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Situational analysis of mushroom success story in Bihar: From humble beginning to India's leader

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ABSTRACT

India ranks fourth worldwide in mushroom production, recording a total output of 351.08 thousand MT during 2023–24. Since 2021–22, Bihar has emerged as the frontrunner in this sector, witnessing remarkable growth in mushroom production from merely 0.06 thousand MT in 2013–14 to 42.19 thousand MT in 2023–24, reflecting an exceptional CAGR of 92.62%. This rapid expansion has positioned Bihar as the leading mushroom-producing state in the country, contributing 12.02% of India's total mushroom production. The Cuddy–Della Valle Index indicated a high level of instability in Bihar's mushroom production, with an index value of 84.03%, which reflects the rapid and exponential nature of its growth. Further, exponential growth analysis demonstrated a close correspondence between actual and estimated production values, as the predicted production of 42.65 thousand MT closely aligned with the observed output of 42.19 thousand MT in 2023–24. The substantial growth in mushroom production has been supported by various government initiatives, including the Integrated Development of Horticulture and Mushroom Kit Vitaran Scheme, along with the efforts of institutions such as Dr. Rajendra Prasad Central Agricultural University in promoting mushroom cultivation through training and extension activities. Continued governmental support under the upcoming Bihar Krishi Roadmap, coupled with sustained training programmes for landless and marginal farmers by the University and other extension agencies, is expected to maintain the current exponential growth trajectory in mushroom production.

Key words: Cuddy-Della Valle Index, Exponential growth, Integrated Development of Horticulture, Landless farmers, Mushroom cultivation, Mushroom Kit Vitaran Scheme

Mushroom cultivation has emerged as a significant contributor to agricultural diversification and sustainable income generation in India. Globally, India ranks fourth in mushroom production, trailing China, the largest producer, which contributes approximately 5 million tonnes annually (FAO, 2024). With consistent growth in production, India has positioned itself as a vital player in the global mushroom market. States such as Bihar, Odisha, and Maharashtra have been at the forefront of this growth, leveraging favorable climatic conditions, government support, and innovative farming practices. Among these states, Bihar has emerged as a leader, contributing 12.02% of India's total mushroom production in 2023-24. Government initiatives, such as the Bihar Agriculture Roadmap, Mushroom Kit Vitaran Scheme, and Integrated Development of Horticulture, have played a crucial role in promoting mushroom cultivation. Institutions

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like Dr. Rajendra Prasad Central Agricultural University (RPCAU) have further supported this revolution through training programs, research, and capacity-building initiatives, empowering farmers, particularly women, to adopt mushroom farming as a viable livelihood option. This study aims to analyze the situational dynamics of mushroom production in Bihar, evaluate its growth trends, and assess its contributions to the agricultural landscape. The findings are expected to provide valuable insights into the opportunities and challenges of mushroom farming, serving as a roadmap for sustainable growth in the sector.

India has witnessed a consistent rise in mushroom production over the years, showcasing the increasing adoption of mushroom cultivation across various states (Table 1). The second advance estimate of 2023-2024 says divulged that the total production of mushrooms in India stands at 336.17 thousand MT (Lal and De, 2024) whereas the final third advance estimate of 2023- 2024 disclosed that the total production of mushrooms in India stands at 351.08 thousand MT (Ministry of Agriculture & Farmers Welfare, 2024). Mushroom farming in India has gained momentum, particularly in states like Bihar, Maharashtra, and Odisha, where favorable climatic

