growing demand now casts a long shadow, exposing significant environmental impacts that demand immediate attention. To provide a thorough grasp of the opportunities and difficulties for a more sustainable future, our paper explores the complex relationship between coffee consumption and the emissions that are linked to it.

4.2 The Vulnerability through Bean to Brew

Despite the continuous rise in global coffee demand, the environment ideal for its cultivation are severely threatened by climate change. This precarious situation turns a cherished daily ritual into a significant climate risk.

The global coffee supply is under increasing pressure from rising temperatures and extreme weather events, which are reducing the areas where coffee plantations can flourish. Climate models forecast a drastic reduction in land suitable for coffee cultivation, with projections indicating a 50% decrease by 2050 in key regions. The growing climate threats require urgent adaptation strategies to ensure the long-term viability of coffee production.

Researchers are actively investigating wild coffee species as potential solutions to strengthen supply chain resilience. One notable option gaining attention is Coffee Stenophylla, a West African plant known for its ability to thrive in hotter climates and withstand dry conditions more effectively than Arabica. Early trials have shown promising taste results with positive comparisons to high-quality varieties. At the same time, efforts are underway to develop more resilient coffee varieties, including drought-tolerant and heat-resistant strains, specifically designed to counteract the negative impacts of climate change on coffee production.

The clear statement that "Global demand continues to grow, yet climate models forecast a 50% reduction in land suitable for coffee cultivation by 2050," highlights a critical tension. This situation suggests that the problem extends beyond environmental degradation to an impending economic crisis for the coffee industry. Rapid price fluctuations for green coffee beans serve as an early warning of this looming scarcity and market instability, potentially turning coffee from a readily available commodity into a luxury. This situation underscores that the climate risk isn't just about minor adjustments but requires fundamental changes in cultivation, potentially altering the genetic makeup of future coffee crops, thereby emphasizing the severity and systemic nature of the threat.

4.3 Mounting Strains: Climate Change as the Unseen Predator

The Indian coffee sector, despite recent record export growth and a burgeoning domestic market, is confronting a formidable nexus of systemic challenges across climate, agronomy, and logistics. India's total coffee production is forecast to decline in the 2025/26 market year (October through September), with total output expected to fall by 2.5% to 363 Mkg from 372 Mkg in 2024/25, according to the latest USDA estimates.

Coffee cultivation in India is highly sensitive to unpredictable weather patterns, including prolonged droughts, insufficient rainfall, and heavy, unseasonal rains during the harvest season. Such events can cause coffee cherries to drop prematurely and spoil crops, particularly threatening Arabica, which is more sensitive to rising temperatures. This heightened vulnerability has led some Arabica planters to remove their crops, despite high market prices, as the risk of climate-induced crop failure outweighs the potential reward.

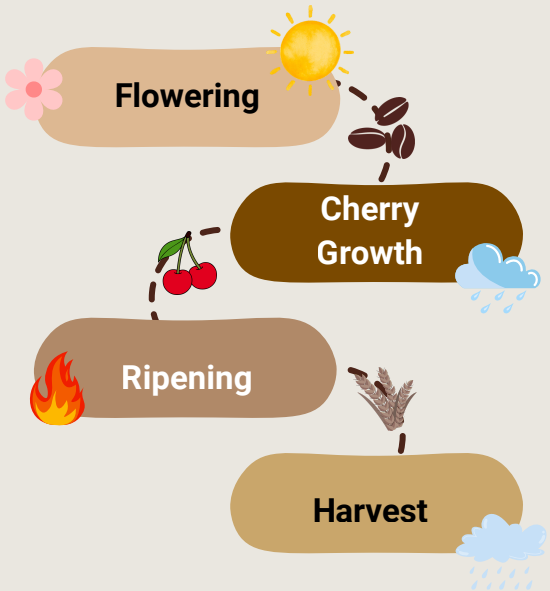


Figure 9.
The Coffee Cherry's Journey Interrupted by Climate

Coffee plants require a delicate balance of water, nutrients, and sunshine for healthy growth. However, extreme climatic events are disrupting this balance. Prolonged dry spells and droughts impair plant growth and reduce yields.8 Conversely, heavy, unseasonal rains, which have become a frequent occurrence, are causing significant damage. Rain during the harvest season, which is traditionally a dry period, can cause coffee cherries to burst and drop prematurely, leading to crop spoilage.8 This is especially problematic for Indian coffee, which is unique in its reliance on sun-drying for post-harvest processing.

These climatic pressures are directly linked to agronomic issues, creating a vicious cycle. Extreme weather weakens coffee plants, making them more susceptible to devastating pests and diseases. The most destructive pests include the Coffee White Stem Borer and the Coffee Berry Borer, which can cause significant crop loss and quality deterioration. Furthermore, the overuse of chemical fertilisers and pesticides, a common practice in modern agriculture, leads to soil and water contamination, posing a threat to the ecologically sensitive Western Ghats, a global biodiversity hotspot.

The economic burden of these challenges falls disproportionately on India's coffee growers, 98% of whom are smallholders with limited access to financial resources and modern technology. Rising labor costs, which account for about 60% of the total cost of cultivation, further strain their profitability. This economic distress often prevents farmers from investing in crucial adaptive measures, such as irrigation systems or climate-resilient varieties, trapping them in a cycle of poverty and declining productivity. In some cases, farmer indebtedness in cash crop regions, including those with coffee, has been linked to severe humanitarian consequences.

