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Research Article

Global and regional dynamics of coffee production: a comparative growth and decomposition analysis

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Abstract

Coffee is a globally traded and economically vital agricultural commodity supporting millions of smallholder farmers. While extensive country-specific literature exists, a comprehensive comparative evaluation using growth and decomposition frameworks across major global and Indian states has remained missing. This study analyzes the growth performance of coffee area, production, and productivity across major producing countries and Indian states while identifying key structural shifts. Utilizing secondary data from FAOSTAT and the Coffee Board of India (1995-2024), the study applies an exponential growth model to calculate Compound Annual Growth Rates and a decomposition model to measure the effects of area, yield, and their interactions. Key findings reveal that Brazil's production growth was driven primarily by productivity improvements (95%), whereas Vietnam's growth was propelled by substantial area expansion (60%). Nationally, India's production increased despite declining yields, mainly supported by area expansion and geographic shifts toward robusta and non-traditional regions. Regionally, Karnataka's growth relied on area expansion and high-yielding varieties, while Kerala's growth was overwhelmingly led by yield optimization (97%). These insights provide critical guidance for policymakers and stakeholders to enhance the economic viability and climate resilience of the global coffee sector through targeted agronomic and climate-smart adaptations.

Keywords: Area and yield effects, Coffee production, Decomposition analysis, Structural shifts

Introduction

Coffee is one of the most widely traded and economically significant agricultural commodities globally, serving as vital source of livelihood for millions of smallholder farmers across developing and emerging economies (Vegro *et al.,* 2020). The dynamics of global and national coffee production primarily affected by complex interplay of environmental factors, technological adoption, shifting consumer demand and institutional support systems (Ngure *et al.,* 2024). Understanding the long-term growth patterns of area expansion, production and disparity in productivity is essential for evaluating the resilience and economics viability of the coffee sector. Across major coffee producing nations, production paradigm varies substantially due to localized agronomics practices, structural adjustments and susceptibility to climate change.

The global coffee production dominated by the few countries such as Brazil, Vietnam Colombia and Indonesia (Vegro *et al.,* 2020). In Brazil coffee cultivation faces pressure from climate indued crop migration, however the coffee production increased significantly primarily due to productivity improvement adopting climate resilient hybrids, advanced farming practices (Bracken *et al.,* 2021). The Vietnam experienced remarkable growth driven by both substantially area expansion and continuous productivity improvement over the decades (Ho, 2023). Conversely, the Colombia have confronted severe challenges such as climate change, extreme weather events and labor shortage resulting the fluctuating and stagnant growth (del Campo Parra Muñoz, 2016). Similarly, Indonesian coffee production has also witness vulnerability due to weather variability, aging trees and production risk due to pest, however the coffee production has been improved significantly due to structural and agronomic interventions (Fuerzas & Delina, 2026).

The Indian coffee sector occupies an important position, characterized by unique regional adaptations and structural shifts (Jha *et al.,* 2011). Indian coffee production has expanded over the long term, national yields have experienced downward pressures driven by erratic weather patterns, climate change, and rising production costs (Atkinson, 2019). To sustain growth, the sector has increasingly relied on strategic geographical expansion into non-traditional areas such as the Araku Valley in Andhra Pradesh, Odisha, and parts of the North Eastern states alongside a structural shift favouring hardier Robusta cultivation over Arabica. Regionally, the traditional southern states of India exhibit diverse growth mechanisms. Karnataka has sustained coffee production growth through a combination of high-yielding varieties, modernization, and expanding cultivation areas. Kerala's production dynamics have been predominantly driven by remarkable yield optimizations, precision farming, and institutional support, whereas Tamil Nadu has displayed cyclical phases of decline and subsequent recovery.

Despite the extensive literature on country specific trends, a comprehensive, comparative evaluation utilizing growth and decomposition frameworks across major global and Indian regional markets remains essential. Therefore, this study undertakes a rigorous growth performance and decomposition analysis of area, production, and productivity for coffee to identify the primary sources of growth and structural shifts influencing the global and national agricultural economy. The present study aims to analyse the growth performance of coffee production in

terms of area, production, and productivity across major producing countries and Indian states. It will also examine India's position in the global coffee economy and identify the structural shifts influencing production dynamics at the Global and National level.

Data and methodology

Secondary data regarding the area, production, and yield of coffee, collected from the FAOSTAT, and Coffee Board of India for the period of 1995 to 2024. The major coffee producing countries and states selected based on the coffee production. The exponential growth model used to estimate the Compound Annual Growth Rate (Growth Rates) of area, production and productivity of coffee at global, national and regional level.

$$Y = a\, b^t e$$

Where,
Y - Dependent variable Area/Production/Productivity
a - Intercept/Constant
b - Regression coefficient
t - Time variable
e - Error term

Decomposition analysis was used to examine the contribution of area, yield, and their interaction to changes in coffee production. The method is expressed as:

$$\Delta P = A_0 \Delta Y + Y_0 \Delta A + \Delta A \Delta Y$$

Where:
$A_0 \Delta Y$ = Yield Effect
$Y_0 \Delta A$ = Area Effect
$\Delta A \Delta Y$ = Interaction Effect

This model decomposes the major source of production growth.