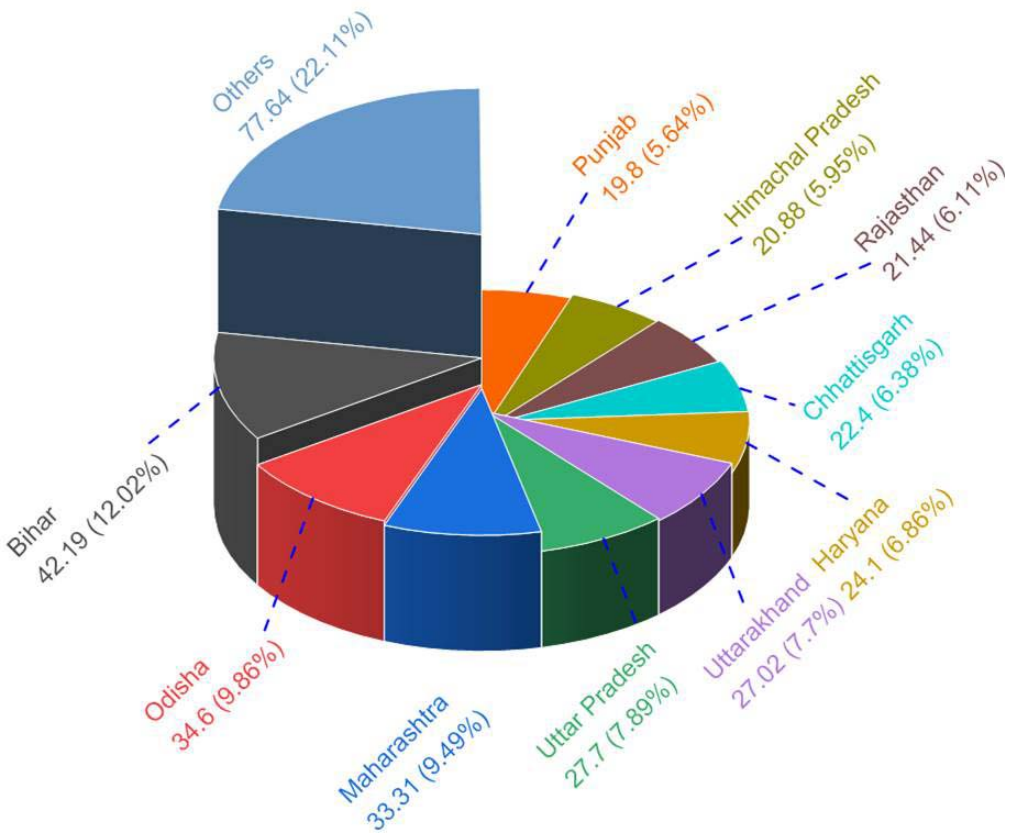

Fig. 1. 3-D incremental thickness stairs diagram denoting percentage share and production of mushroom of states (x1000 MT)

Table 1. Annual Mushroom Production in India from 2019-20 to 2023-24 (Production in '000 MT)

5 years data	2019-20	2020-21	2021-22	2022-23	2023-24 (Final 3rd Advance Estimate)
Mushroom	211	243	280	315	351.08

Source: Ministry of Agriculture & Farmers Welfare, 2024

conditions and dedicated efforts have fostered growth (Fig. 1).

Bihar has recorded a production of 42.19 thousand MT in 2023-24 bagging the first position in India (Ministry of Agriculture & Farmers Welfare, 2024). In this backdrop, the study was conducted with two primary objectives: i) To execute the situational analysis of mushroom production in Bihar and ii) To validate the exponential growth rate of the last five years of production.

MATERIALS AND METHODS

This study harnessed secondary data to assess the Situational Analysis of mushroom production in Bihar. The data was originally gathered through the FAO, RPCAU, Bihar Krishi Road Maps and Ministry of Agriculture & Farmers Welfare, GOI recent documents. Secondary data analysis involves examining data that has already been collected by other sources (Srivastava and Lal, 2021). Various analytical tools such as Compound Annual Growth Rate (CAGR) for growth rate analysis, Coefficient of Variation (CV), Cuddy Della Valle Index, Index Number for instability analysis, and R-square for linear trend analysis including exponential growth were employed which served as a metric for the goodness of fit.

Compound annual growth rate (CAGR) to determine decadal growth of mushroom production

CAGR was utilized to evaluate the decadal growth in mushroom production (measured in thousand MT) in Bihar. The log-linear function was applied to calculate CAGR as it is considered the most appropriate functional form. This method has been widely employed for similar calculations in several other studies. The formula to calculate CAGR is:

$$CAGR= \left(\frac{V_{initial}}{V_{final}}\right) 1/N - 1$$

Where,

CAGR= Compound Annual Growth Rate

$V_{initial}$= initial value

V_{final}= closing value

N=time in years

Cuddy-Della Valle Instability Index (CDVI) to Measure Instability

Instability in the decadal growth of mushroom production (in thousand MT) in Bihar was analyzed using the Cuddy-Della Valle Instability Index. While the coefficient of variation (CV) is a common measure of instability, it often overestimates instability in time-series data. The Cuddy-Della Valle Index (Cuddy and Valle, 1978) adjusts for trends in the data and accurately captures the direction and extent of instability (Srivastava and Lal, 2021). The equations are mentioned as follows

$$CV= \frac{SD}{Mean} \times 100$$

Where,

SD= Standard Deviation

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

CDVI = Cuddy-Della Valle-Instability index (%)

I = Instability Index (in %)

CV = Coefficient of variation (in%)

AdR^2 = Adjusted R-Square = Coefficient of determination

Along with the above-mentioned tool, the GROWTH function was used to compute the exponential growth and which was the return numbers

in an exponential growth rate matching known data points. The GROWTH function was computed in MS Excel 2021, which calculated predicted exponential growth based on existing data.

RESULT AND DISCUSSION

A) Bihar's Role as a Leader in Mushroom Production

Mushroom production in Bihar has experienced remarkable growth over the past decade, transforming from a nascent sector to a thriving industry. In 2013-14, mushroom production in Bihar was a modest 0.06 thousand MT, but it climbed over the years, reaching an impressive 42.19 thousand MT by 2023-24 (Fig 2). The growth performance of mushroom production was assessed using the compound annual growth rate (CAGR) between 2013-14 and 2023-24.

$$CAGR = \left(\frac{V_{final}}{V_{initial}}\right) 1/N - 1 = \left(\frac{0.06}{42.19}\right) 1/10 - 1 = 1.9262 - 1 = 92.62\%$$

The decade-long production growth rate of mushrooms was notably high, achieving an impressive 92.62% CAGR. As shown in Fig 2, over the ten years interval from 2013-14 to 2023-24, mushroom production increased significantly from 0.06 thousand MT to 42.19 thousand MT. This exceptional growth underscores the state's leading position in mushroom production.

Instability index in the production of mushrooms in Bihar: The instability in mushroom production was measured using the Cuddy-Della Valle Index (CDVI), which revealed a high instability index of 84.03%.

$$CV = \frac{16.0098}{14.2572} \times 100 = 112.2926$$

$$CDVI = I = 112.2926 \times \sqrt{1 - 0.4673} = 84.0255$$

According to Srivastava and Lal (2021), CDVI values are categorized as follows: low instability (0 to 15), medium instability (>15 to 30), and high

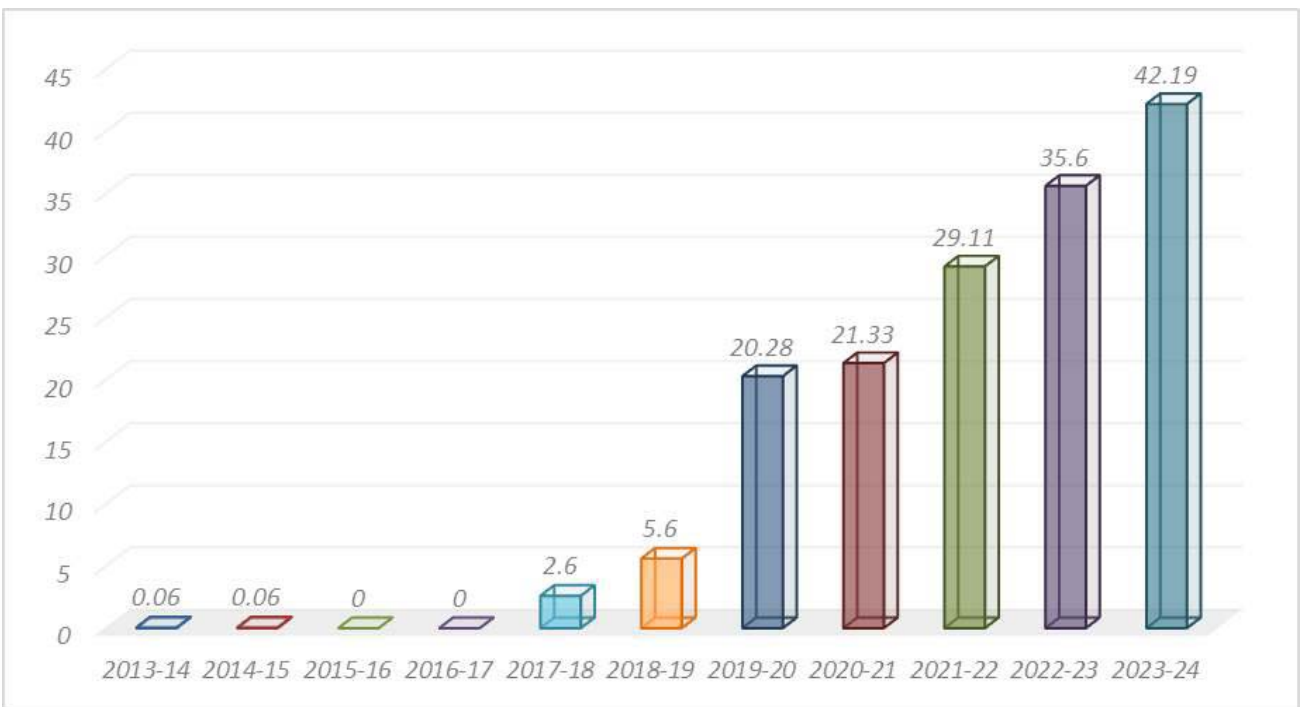

Fig. 2. Annual Mushroom Production in Bihar from 2013-14 to 2023-24 in '000 MT (Source: Ministry of Agriculture & Farmers Welfare, 2024)

instability (>30). The instability index is 84.0255 which is very high and represents that there was exponential growth in mushroom production in Bihar.

Exponential growth validation: It was tried to test that since Bihar marks its presence at the national level in the last five years, what was the incremental growth in terms of mushroom production. Using the GROWTH function, the predicted values for mushroom production in Bihar for the last five years from 2019-20 to 2023-24 were calculated, which denotes that the trend in the last five years matched with the exponential growth as the computed exponential value was 42.65 was against the production of 42.19 thousand MT in 2023-24 thus validating the alternative hypothesis.

B) Mushroom Kranti in Bihar

Mushrooms, a popular food item across India, have sparked a revolution in Bihar, making it one of the largest producers in the country. During the revolution, various websites widely reported data suggesting mushroom production in Bihar amounted to 28,000 MT, often accompanied by graphs based on the First Advance Estimate 2021-22 but the actual production was 29,110 MT. However, the final third Advance Estimate for 2023-24 revealed a significantly higher figure, indicating that mushroom production in Bihar had reached 42.19 thousand MT. The Integrated Development of Horticulture in Bihar has been instrumental in providing subsidies for mushroom units, compost, and spawning (Table 2).

Table 2. Government Programs/Schemes for Mushroom Cultivation in Bihar

Year	Program/Scheme	Objective
2012-2017	Bihar Agriculture Roadmap (Phase II)	• Promoted mushroom production units, to increase production and productivity.
2017-2022	Bihar Agriculture Roadmap (Phase III)	• Promoting mushroom production, introducing integrated mushroom units, and organizing women farmers into producer groups
2017	Integrated Mushroom Development Units	• Established units in districts like Nalanda to support mushroom spawn production and training, particularly for women farmers • Enhancing production and market linkages.
2019	Crop Residue Management Initiatives	• