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Evolution and turning points in India's milk production: A structural break approach to understanding dairy sector growth

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Abstract

The present study examined shifts in the growth trajectory of India's dairy sector by analysing structural discontinuities in milk production over the 2000–2024 period. To endogenously detect turning points in the production series, the Bai-Perron multiple structural breakpoint procedure was applied. The analysis identified three statistically significant break points, occurring in 2007, 2014, and 2019, each signalling a notable alteration in the underlying growth dynamics of milk output. Estimates of the compound annual growth rate (CAGR) across the resulting structural regimes revealed considerable heterogeneity in sectoral performance over time. Notably, the sub-period spanning 2015–2019 exhibited the most rapid expansion, pointing to a phase of intensified output growth. The observed inter-regime variation reflects the cumulative influence of evolving policy frameworks, institutional arrangements, and broader economic developments on the long-run trajectory of the Indian dairy economy.

Keywords: Dairy; Milk production; Bai-Perron test; Structural breaks

1. Introduction

The dairy sector occupies a pivotal position within India's agricultural economy, functioning as a cornerstone of rural incomes and employment generation. As a fundamental pillar of the rural economy, it makes substantial contributions to farm household earnings, workforce absorption, and food and nutritional security (Lyngkhoi et al., 2022). India's stature in global dairy is unparalleled, as it currently holds the position of the world's foremost milk-producing nation (FAO, 2025). Domestic milk output rose from 239.30 million tonnes in 2023-2024 to 247.87 million tonnes in 2024-2025, reflecting a year-on-year increase of 3.58 per cent. Per capita milk availability has shown a sustained upward trend since 2018-2019, climbing from 390 gm/day to 485 gm/day by 2024-2025 (GOI, 2025). At present, the dairy sub-sector accounts for approximately 5 per cent of national income, making it the single largest agricultural commodity in the country by economic value (as per National Accounts Statistics). The transformation of Indian dairying from a state of deficit to one of surplus has been underpinned by targeted policy interventions, institutional frameworks, technological progress, and the proliferation of cooperative structures across the country (Kalimuthu et al., 2021). From the pioneering White Revolution to the contemporary White Revolution 2.0, the sector has advanced through successive developmental phases. With close to 8 crore individuals deriving livelihoods from dairy-related activities (as per National Accounts Statistics), the sector has transcended its origins as a subsidiary livestock enterprise to become an integral component of the broader Indian economy (Jothilakshmi et al., 2011).

The Indian dairy sector has undergone profound structural transformation over the course of several decades (Kumar et al., 2013). The concept of structural change admits multiple interpretations. Goddard et al. (1993) characterise it as a shift in the relative proportions of major components of aggregate economic activity, encompassing national output,

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expenditure, trade flows, and labour force composition. At the microeconomic level, structural change in agriculture refers to the capacity of farm enterprises to transition away from smallholder subsistence operations toward commercially oriented production systems (Landi et al., 2013). Hollis B. Chenery conceptualised structural change as an interconnected set of transformations in a country's economic architecture, constituting a precondition for sustained growth and development (Behrman, 1982). Within the Indian dairy context, structural change denotes the long-term metamorphosis of dairy farming from a traditional, subsistence-oriented activity into a modern, market-integrated, and technology-intensive enterprise, encompassing shifts in production organisation, institutional design, and value chain configuration (Kona et al., 2025). Among the most consequential structural shifts within the sector is the changing composition of the dairy herd, particularly the growing proportion of crossbred and improved indigenous bovines in total milk output. A critical force behind structural transformation has been the expansion of cooperative dairy networks, which incorporated vast numbers of smallholder producers into formalised procurement and marketing channels (Ohlan, 2016), access to simplified tax frameworks and digital financial services has been identified as a key enabler of microentrepreneur formalization in emerging economies (Yacoubian et al., 2025a; Krysovatyy et al., 2026). The entry and growth of private dairy enterprises have simultaneously accelerated commercialisation and intensified competitive dynamics (Thakur, 2020). In parallel, the emergence of dairy-focused startups and agri-entrepreneurial ventures signals a new era of innovation-driven sectoral evolution (Dixit et al., 2024). Furthermore, widespread mechanisation, advances in breeding technology, expanded veterinary services, artificial insemination programmes, and improved feed and fodder management have collectively enhanced livestock productivity and overall dairy sector output (Patro et al., 2026). The growing engagement of women in dairy production and entrepreneurship has further reinforced the inclusive dimensions of this transformation (Bidhan et al., 2024). Taken together, the structural changes that have unfolded over time have meaningfully increased milk volumes, raised per-animal yields, transformed marketing systems, and stimulated diversification into processed and value-added dairy products (Sarkar et al., 2024). These cumulative transformations have been central to the sustained development of the dairy sector as a whole.