Furthermore, smallholders have limited access to credit, advanced technology, and in-depth expertise, which makes it difficult for them to adopt modern farming practices or make necessary capital investments. The economic distress and lack of financial support create a cycle where short-term, unsustainable fixes lead to further degradation of soil health and increased costs, all while potentially creating pesticide resistance in pests. The reports of farmer indebtedness and suicide in cash crop-producing regions, including those with coffee, underscore the dire humanitarian consequences of these compounding economic pressures, highlighting the urgent need for a comprehensive, systemic solution.

Beyond the farm, the industry faces significant logistical and regulatory bottlenecks. Transporting coffee from remote growing districts to ports is difficult due to poor highway infrastructure, which acts as a de facto tax on profitability. On an international level, India's coffee supply chain is vulnerable to global disruptions like the Red Sea crisis, which has led to significant shipping delays and increased costs. The new European Union Deforestation Regulation (EUDR) presents an additional, existential threat, requiring products to be traceable to their point of origin and proven to be free from deforestation. This is particularly challenging for smallholders who lack the financial and technical resources for sophisticated tools like geolocation mapping and digital record-keeping.

The challenges across climate, agronomy, and logistics are not isolated but are deeply intertwined and compounding. Climate change weakens plants and makes them vulnerable to pests; pest infestations reduce yields and increase costs, which in turn leads to farmer debt and an inability to invest in new technology.

This lack of investment leaves them exposed to the next climatic shock and renders them unable to meet the stringent traceability requirements of new international regulations like the EUDR. To build a resilient and sustainable future, the Indian coffee sector must address these systemic issues through coordinated efforts, leveraging technology, and empowering its smallholder-dominated community.

5.Decarbonizing Logistics and Supply Chain Transparency

Coffee beans are often transported over long distances from their countries of origin to consumer markets, leading to significant greenhouse gas emissions from shipping. Around 15% of the total greenhouse gas emissions in the coffee lifecycle are due to international transportation. The mode of transport greatly affects these emissions. For example, exporting coffee beans by cargo ship instead of by air freight can significantly reduce the carbon footprint.

Emissions are not confined to individual stages but are intricately linked throughout the coffee value chain, indicating that effective decarbonization necessitates a comprehensive, system-wide strategy rather than isolated actions to achieve significant reductions. Although 75-91% of emissions occur "before the coffee beans even leave the farm," the total footprint is also "influenced by various factors, including transportation, roasting, packaging, and brewing methods." The fact that a notable 77% reduction for sustainable coffee is accomplished through a mix of factors, such as cargo ship transport and decreased agrochemical inputs, shows that optimizing one stage without addressing others will lead to less effective outcomes. This insight highlights that a genuinely sustainable coffee industry requires integrated solutions across the entire value chain, acknowledging the complex interaction of emission sources from "cradle-to-grave."

5.1 Tracking the Trace: Why Transparency is Non-Negotiable

The Indian coffee sector is on a fascinating journey toward complete traceability, with transparency becoming a cornerstone of the industry. Instead of being a mere trending word, traceability is a strategic tool that is fundamentally reshaping how coffee is grown, processed, and sold.

Integrating almost every aspect of the coffee value chain from seed to cup, Chandini has a transparent traceability setup for the clients who prioritize this part of the coffee operations. The client can trace back the coffee to the exact micro-block of the farm, which provides complete visibility and confidence in the journey of a coffee bean.

Passionate producers like Navin, have implemented a 100% traceable program at MSP Coffee are leading the charge. His farm is divided into detailed grids based on elevation and soil type, allowing for precise data collection from harvest to fermentation. This meticulous approach not only ensures consistent quality for repeat processes but also provides invaluable data that high-end clients, particularly in Europe, demand. This commitment to full transparency transforms the coffee experience, allowing consumers to literally see where their coffee comes from.

The roaster community is also adapting brilliantly to this shift. Mishthi, believes in providing just enough information to be transparent without making coffee seem "too complicated." Every packet is labeled with the estate name, harvest date, and processing details, while a more in-depth story is available for those who seek it. This thoughtful approach, combined with a roast-on-order policy and varied roaster capacities, ensures every customer receives a fresh, high-quality product.

While the desire for traceability is strong among many smaller brands and roasters, the industry still faces hurdles. Rajeshwari points out that while brands like SUBKO, True Black and Blue Tokai have implemented fair trade ways and traceability programs, many large coffee players are yet to adopt traceability protocols.

Sustainable supply chain partnerships are pivotal in fostering regenerative practices within the Indian coffee sector. Certifications play a crucial role in validating sustainable practices and ensuring market access for Indian coffee. Organizations like the Specialty Coffee Association (SCA) offer globally recognized training and certification programs in areas like Barista Skills and Sensory Skills, enhancing the professionalism and quality within the industry. Beyond professional development, certifications like Rainforest Alliance, UTZ, and Fairtrade are widely recognized standards that ensure producers adhere to environmental and social criteria, promoting fair wages, limiting deforestation, and banning harmful pesticides. Sustainable logistics practices are essential for reducing the environmental footprint of coffee transportation. While international transport accounts for a significant portion of coffee's lifecycle GHG emissions (around 15%), particularly due to reliance on heavy fuel oil for sea freight, optimizing logistics is key.