Results and discussion

Global coffee production

Table 1 presents the annual growth rates and source of the growth of coffee production in Brazil from 1995 to 2024.The area, production and yield of coffee significantly increased by 3.04, 9.87, and 6.63 percent annually during 1995 to 2004. The area under coffee during the recent decades declining due to climate change induced crop migration (Zilli *et al.,* 2020). However, the coffee production has increased significantly mainly due to productivity improvement. At overall period, the coffee production significantly increased primarily due to productivity improvement, new climate resilient hybrids and high yielding varieties, improved farming techniques. The productivity improvement was observed to be key source of the growth in the coffee production.

Table 2 shows the annual growth rates and source of the growth of coffee production in Vietnam from 1995 to 2024. Despite the yield deterioration, the area under coffee cultivation and production significantly increased during 1995 to 2004 by 19.07 and 15.89 percent per annum respectively. From 2005 to 2024, the area, production and yield were substantially increased. At overall period the area, production and yield significantly increased by 4.3, 6.15 and 1.78 percent per annum respectively. The growth was mainly attributed by the contribution of area expansion under coffee cultivation and yield improvement during the study period (Ho, 2018).

Table 3 illustrates the annual growth rates and source of the growth of coffee production in Colombia from 1995 to 2024.The area under coffee cultivation, production and yield was substantially decreased during 1995 to 2024. However, the area under coffee cultivation increased by 0.32 percent in the study period. The coffee production fell mainly attributed by the climate change, severe labour shortage (Romero *et al.,* 2023; Abrego-Perez & Nuñez-Mora, 2026).

Table 4 shows the annual growth rates and source of the growth of coffee production in Indonesia from 1995 to 2024. Despite the coffee yield decreased by 1.54 percent annually, the area under coffee cultivation and production substantially decreased during 1995 to 2024. During the 2005-2014, the area, production and yield of coffee in Indonesia declined due to extreme weather variability, aging trees, production risk from the pests and farmers shifted to profitable crops (Sarvina *et al.,* 2021). However, the area under coffee, production and yield increased significantly during 2015-2024, due to certain structural and agronomic interventions including area optimization and expansion under coffee cultivation, tree aging and rehabilitation and input management (Pratama & Rachman, 2024).

Coffee production: National scenario

The Table 5 shows the annual growth rates and source of the growth of coffee production in India from 1995 to 2024. Despite the coffee yield decreased by 0.64 percent annually, the area under coffee cultivation and production substantially increased during 1995 to 2024.During the 2015-2024, the yield of coffee in India declined potentially

Table 1: Growth rates and decomposition of coffee production in Brazil

Period	Growth rates			Source of growth		
	Area	Production	Yield	Area (%)	Yield (%)	Interaction (%)
1995-2004	3.04***	9.87***	6.63***	16	66	18
2005-2014	-1.51***	3.07***	4.65***	-45	169	-24
2015-2024	-0.19^{NS}	2.12*	2.32*	-6	108	-2
Overall	-0.57***	3.34***	3.93***	1	95	4

***, ** and * significant 1, 5, and 10 per cent, respectively, NS: Non-significant

Table 2: Growth rates and decomposition of coffee production in Vietnam

Period	Growth rates			Source of growth		
	Area	Production	Yield	Area (%)	Yield (%)	Interaction (%)
1995-2004	19.07***	15.89***	-2.68*	100.05	-0.05	0
2005-2014	2.53***	4.63***	2.05*	31	57	12
2015-2024	1.56***	4.09***	2.49***	37	55	8
Overall	4.3***	6.15***	1.78***	60	7	33

***, ** and * significant 1, 5, and 10 per cent, respectively, NS: Non-significant

Table 3: Growth rates and decomposition of coffee production in Colombia

Period	Growth rates			Source of growth		
	Area	Production	Yield	Area (%)	Yield (%)	Interaction (%)
1995-2004	-2.02**	-0.88^{NS}	1.17^{NS}	53	52	-5
2005-2014	-0.58^{NS}	-2.06^{NS}	-1.49^{NS}	-15	117	-2
2015-2024	0.28^{NS}	-2.14^{NS}	-2.41^{NS}	312	-203	-9
Overall	0.32**	0.39^{NS}	0.07^{NS}	-79	182	-3

***, ** and * significant 1, 5, and 10 per cent, respectively, NS: Non-significant

Table 4: Growth rates and decomposition of coffee production in Indonesia

Period	Growth rates			Source of growth		
	Area	Production	Yield	Area (%)	Yield (%)	Interaction (%)
1995-2004	7.26***	5.61***	-1.54^{NS}	130	-20	-11
2005-2014	-0.48**	-0.1 NS	0.38^{NS}	-35	46	-9
2015-2024	0.41***	2.34***	1.92***	12	85	3
Overall	0.99***	1.69***	0.70***	65	23	12