A substantial body of scholarly work has examined milk production trends in India. However, despite the breadth of existing literature on the dairy sector, the predominant focus has been on production trends, productivity growth, and cooperative development. Many studies evaluate dairy progress against pre-specified policy phases rather than endogenously identifying turning points in the production trajectory. While some research has explored long-run growth patterns in dairying, comparatively little attention has been devoted to applying the Bai-Perron multiple structural breakpoint framework to detect endogenous discontinuities in milk production series. Moreover, existing studies have rarely examined how milk output growth varies across structurally distinct regimes, or how such regime transitions relate to the timing of major policy interventions. There also remains a lack of systematic empirical evidence on the chronology and character of structural shifts in the Indian dairy sector's growth path. The present study directly addresses these gaps by endogenously locating structural breaks in India's milk production series and assessing sectoral growth performance across the resulting regimes, thereby generating a more nuanced understanding of the evolving dynamics of Indian dairying.

2. Data and methods

The empirical analysis draws on secondary data compiled from a range of official published sources. Data were sourced from the online portals of the Government of India, the Ministry of Agriculture and Farmers' Welfare, the Ministry of Fisheries, Animal Husbandry and Dairying, the National Dairy Development Board (NDDB), and the National Cooperative Database. Annual time series data on milk production in India (in million tonnes) covering a 25-year span from 2000 to 2024 were extracted from the Basic Animal Husbandry Statistics (BAHS), a publication of the Department of Animal Husbandry, Dairying and Fisheries under the Ministry of Agriculture, Government of India.

2.1. Methodology

The compound annual growth rate (CAGR) of milk production for the full study period (2000–2024) was derived by fitting an exponential function of the form:

$$Y = a + bt$$

The CAGR was subsequently computed from the estimated slope coefficient as follows:

$$CAGR = (\text{Antilog of } b - 1) \times 100$$

2.2. Structural Break Analysis (The Bai-Perron Test)

Endogenous structural break detection was conducted using the Bai-Perron multiple structural breakpoint procedure (Bai, 1994; Bai & Perron, 1998; 2003). This technique enables the simultaneous identification of multiple unknown break points within a time series, applied here to year-on-year changes in milk production. A key advantage of the Bai-Perron method relative to conventional approaches is its flexibility in detecting more than one structural discontinuity within the same series (Antoshin et al., 2008; Casini & Perron, 2019). Break point dates are determined by minimising the sum of squared residuals from an ordinary least squares (OLS) regression across all feasible sample partitions. Formally, let T1, T2, …, Tm denote the break dates, where m is the total number of structural breaks. The procedure evaluates all admissible sample segmentations and selects the set of break dates that minimises the residual sum of squares. In the present analysis, the Bai-Perron test was applied to the log-transformed milk production series in order to identify significant inflection points in the sectoral growth trajectory. The resulting break dates partition the overall study period into distinct growth regimes, within each of which compound annual growth rates are subsequently estimated.

3. Results and discussion

3.1. Detection of Structural Discontinuities in India's Milk Production Series

Application of the Bai-Perron multiple structural breakpoint test to the log-transformed milk production series yielded evidence of three statistically significant break points in 2007, 2014, and 2019 (Table 1). These inflection points mark fundamental shifts in the prevailing growth regime of milk output and segment the overall study window into four structurally distinct sub-periods: 2000–2007, 2008–2014, 2015–2019, and 2020–2024.

Table 1 Bai-Perron Multiple Structural Break Test Results for Milk Production in India.