Nespresso, for instance, collaborates with Aspinwall Coffee, a prominent Indian exporter and processor, and also works with Allanasons in India, who have successfully implemented the AAA Program. Neumann Kaffee Gruppe (NKG) India Coffee has established the "NKG India Planter's Group," encompassing coffee producers of all sizes across India.

This initiative provides technical assistance to farmers on implementing sustainable coffee production protocols under UTZ and Rainforest Alliance codes, thereby improving coffee quality, productivity, and long-term income. NKG India also supports the marketing of Fairtrade and Fairtrade-Organic coffees, helping smallholder farmer groups achieve fair market prices. Their facilities, including the Hassan Mill and Mangalore Monsooning Facility, are certified to process various sustainable coffees, further reinforcing their commitment to responsible sourcing. South India Coffee Company (SICC) similarly emphasizes an economically feasible supply chain by sourcing directly from partner farms, managing logistics, and investing in research on climate-resilient coffee species through SICC Labs.

Marketing integrity and the prevention of greenwashing are crucial for building and maintaining consumer trust in the sustainable coffee market. D2C coffee brands in India are at the forefront of promoting sustainable consumption by prioritizing ethical sourcing, environmentally friendly farming, and eco-conscious packaging.

Indian coffee companies are succeeding in sustainability by building direct relationships with farmers and using traceability systems, which enhance consumer trust. They focus on specialty and high-quality beans, meeting consumer demand for unique flavours and ethical sourcing. Eco-friendly packaging is also being adopted to reduce waste. On the other hand, for small-scale players, Systemic issues hinder sustainability, with high costs of certifications barring smallholder farmers from premium markets, creating inequity.

Transparency in supply chains is improving but verifying data on environmental and social conditions remains challenging, affecting consumer trust. A global financing gap in agriculture, especially for small producers, shows that current financial models are not scalable or accessible, with traditional lenders viewing smallholder agriculture as risky, limiting investments in sustainable practices. The collective effort from farmers, roasters, and industry players is creating a dynamic ecosystem where every bean has a story, and that story is easily accessible to all.

An environmental consultancy firm can link agriculture, land-use change, and supply chain sectors by offering specialised expertise in fit-for-purpose MRV solutions and strategy development.

How an Environmental Consultancy Can Help?

- Develop accurate baselines for emissions and removals by integrating satellite remote sensing, field surveys, and agricultural data analytics.
- Map upstream and downstream emissions embedded in agricultural inputs, land conversion, and commodity movement, providing clarity for scope 3 inventories and identifying key mitigation leverage points.
- Design tailored MRV systems that combine digital monitoring tools, remote sensing, mobile data capture, and stratified ground truthing for credible, cost-effective reporting and verification.
- Facilitate coordination between stakeholders, creating interoperable data flows and harmonisedharmonized metrics for shared accountability.
- Support scenario modellingmodeling and pathway development to evaluate mitigation potential and prioritiseprioritize investments with the highest climate and environmental returns.
- Provide training, outreach, and toolkits to empower agricultural producers and supply chain actors to adopt better practices, collect reliable data, and engage in carbon and sustainability programs.

Environmental consultancies design MRV platforms that adapt to local contexts, support scalability and modularity, and integrate with multiple protocols for seamless feed into carbon markets, compliance schemes, and ESG frameworks. They ensure economic usability, simplify data capture, automate remote sensing, and generate transparent reports. Robust data governance ensures privacy, quality assurance, and traceable audit trails for market credibility. By leveraging environmental, technical, and market expertise, supply chains can confidently address climate impacts, optimize interventions, and participate in carbon markets with a fit-for-purpose MRV solution that balances accuracy, cost, and resource realities. With rising government and private interest, strategic actors can shape standards and incentive schemes via advocacy, blended finance design, and programmatic crediting frameworks tailored to India's coffee sector.

6.Cultivating the Future: Strategies for Climate-Smart Coffee

6.1 Back to the Roots: Harnessing Biodiversity through Agroforestry

Holistic Farm Management: "Sustainable practices extend beyond just soil and shade to a more holistic approach to farm management. "

For Indian coffee farms, sustainability is not a new concept, but a practice ingrained over a century of traditional methods. Rather than a modern trend, it's a way of life that has allowed farms to thrive for generations. The key to this approach lies in smart land management, which includes rainwater harvesting, maintaining a diverse shade canopy, and nurturing soil health.

NAVIN notes that a coffee plant uses about 190 micronutrients, but most farmers only replenish three (NPK) through fertilizers. Traditional Indian farms, however, are essentially **agroforestry ecosystems.** With thousands of trees per acre, a multi-tiered canopy of native trees and fruit trees naturally provides the 187 missing micronutrients. This contrasts sharply with modern, industrial farms that achieve higher yields using more chemicals, a practice whose long-term viability is questionable. "**If there were no sustainable practices, we wouldn't be surviving 100 years later.** This includes careful oversight of soil, shade, and plant health, as well as **multi-cropping.** By maintaining adequate shade, farmers can naturally control weeds, eliminating the need for harmful weedicides. This is part of a larger philosophy of avoiding pesticides and other harsh chemicals, which keeps both the workers and the environment healthy. Since many farmers live on their land, this commitment to a clean and sustainable environment is a personal one.

Chandini D Purnesh (hereafter to be referred as Chandini) founder, LunyBee, views **sustainability** as an essential, non-negotiable component of Harley Estate's coffee production and existence, not merely an optional add-on. Their holistic approach is centered on achieving **balance** across three core natural resources: **Soil, Water, and Energy. Soil health** is maintained through completely avoiding synthetic pesticides and weedicides. Instead, they use natural fertilization methods, including **organic compost**, mulch from native jungle trees, and Jeevamrutha to nourish the soil. Furthermore, all farm work is performed manually to prevent soil compaction and ecosystem disruption caused by heavy machinery. **For water and ecosystem conservation,** nine man-made lakes have been created to store water and recharge groundwater. They also maintain the native **rainforest canopy,** ensuring that wildlife corridors remain intact and that the coffee plantation coexists harmoniously with the local biodiversity. In addition, Harley Estate is actively working toward **energy independence** by utilizing **solar and hydropower** to run estate utilities and supply homes, thereby significantly reducing their reliance on fossil fuels.

At St. Margaret Coffee Estate, sustainable practices are at the core of the operation. **Weeding** which was previously carried out five times a year, has now been reduced to three. This sustainable practice helps retain the topsoil, improving soil fertility and creating a favourable habitat for ground-level birds. As a result, both soil health and crop productivity have significantly improved.

6.2 The Feathered Guardians: Birds as Bio-indicators of Farm Health

Lynn's approach to sustainability is deeply tied to the farm's ecosystem, particularly its bird population. She tracks **endemic, generalist, and specialist birds** to assess the farm's overall health. The presence of specific species, **like specialist insect-eating birds,** indicates a thriving and balanced environment. The birds on the estate are not just passive inhabitants; they are crucial to its sustainability. **Insect-eating birds** provide a natural form of pest control, while other insects ensure effective **cross-pollination.** The presence of **aquatic birds** further signals a healthy water source, reinforcing the farm's ecological well-being. "Existence of the different kind of birds tells a lot about the condition of my farm"

6.3 Environmentally Conscious Choices

At certain Indian coffee estates, significant strides have been made to conserve water during processing. A key innovation is a recycling unit that has reduced the water needed to process one kilogram of coffee cherries from five liters to just 800 ml. In regions with water scarcity, estates are also adapting by producing **honey-sundried** and **natural process** coffees, which require minimal water. While new irrigation solutions are being developed, these creative and efficient methods allow the production of high-quality specialty coffee despite environmental challenges.

Chandini focuses on reducing water and energy use in fermentation and processing. They use an **eco-pulper** that consumes far less water than conventional machines, and all wastewater passes through an **effluent treatment system** that neutralizes its acidity. Once treated, this water is **reused for irrigation**, creating a **closed loop** that minimizes waste and impact.

Lynn is working towards energy conservation by implementing innovative practices such as using solar tarpaulins for drying coffee. This method has been especially vital during the harvest season (December & January), as the past four years have brought unexpected rains during this crucial period. Additionally, the estate has observed a transformation in the following season, with blooms now appearing as early as December-January instead of the usual February-March. These early blossoms are carefully harvested and creatively used to craft unique beverages, adding a new dimension to the coffee experience and sustainability.

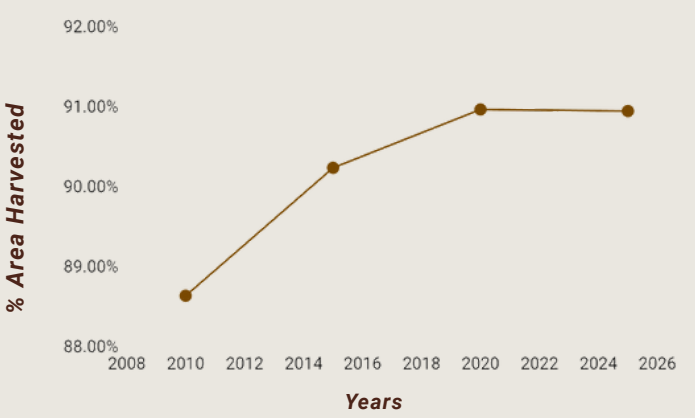
6.4 More than a Step' towards Future

Sustainability is deeply intertwined with making environmentally friendly choices. This involves planting with minimal environmental impact, avoiding plastics, and using heavy chemicals sparingly. Navin emphasizes that traditional farmers did not have access to these chemicals, which limited their potential for over-cultivation. The moment a person is in pursuit of unreasonable higher yields, they risk depleting the land. While some farms use three times the amount of water and chemicals to triple their output, this approach is not sustainable. It exploits the soil and land, leaving little for future generations. "The minute we get a bit too greedy and adventurous and want to achieve more crops... we might make huge profits, but what's left for the next generation? -Navin"