***, ** and * significant 1, 5, and 10 per cent, respectively, NS: Non-significant

Table 5: Growth rates and decomposition of coffee production in India

Period	Growth rates			Source of growth		
	Area	Production	Yield	Area (%)	Yield (%)	Interaction (%)
1995-2004	4.12***	4.96***	0.8^{NS}	84	11	5
2005-2014	1.47***	1.78**	0.3^{NS}	137	-32	-5
2015-2024	1.58**	1.15^{NS}	-0.42^{NS}	146	-40	-6
Overall	2.2***	1.55***	-0.64***	113	-6	-7

***, ** and * significant 1, 5, and 10 per cent, respectively, NS: Non-significant

due to erratic weather patterns, climate change, and rising production costs (Prabha *et al.,* 2021). However, the area under coffee and production increased significantly during 2015-2024, due to certain shift toward robusta cultivation that prioritized robusta over arabica, strategic geographical expansion supported by moving into non-traditional areas like the Araku Valley in Andhra Pradesh, Odisha, and parts of the North Eastern states (Vijayakumar & Shilpa, 2025).

Coffee production: Regional analysis

Table 6 shows the annual growth rates and sources of growth for coffee production in Karnataka from 2007 to 2024. Although the overall coffee yield increased by 0.26 percent annually, the area under coffee cultivation and total production substantially increased during this period. During 2007-2015, the production and yield of coffee in Karnataka increased significantly, driven primarily by the widespread adoption of high-yielding, disease-resistant plant varieties, a structural shift toward hardier Robusta cultivation, and intensified government policy support (Joseph *et al.,* 2019). However, the area under coffee and production continued to increase significantly during 2016–2024, but the primary source of this growth shifted to area expansion (58 percent), potentially due diffusion of high-yielding varieties (HYVs), transition to robusta cultivation, institutional support and modernization (Basavalingaiah *et al.,* 2022).

Table 7 shows the annual growth rates and sources of growth for coffee production in Kerala from 2007 to 2024. The area under coffee cultivation increased by only 0.08 percent annually overall, the coffee yield and total production substantially increased during this period. During 2007-2015, the production and yield of coffee in Kerala increased significantly, primarily attributed by yield improvements potentially due to favourable blossom showers, widespread adoption of high-yielding varieties and resilience against climate extremes (Jayakumar *et al.,* 2016). Furthermore, production and yield continued to increase significantly during 2016-2024, with yield as the dominant source of growth (99 percent), due to high-yielding and climate-resilient varieties, precision farming, aggressive mechanization and institutional support (Sreeni, 2023).

Table 8 presents the annual growth rates and sources of growth for coffee production in Tamil Nadu during 2007 to 2024.The area under coffee cultivation, production and yield decreased during the 2007 to 2015. However, area under coffee cultivation, production and yield was significantly increased during 2016-2024.

Table 6: Growth rates and decomposition of coffee production in Karnataka

Period	Growth rates			Source of growth		
	Area	Production	Yield	Area (%)	Yield (%)	Interaction (%)
2007-15	0.81***	2.69***	1.87***	22	73	5
2016-24	0.76**	2.35***	1.58**	58	39	3
Overall	0.94***	1.2***	0.26^{NS}	61	32	7

***, ** and * significant 1, 5, and 10 per cent, respectively, NS: Non-significant

Table 7: Growth rates and decomposition of coffee production in Kerala

Period	Growth rates			Source of growth		
	Area	Production	Yield	Area (%)	Yield (%)	Interaction (%)
2007-15	0.08***	3.38***	3.29***	2	97	1
2016-24	0.01***	1.73***	1.71***	1	99	0
Overall	0.08***	1.43***	1.35***	2	97	1

***, ** and * significant 1, 5, and 10 per cent, respectively, NS: Non-significant

Table 8: Growth rates and decomposition of coffee production in Tamil Nadu

Period	Growth rates			Source of growth		
	Area	Production	Yield	Area (%)	Yield (%)	Interaction (%)
2007-15	0.46^{NS}	-0.73^{NS}	-1.18^{NS}	-174	254	20
2016-24	0.21***	1.86***	1.64 ***	8	90	1
Overall	0.98***	0.09^{NS}	-0.88***	203	-91	-12

***, ** and * significant 1, 5, and 10 per cent, respectively, NS: Non-significant

Conclusions

The Brazil experienced significant growth in coffee production primarily driven by productivity improvements rather than area expansion. Conversely, Vietnam achieved substantial growth in coffee production predominantly attributed to area expansion alongside productivity improvements. The coffee production in Colombia remained stagnant during the study period despite a slight increase in cultivation area, heavily impacted by factors like climate change and labour shortages. Indonesia's coffee production grew significantly mainly due area expansion as major source than the productivity. At the national level, India's national coffee production increased during study period despite declining yields, with growth entirely driven by area expansion and strategic shifts toward robusta and non-traditional regions. Karnataka's coffee production growth was predominantly led by area expansion and high-yielding varieties, whereas coffee production was mainly increased due to productivity improvements in Kerala. Finally, Tamil Nadu exhibited a mixed trajectory, characterized by an overall decline in both area and yield during the study period.

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