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Trend and instability analysis of mushroom production in Haryana

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Abstract

This study examines the growth dynamics and stability of mushroom production and infrastructure (No. of Trays) in Haryana from 1991 to 2025. Using exponential growth models and the Cuddy-Della Valle Instability Index (CDVI), the data across four distinct decades and an overall period were analysed. The results reveal that while growth was highest during the initial phase (1991-2000), a significant resurgence in productivity is observed in the most recent period (2021-2025). Trend fitting analysis shows that the Quadratic model provides the best fit for both production and tray counts, indicating a non-linear expansion of the industry.

Keywords: CDVI, Growth trend, Mushroom

Introduction

Mushroom cultivation has emerged as one of the most significant diversified agricultural activities in India, offering a potent solution for nutritional security, waste management and rural employment. In the state of Haryana, often referred to as the "Mushroom Hub of India," this sector has transitioned from a seasonal, small-scale venture into a sophisticated commercial enterprise. Unlike traditional field crops, mushroom production is a land-saving, indoor activity that utilizes vertical space, making it an ideal subsidiary enterprise for small and marginal farmers.

The economic importance of mushrooms in Haryana is underscored by their ability to convert lignocellulosic agricultural wastes-predominantly wheat and rice straw-into high-quality proteinaceous food. As the state grapples with diminishing per capita land holdings, the high per-unit productivity of mushrooms offers a viable pathway for augmenting farm income. This study aims to quantify the long-term growth dynamics and the degree of instability in both infrastructure (number of trays) and output (production) over a comprehensive 35-year period (1991-2025), providing a data-driven perspective on the sector's evolution through various economic phases.

Within India, Haryana, along with Punjab and Bihar, remains a dominant production hub, particularly for *Agaricus bisporus* (White Button Mushroom), which accounts for roughly 75-90% of the state's total output (Arunachalam *et al.*, 2023) ^[2]. Singh *et al.* (2018) ^[13] conducted an economic assessment of mushroom growers in Haryana, revealing that the "economies of scale" operate significantly on large-sized farms, though small-scale seasonal growers contribute the bulk of the volume during winter months. A study from Krishi Vigyan Kendras (KVKs) in districts like Kurukshetra and Sonapat have highlighted that mushroom farming is a "quick monetary gain" vocation, with benefit-cost ratios typically ranging from 1.61 to 1.83 (Aditya & Bhatia, 2020) ^[1]. The use of the Cuddy-Della Valle Index (CDVI) in agricultural statistics is a standardized method to distinguish between genuine growth and mere fluctuations. Literature on crop instability in Haryana suggests that while horticultural crops often face high price instability, mushrooms maintain a relatively stable production environment due to controlled indoor conditions. However, structural shifts-such as the transition from seasonal "thatched hut" cultivation to year-round "environmentally controlled units" (ECUs)-introduce phases of variability, which are captured through multi-period instability analysis (Mishra *et al.*, 2021) ^[6].

Recent literature identifies a "Shroom Boom" post-2020, driven by rising health consciousness and the demand for vegan protein sources. This level of growth far exceeds the broader global mushroom market, which is estimated to grow at a CAGR of roughly 7% to 9% through 2030 (Sharma *et al.*, 2024; Shonte *et al.*, 2024)^[10, 12].

Sachan *et al.*, (2019) and Singh *et al.*, (2010)^[8, 14] emphasizes that Haryana, particularly districts like Sonipat and Gurgaon, serves as the "Mushroom Hub" of North India. Their studies highlight that mushroom production has historically shown an affirmative correlation with farm size and technological adoption. While the Linear model often captures the basic trajectory of agricultural output, Mishra *et al.*, (2021)^[6] argue that non-linear models like the Quadratic and Exponential functions are more appropriate for high-value horticultural crops that experience "growth spurts" due to policy interventions or technological breakthroughs. National-level data analysed by James Paul (2023)^[15] corroborates a sustained upward trajectory in Indian mushroom production, reporting a CAGR of approximately 9.77% between 1997 and 2021, mirroring the expansion phases observed in state-level datasets. A critical concern in agricultural planning is the distinction between steady growth and volatile fluctuations. The Cuddy-Della Valle Index (CDVI) has been identified as the superior metric for this purpose, as it de-trends the data to prevent the overestimation of instability that often occurs with the standard Coefficient of Variation (Pavani *et al.*, 2025)^[7]. Literature on Indian horticulture suggests that while many crops face high production instability due to weather dependency, mushrooms maintain lower CDVI values because of the controlled indoor environment (Aditya & Bhatia, 2020)^[1]. However, Sharma *et al.*, (2021)^[11] note that instability often spikes during periods of structural transition such as the shift from "long method" composting to "short method" pasteurization-reflecting the temporary disruptions caused by new technology adoption. Koirala (2019) and Sharma (2021)^[5, 11] found that mushroom cultivation contributes significantly to farm income, often accounting for 43% to 72% of total earnings in medium to large categories.