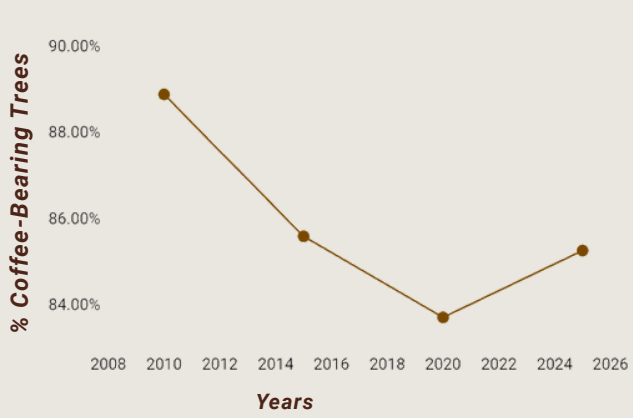
6.5 The Climate Paradox: Addressing Deforestation, Knowledge Gaps, and Chemical Dependency

Indian coffee is globally distinguished for being shade-grown. This traditional method inherently constitutes an ago-forestry system, where coffee trees are interspersed among other native trees. This practice naturally enhances carbon sequestration and boosts local biodiversity. These mixed-crop systems are believed to contribute to the unique cup quality of Indian coffee by inducing volatiles from other plants within the agro-ecosystem.

All we hear is that Coffee is growing, but data from agri-point of view shows a different picture.
Are we really taking care of the crop? Or are we in a situation where adapting huge sustainable practices are a need if we want our coffee crops to sustain in the long run.



Graph 5. Grounded Gains:
Harvest Trends Over Time



Graph 6. Harvest Pulse:
Tracking Coffee Tree Trends

Shade-grown coffee farms serve as crucial habitats for a diverse array of plant and animal species. The presence of a varied tree canopy actively attracts numerous wildlife, including birds and insects, thereby significantly enhancing local biodiversity and contributing to the preservation of fragile ecosystems. The shade trees themselves function as natural carbon sinks, effectively absorbing and storing atmospheric carbon dioxide (CO2). This direct sequestration plays a crucial role in mitigating climate change impacts. Beyond carbon capture, the tree canopy provides essential protection for the soil, minimizing erosion and preventing the runoff of vital nutrients. This natural protective layer helps maintain long-term soil fertility and reduces the necessity for external chemical inputs. The integrated presence of additional trees and plants within these systems actively regulates water flow. They efficiently trap rainwater and reduce surface runoff, which in turn prevents soil erosion and enhances moisture retention within the soil. This natural water management significantly reduces the need for artificial irrigation, making the farms more resilient to water stress. India's traditional shade-grown agroforestry system represents a significant inherent environmental strength, providing natural carbon sequestration, enhanced biodiversity, and improved soil health. This traditional practice aligns perfectly with and even pre-dates modern regenerative agriculture principles.

6.6 Business-as-usual- The Conventional Practices

However, the increasing shift towards Robusta cultivation, which often demands more direct sunlight, contributes to deforestation as existing shade trees are removed. This practice, driven by economic incentives for higher yields, directly undermines India's traditional shade-grown agroforestry systems and their associated environmental benefits.

Reliance on chemical fertilizers is a significant source of greenhouse gas emissions, with around 70% of emissions in some Robusta production attributed to chemical fertilizer use. Moreover, declining soil health, exacerbated by unsustainable practices, leads to a need for increased nutrient inputs, which in turn raises production costs for farmers. Knowledge gaps persist regarding optimized fertilizer application, efficient energy use in processing, and effective pest and disease management in the face of changing climatic conditions.

Organic farming methods are crucial for enhancing soil health by maintaining its natural nutrient balance and greatly minimizing environmental pollution by avoiding synthetic chemical inputs. Techniques like composting, especially using coffee pulp and leaf litter, efficiently restore vital nutrients to the soil, thus boosting its fertility and improving soil structure. Mulching also helps retain soil moisture, suppress weed growth, and gradually enrich the soil as organic matter breaks down. Crop rotation is another important practice that helps preserve soil structure and fertility while also lowering the risk of nutrient depletion and persistent pest problems.

7.The Human Element: Economic Resilience and Farmer Livelihoods

7.1 Value Chain: Ensuring Equitable Distribution

The livelihood of Indian coffee farmers is a complex issue that extends beyond simple commercial transactions. According to Navin, the relationship is deeply communal, with workers often being neighbors and fellow farm owners. This fosters a reciprocal environment where knowledge and practices are shared. The earning from coffee plantations for small farmers alone is not financially viable; a significant portion of their income comes from intercropped commodities like pepper and jackfruit. While coffee prices have increased, they still haven't matched 1972 levels. This is driving many to focus on specialty coffee to gain better recognition and higher prices, though it requires a significant investment in time and resources.

Mishthi highlights the crucial role of ethical trade and fair pricing. She emphasizes paying a deserved price based on quality and ensuring that farmers are treated ethically, with access to medical care and a safe working environment.

Lynn and Rajeshwari touch on the need for education and the realities of sustainable practices. Lynn points out that sharing about techniques about ecological cultivation and processing to farmers is essential for improving quality. Rajeshwari adds that while many Indian farmers continue to embrace old and sustainable methods to maintain their ecosystem, with present inflationary trends, these practices are often more labor-and-energy-intensive, a factor that must be considered. This collective insight reveals that a sustainable future for Indian coffee farmers depends on fair pricing, community support, ongoing education, and recognizing the true value of their labor and eco-friendly practices.

Chandini (Founder, LunyBee) mentions that teams at Harley Estate see themselves as a resource hub for many other producers. A lot of their work through the Harley Plantation Research Institute centres on documenting processes, developing new fermentation techniques, is shared widely. Farmers and partners often visit them to observe and adapt sustainable practices for their own estates. By opening their knowledge and making it accessible, they aim to give producers tools to improve quality, gain better market access, and realize higher value for their coffee.

7.2 Innovating Financing, Affordable MRV, Performance-based Models

Smallholder farmers, who are essential to coffee production, frequently encounter significant financial obstacles and risks that hinder their adoption of sustainable practices. Access to financial resources is crucial for promoting deforestation-free supply chains and improving transparency, yet traditional lenders often exclude smaller producers due to high investment risks, operational costs, and insufficient collateral.

Blended finance emerges as a vital solution. This model combines public or philanthropic capital with private capital to achieve a desired impact, often social or environmental. The public contribution reduces investment risks for private lenders, allowing banks to provide larger amounts of financing for projects that would otherwise be too risky, such as long-term loans for reforestation or sustainable agriculture. This approach can bridge the financing gap, facilitating smallholders' access to the capital needed for sustainable land use practices and new technologies like traceability systems.

MRV for the supply chain and certifications is one of the major problems. Traditional MRV protocols can be costly and complex, creating a barrier for small-scale farmers. Innovations in digital and remote sensing technologies, such as satellite-driven solutions and AI-driven advisory systems, offer scalable and cost-effective monitoring of crop health, soil carbon, and land use. Affordable Measurement, Reporting, and Verification (MRV) systems are essential for enabling smallholders to participate in carbon markets and receive performance-based payments, which could be related to the yield-based incentives, quality premiums or certification-linked premiums, such as achieving Rainforest Alliance, Fairtrade, or organic certification and make the overall supply chain transparent and traceable.

Government initiatives for coaching coffee farmers include India's Integrated Coffee Development Project (ICDP) and Coffee Development Programme (CDP), implemented by the Coffee Board of India, which provide education on advanced technologies and improved cultivation practices, along with financial assistance for equipment and expansion into non-traditional areas. These technologies help improve accuracy, reduce biases, and streamline the verification process, allowing smallholders and cooperatives to combine their efforts and benefit from carbon credit markets by lowering transaction barriers and distributing costs.

Indian coffee is largely grown under shade in diverse agroforestry systems, which makes it more sustainable and climate-friendly compared to many sun-grown coffees. Shade trees not only sequester carbon but also improve soil health, conserve water, and support biodiversity. Plantations often intercrop with pepper, cardamom, and fruit trees, reducing reliance on chemical inputs while diversifying income. Many estates use organic manures, composted coffee pulp, and bio-fertilisers instead of synthetic fertilisers, which lowers nitrous oxide emissions. Soil and water conservation measures like mulching, contour planting, and rainwater harvesting further enhance carbon storage. In addition, farmers recycle coffee by-products for compost or biogas, adopt integrated pest management with natural pesticides, and increasingly use energy-efficient processing methods such as solar dryers. These practices collectively reduce the carbon footprint of Indian coffee, making it a model of low-emission, sustainable production.

But these practices are not linked to any incentives. Performance-based payment models motivate farmers to adopt sustainable practices by linking financial rewards directly to measurable environmental or social outcomes. Inspired by tech sector innovations, some financing models use alternative data to assess creditworthiness, bypassing traditional requirements like balance sheets. For example, evaluating producers based on customer retention, shipment delays, and quality claims can enable access to credit. These models ensure that farmers are compensated for their efforts in environmental stewardship and quality improvement, making sustainable agriculture economically viable and appealing.

Smallholder farmers face financial barriers in adopting sustainable practices. Blended finance, combining public and private capital, helps de-risk investments, enabling banks to finance projects like sustainable agriculture. Low-cost MRV systems allow smallholders to join carbon markets, using technologies like satellite and AI for cost-effective monitoring. Performance-based models link financial rewards to environmental outcomes, using alternative data for credit assessment, making sustainable agriculture viable.

However, there is a transformative opportunity to leverage remote sensing technologies, artificial intelligence (AI), and mobile technology to overcome these barriers. Remote sensing, including satellite imagery and drone-based sensors, can provide precise, large-scale data on land use change, vegetation cover, and biomass accumulation, which are key indicators for carbon stock changes. When coupled with GIS and data analytics, these tools enable remote assessment of carbon sequestration potential, significantly reducing the need for costly physical soil sampling and lab tests while ensuring measurement integrity. The proliferation of mobile technology in developing regions also creates new avenues for data collection and farmer engagement, allowing for mobile apps to facilitate farmer data input and ground-truthing of remote sensing data.

Scaling coffee production for domestic and export markets without increasing carbon emissions, water use, biodiversity loss, or pollution is crucial. Conventional practices like clear-cut monocultures, unsustainable irrigation, and unchecked fertilizer use threaten to make coffee a contributor to climate and ecosystem problems.

To address this, promote regenerative farming over sustainability minimums. Move from maintaining shade and basic organic standards to truly regenerative practices like multilayered agroforestry, biodiversity corridors, and on-farm composting that actively rebuild soil, capture more carbon, prevent runoff, and restore landscape resilience.

Adopt and scale advanced water conservation techniques like precision irrigation, ecological wet mills, and water recycling, and best-in-class effluent management. Industry leaders can go beyond AWD and basic treatment, piloting zero-discharge and biogas generation from mill effluents, which are only sporadically practised today.

Valorise all coffee byproducts (husk, pulp, wastewater) through bioenergy, biochar, and circular use as soil amendments, enhancing yields and storing carbon. Industry should adopt standardised waste-to-value strategies beyond traditional composting.

Unlocking Access to Carbon Revenue and Premium Markets: Farmers who adopt digital MRV tools, such as yield-tracking apps, daily practice logs, and traceability systems, gain access to verified carbon markets and sustainably certified buyers. These solutions enable proof of practice, facilitate aggregation, and lower barriers to entry for smallholders and cooperative groups.

Aggregate hundreds or thousands of small farms for scale, equity, and resilience, rather than focusing on single estates for carbon or ESG initiatives. FCF India and similar actors can facilitate cooperative registry and carbon pooling, setting a new standard for collective climate action.

Partner to reform certification and incentive frameworks to recognise multi-benefit systems, landscape restoration, and smallholder inclusion.

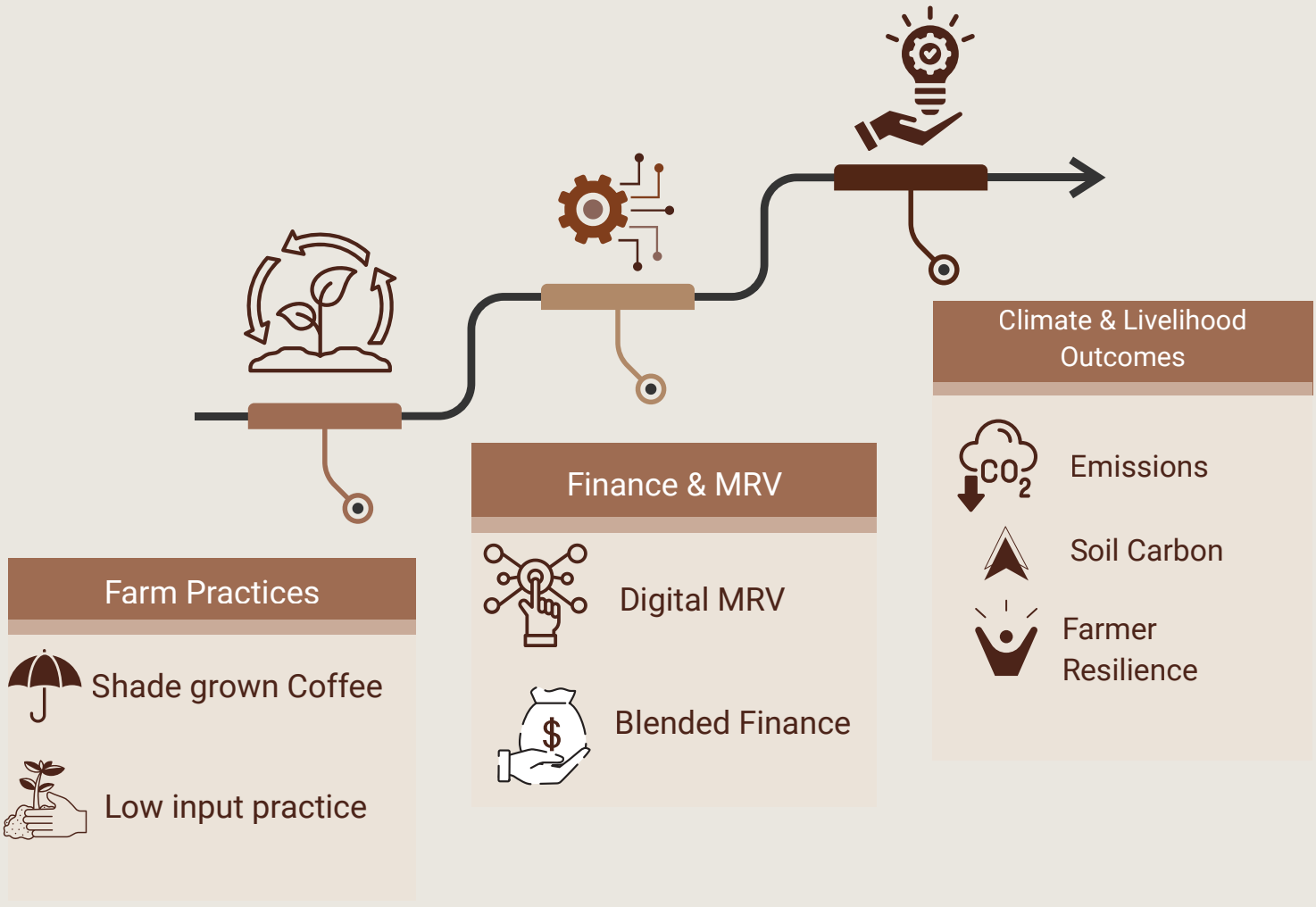


Figure 10. Coffee as a Climate System

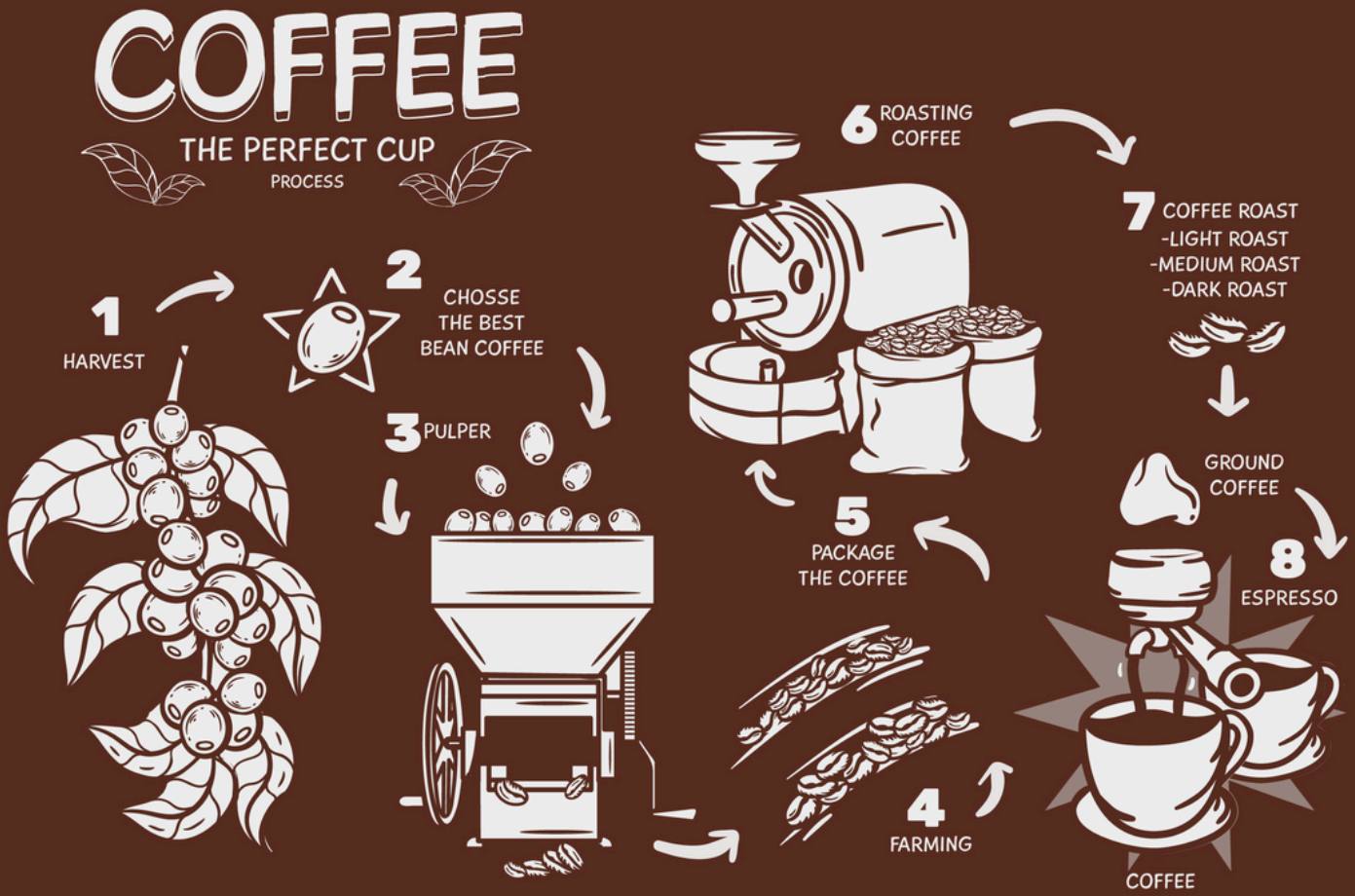
8.The Final Brew:

Will India Be Coffee's Climate Catalyst or Casualty?

Although many companies declare "carbon-conscious" objectives, there is a distinct need for more precise, verifiable, and standardized methods for measuring and reporting reductions in carbon footprints. The lack of clear definitions, industry-wide methodology for assessing the carbon footprint of green coffee across diverse growing regions and farming systems remains a major challenge. This absence of standardization impedes accurate comparison and effective progress tracking.

Secondly, while many well-known players successfully implement agroecology and regenerative agriculture, the challenge is in scaling these practices across India's vast and fragmented smallholder base. This requires significant support and infrastructure, including training, climate-resilient seeds, and access to suitable markets.

Finally, beyond the farm level, further innovation is needed in developing and implementing energy-efficient roasting technologies, optimizing sustainable logistics especially for transport, which can be a critical area and enhancing comprehensive waste management systems throughout the supply chain, including the repurposing of coffee by-products.



Brewing Resilience

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