Sequential F-statistic determined breaks: 3			
Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	74.70654	74.70654	8.58
1 vs. 2 *	17.25271	17.25271	10.13
2 vs. 3 *	32.00961	32.00961	11.14
* Significant at the 0.05 level.			
** Bai-Perron (Econometric Journal, 2003) critical values.			
Break dates: 1 → 2007 2 → 2014 3 → 2019			

Source: Authors' calculation based on secondary data from Basic Animal Husbandry Statistics 2025, Government of India.

The first break point, occurring in 2007, captures a phase of structural transition in Indian dairying, marked by a strengthening of production momentum. This shift may be linked to the concurrent introduction of the Rashtriya Krishi Vikas Yojana (RKVY) and the adoption of the National Policy for Farmers in 2007. Together, these frameworks served as overarching instruments for the integrated development of agriculture and its allied sectors. Among their priorities were the promotion of diversification into activities such as dairy farming, enhanced access to formal credit, and investments in livestock and fodder resource development.

The second break point, detected in 2014, signals a decisive shift toward a more intensive, productivity-oriented growth regime within the dairy sector. This year marked the onset of the most vigorous phase of sectoral expansion, coinciding with heightened policy emphasis on livestock and dairy development through flagship schemes such as the Rashtriya Gokul Mission and the National Livestock Mission, both launched in 2014. The National Dairy Plan Phase 1 (initiated in 2012) and the operationalisation of the National Programme for Dairy Development during 2013-2014 may also have contributed to this structural shift. These programmes have been instrumental in reinforcing the foundations of Indian dairying and in lifting milk production. Their contributions span improvements in cattle productivity and genetic quality, fodder availability, and livestock management systems. In their revised and expanded forms, these initiatives continue to sustain productivity gains and strengthen the overall resilience of the milk production system.

The third break point, identified in 2019, reflects an additional phase of transition in the dairy sector's growth pattern. This juncture aligns with the launch of the National Artificial Insemination Programme (NAIP) under the Rashtriya

Gokul Mission in 2019, designed to deliver free insemination services directly at farmers' premises. Contributing factors may also include the influence of earlier dairy schemes such as the Dairy Processing and Infrastructure Development Fund (DIDF) and the scheme Supporting Dairy Cooperatives and Farmer Producer Organisations Engaged in Dairy Activities, both operationalised during 2017-2018. Additionally, the establishment of the dedicated Ministry of Fisheries, Animal Husbandry and Dairying in 2019 imparted greater institutional focus to livestock and dairy affairs. Broadly, the occurrence of multiple structural discontinuities confirms that the growth of milk production in India has unfolded through successive and qualitatively distinct phases, shaped by the interplay of policy interventions, technological improvements, and market expansion. These break points underscore the non-linear and dynamic character of dairy sector development and provide the basis for a regime-specific analysis of growth performance.

3.2. Dairy Sector Performance Across Structural Regimes

India's dairy sector has posted a remarkable performance record over recent decades, ascending to the position of the world's leading milk producer and traversing the path from supply scarcity to relative abundance. Building on the break points identified in 2007, 2014, and 2019, the study period is segmented into four growth regimes: 2000–2007, 2008–2014, 2015–2019, and 2020–2024. To evaluate sectoral performance across these regimes, compound annual growth rates (CAGR) in milk production were estimated using a log-linear trend model.

Table 2 Regime-Wise Compound Annual Growth Rates in Milk Production**.**

Period	CAGR (%)
2000–2007	4.16
2008–2014	4.44
2015–2019	6.33
2020–2024	4.15

Source: Authors' calculation based on secondary data from Basic Animal Husbandry Statistics, Government of India.

In estimating regime-specific growth rates, each identified break year was assigned to the upper boundary of the preceding regime, thereby capturing any immediate adjustments in output that may have followed a structural shift or external shock (Table 2). In the first regime (2000–2007), milk production expanded at an annual rate of 4.16 per cent, reflecting a phase of steady but measured growth. This performance is attributable to the institutional foundations laid in earlier decades, principally the cumulative impact of the Operation Flood programme and the gradual consolidation of dairy cooperative networks across the country.