Materials and Methods

Data Source

The study is based on secondary data pertaining to mushroom production and number of trays in Haryana. The data were collected from the official website of the Department of Horticulture, Haryana (Hort Haryana). The dataset covers a time period of 35 years, from 1990-91 to 2024-25. The data are annual in nature and represent aggregated state-level statistics.

Nature of Data

Two key variables were considered for analysis:

- Total mushroom production (in metric tonnes)
- Number of trays used for mushroom cultivation

The data were organized as a time series to examine changes over time. Prior to analysis, the dataset was checked for consistency, missing values and any abnormal observations.

Trend Analysis

To examine the long-term movement in mushroom production and number of trays, a linear trend model was fitted:

$$Y_t = a + bt + \varepsilon_t$$

where Y_t represents production or number of trays at time t , a is the intercept, b is the trend coefficient, and ε_t is the random error term.

The sign and magnitude of the coefficient b indicate the direction and rate of change over time. A positive value of b indicates an increasing trend, while a negative value indicates a declining trend.

Growth Rate Estimation

The compound growth rate of mushroom production and number of trays was estimated using a semi-log (log-linear) model: $\ln(Y_t) = \alpha + \beta t$

The compound annual growth rate (CAGR) was computed as: $CAGR = (e^\beta - 1) \times 100$

This method captures the exponential growth pattern and provides a more accurate measure of growth over time compared to simple averages.

Measurement of Instability

Instability in mushroom production and number of trays was measured using both the coefficient of variation (CV) and the Cuddy-Della Valle Index (CDVI).

The coefficient of variation was calculated as: $CV = \frac{\sigma}{\mu} \times 100$, where σ is the standard deviation and μ is the mean.

To account for the effect of trend in the data, the Cuddy-Della Valle Index was used:

$$CDVI = CV \times \sqrt{1 - R^2}$$

where R^2 is the coefficient of determination obtained from the trend regression. The CDVI provides a more reliable measure of instability by eliminating the influence of long-term trend.

Results and Discussion

Trend Fitting and Model Selection

The trend fitting analysis indicates that the expansion of mushroom cultivation in Haryana follows a non-linear path. The Quadratic model emerged as the best fit for both variables, suggesting that growth has not been constant but has accelerated or stabilized at different intervals.

Table 1: Comparison of Trend Models (R^2)

Variable	Linear	Quadratic	Exponential
No. of Trays	0.901	0.947	0.654
Production (MT)	0.94	0.95	0.833

Growth Rate Analysis (CAGR)

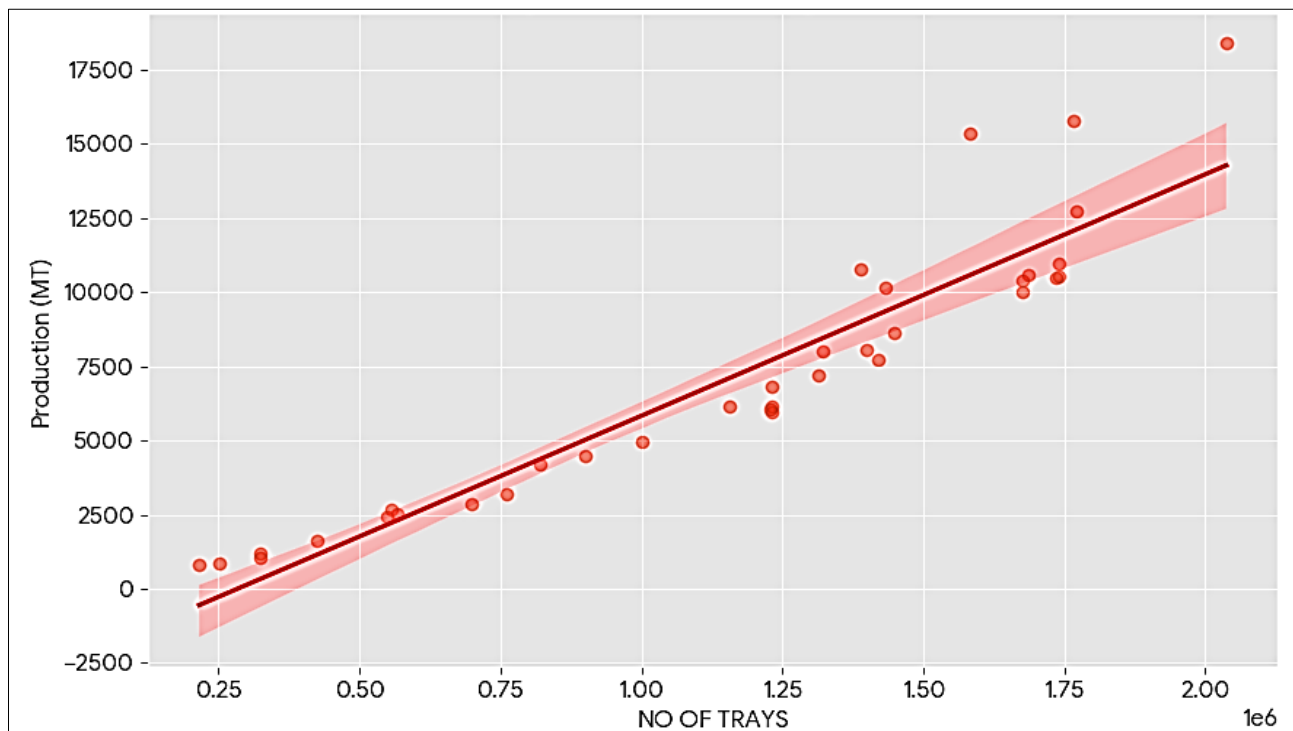
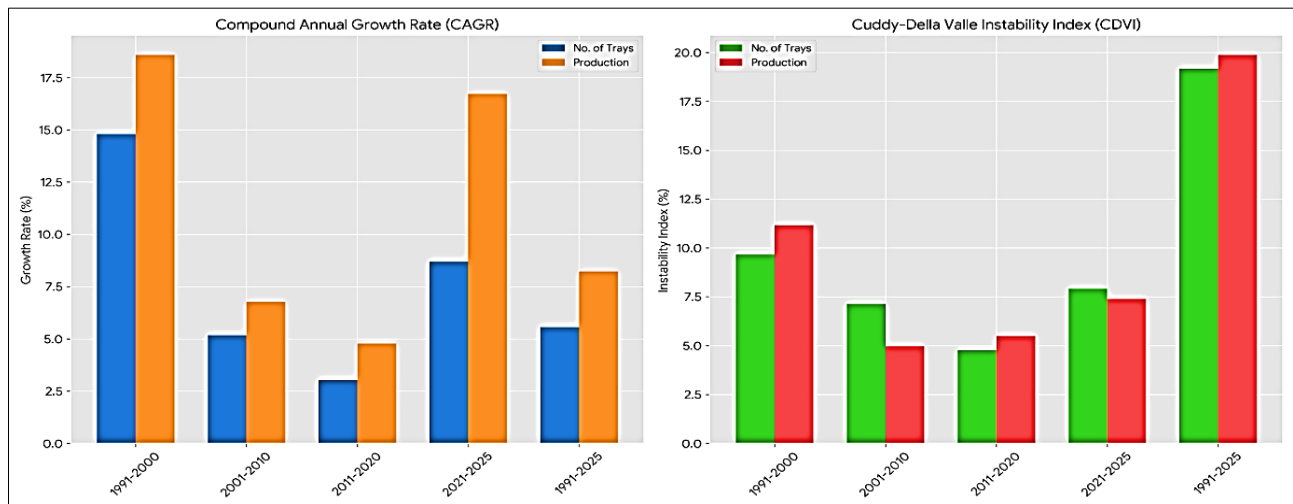
The industry experienced its most rapid expansion in the 1990s (Production CAGR: 18.59%). After a period of deceleration between 2001 and 2020, there is a notable "Second Wave" of growth in 2021-2025, with production growing at 16.72%.

Instability Analysis (CDVI)

Instability remained relatively low and manageable throughout the sub-periods (ranging from 4.97% to 11.17%). However, the overall period (1991-2025) shows a higher index (approx. 19.88%), reflecting the structural shifts and the transition from traditional to modern cultivation practices over 35 years.

Table 2: Growth and Instability Measures

Period	Trays CAGR (%)	Trays CDVI (%)	Prod. CAGR (%)	Prod. CDVI (%)
1991-2000	14.79	9.66	18.59	11.17
2001-2010	5.17	7.14	6.76	4.97
2011-2020	3.02	4.77	4.79	5.49
2021-2025	8.69	7.92	16.72	7.39
1991-2025	5.56	19.16	8.23	19.88

**Fig 1:** Relationship between No. of Trays and Production**Fig 2:** Compound Annual Growth Rate (CAGR) and Cuddy-Della Valle Instability Index (CDVI) by Period

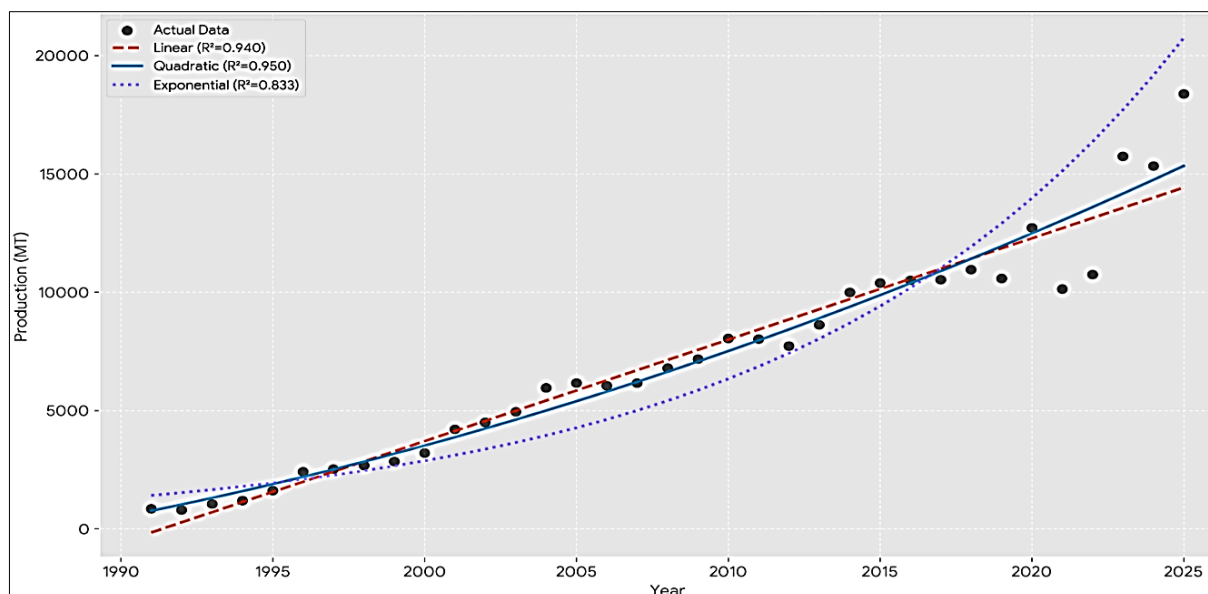


Fig 3: Trend Analysis of Mushroom Production in Haryana (1991-2025)

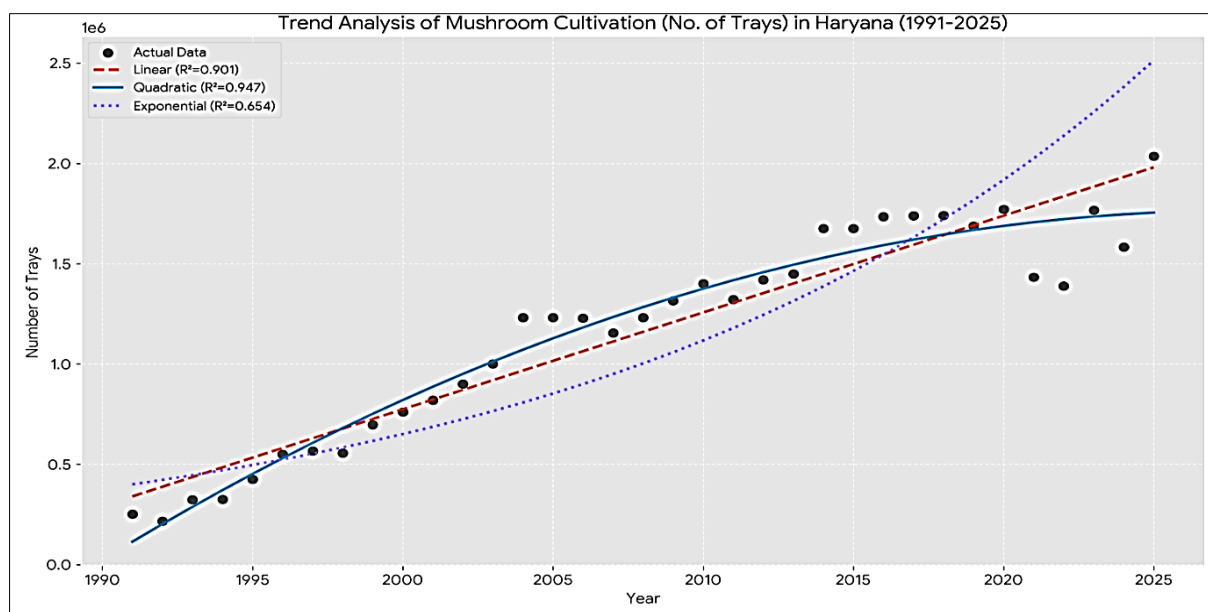


Fig 4: Trend Analysis of Mushroom Cultivation (No. of Trays) in Haryana (1991-2025)

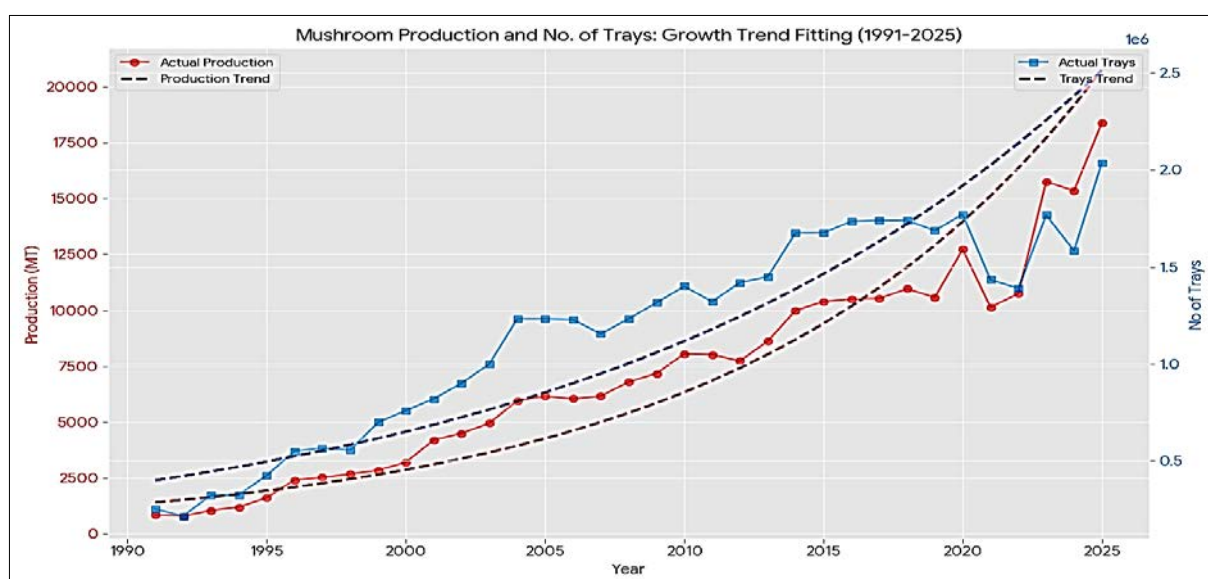


Fig 5: Mushroom Production and No. of Trays: Growth Trend Fitting (1991-2025)

Conclusion

The mushroom sector in Haryana has shown remarkable resilience and a recent return to high growth levels. The higher growth rate of production compared to the number of trays in the recent decade points towards improved vertical productivity (yield per tray). Future policies should focus on maintaining this stability while encouraging technological adoption to sustain the high growth observed in the 2020s.

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