In the second regime (2008–2014), the CAGR edged upward to 4.44 per cent, pointing to a moderate improvement in growth momentum in the wake of the 2007 structural break. The third regime (2015–2019) recorded the highest growth rate of 6.33 per cent, indicating a marked acceleration in dairy output following the 2014 structural break. This sub-period constitutes the most dynamic growth phase of the entire study window and is consistent with the productive outcomes generated by major dairy development schemes, most notably the Rashtriya Gokul Mission and the National Livestock Mission.

In contrast, the fourth regime (2020–2024) saw a deceleration in growth, with the CAGR retreating to 4.15 per cent. This moderation signals a transition from peak expansion to a more stabilised growth trajectory following the 2019 structural break. Notwithstanding the continuation of supportive policy measures, the reduced pace of growth during this period may reflect headwinds from shifting market conditions, escalating input costs, and ongoing structural adjustments within the dairy economy. The variation in growth rates across regimes confirms that Indian dairying has progressed through qualitatively distinct phases rather than a uniform linear trajectory. The correspondence between structural regime transitions and major policy events suggests that institutional and programmatic support have been significant determinants of the long-run growth path of milk production in India.

4. Conclusion

India's dairy sector has undergone substantial structural transformation over the study period, characterised by recurring and statistically identifiable shifts in its growth dynamics. The detection of three structural break points in 2007, 2014, and 2019 establishes that milk production has evolved through a succession of distinct regimes rather than

following a uniform, continuous growth path. These break years represent critical junctures in the developmental trajectory of Indian dairying and reflect the changing nature of production dynamics over time.

The regime-specific growth analysis demonstrates that sectoral performance has varied considerably across structural sub-periods. The highest growth rate was recorded between 2015 and 2019, identifying this interval as the phase of maximum expansion within the Indian dairy sector. The findings indicate that key policy interventions and institutional mechanisms — spanning livestock development programmes, genetic improvement initiatives, dairy infrastructure investments, and fodder enhancement schemes — have likely exercised a formative influence on these growth patterns. Although the pace of expansion moderated in the post-2019 period, the dairy sector has continued to display resilience in the face of evolving economic and market pressures. The study thus underscores the indispensable role of enduring institutional commitment and flexible, adaptive policy frameworks in securing the long-run growth and stability of India's dairy economy.

Future research could examine whether the structural shifts identified in milk production are associated with the increasing digitalization of agricultural and financial services in rural areas. As noted by Yacoubian (2025b), trust, technological accessibility, and institutional support play a crucial role in the adoption of digital banking in developing countries; therefore, future studies could investigate how these factors influence financial inclusion and productivity outcomes within India's dairy sector.

References

[1] Antoshin, S., Berg, A., & Souto, M. (2008). Testing for structural breaks in small samples (IMF Working Paper No. WP/08/75). International Monetary Fund.

[2] Bai, J. (1994). Least squares estimation of a shift in linear processes. Journal of Time Series Analysis, 15(4), 453–472. https://doi.org/10.1111/j.1467-9892.1994.tb00204.x

[3] Bai, J., & Perron, P. (1998). Estimating and testing linear models with multiple structural changes. Econometrica, 66(1), 47–78.

[4] Bai, J., & Perron, P. (2003). Computation and analysis of multiple structural change models. Journal of Applied Econometrics, 18(1), 1–22.

[5] Behrman, J. R. (1982). Review article on Hollis B. Chenery, Structural change and development policy. Journal of Development Economics, 10, 313–323.

[6] Bidhan, S., Tyagi, R., Kathpalia, J., & Chander, S. (2024). Feminisation of dairy farming or distress? Tracking the progression of women in dairy farming in India. Universal Research Reports, 11(4), 85–105. https://doi.org/10.36676/urr.v11.i4.1315

[7] Casini, A., & Perron, P. (2019). Structural breaks in time series. In Oxford Research Encyclopedia of Economics and Finance.

[8] Dixit, A. K., Sirohi, S., Ravishankar, K. M., Cariappa, A. G. A., Kumar, S., Bhandari, G., Sharma, A. K., Thakur, A., Bhullar, G. K., & Thakur, A. (2024). Understating emerging value chains and business performance: evidence from dairy industry in India. Journal of Agribusiness in Developing and Emerging Economies, 14(3), 607–621. https://doi.org/10.1108/JADEE-10-2022-0219

[9] FAO. (2025). Dairy market review: Overview of global market developments in 2024. Food and Agriculture Organization of the United Nations.

[10] Goddard, E., Weersink, A., Chen, K., & Turvey, C. G. (1993). Economics of structural change in agriculture. Canadian Journal of Agricultural Economics, 41, 475–489.

[11] Government of India. (2025). Basic animal husbandry statistics 2025. Ministry of Fisheries, Animal Husbandry & Dairying, Department of Animal Husbandry & Dairying.

[12] Gupta, N., & Kannan, E. (2024). Agricultural growth and crop diversification in India: a state-level analysis. Journal of Social and Economic Development, 26(3), 709–733. https://doi.org/10.1007/s40847-023-00311-7

[13] Jothilakshmi, M., Thirunavukkarasu, D., & Sudeepkumar, N. K. (2011). Structural changes in livestock service delivery system: A case study of India. Asian Journal of Agricultural Research, 5, 98–108. https://doi.org/10.3923/ajar.2011.98.108

[14] Kalimuthu, K., Kumar, S., Priyadharshini, P., Sasikumar, S., Shamsia, A., & Vaishnavi, C. M. (2021). Dairy sector in India: Production and utilization of milk and milk products—A short review. Indian Journal of Applied Research, 11(8), 482–486.

[15] Kona, S. S. R., Ravikiran, G., Sasidhar, P. V. K., Sivakumar, A. V. N., & Rao, V. H. (2025). Perspectives in milk production in India. Theriogenology, 231, 116–126. https://doi.org/10.1016/j.theriogenology.2024.10.001

[16] Krysovatyy, A., et al. (2026). Modeling differentiated rates of the single tax in Ukraine based on the Polish experience. Journal of European Economy, 25(1), 155–180. https://doi.org/10.35774/jee2026.01.155

[17] Kumar, A., Parappurathu, S., & Joshi, P. K. (2013). Structural transformation in dairy sector of India. Agricultural Economics Research Review, 26(2), 209-219.

[18] Landi, C., Stefani, G., Rocchi, B., Lombardi, G. V., & Giampaolo, S. (2013). Determinants of structural change in the agricultural sector: An empirical analysis of farm exit in Tuscany. Paper presented at the 2nd AIEAA Conference, Parma, Italy.

[19] Lyngkhoi, D. R., Singh, S. B., Singh, R., & Tyngkan, H. (2022). Trend Analysis of Milk Production in India. Asian Journal of Dairy and Food Research, 41(2), 183–187. https://doi.org/10.18805/ajdfr.DR-1789

[20] Ngobeni, E., & Muchopa, C. L. (2023). Structural change in the South African agricultural sector: Bai-Perron modelling. Scientific African, 21, e01732. https://doi.org/10.1016/j.sciaf.2023.e01732

[21] Ohlan, R. (2016). Dairy economy of India: Structural changes in consumption and production. South Asia Research, 36(2), 241–260.

[22] Patro, A., Lathabhavan, R., Sulaiman, E., & Varghese, R. (2026). Effect of digitalisation on performance: evidence from dairy cooperatives of South India. International Journal of Productivity and Performance Management, 75(3), 783-808.

[23] Sarkar, A., Gupta, H., & Dutta, A. (2024). Sustainable dairy sector of an emerging economy: An empirical quest based on India. Agricultural Systems, 218, 103970. https://doi.org/10.1016/j.agsy.2024.103970

[24] Thakur, D. (2020). Milk producer companies in India: A review. International Journal of Current Microbiology and Applied Sciences, 9(11), 1385–1393. https://doi.org/10.20546/ijcmas.2020.911.163

[25] Yacoubian, L. J., Garcia, D. S. P., & de Carvalho, G. H. F. (2025a). Comparative analysis of tax regimes to stimulate micro-entrepreneurship in Latin America: The experience of Argentina and Brazil. Financial and Credit Activity: Problems of Theory and Practice, 6(65), 206–221. https://doi.org/10.55643/fcaptp.6.65.2025.4889

[26] Yacoubian, L. J. (2025b). Trust in digital banking: A thematic review of drivers, barriers and emerging evidence in developing countries. World Journal of Advanced Research and Reviews, 26(2), 4141–4147. https://doi.org/10.30574/wjarr.2025.26.2.2140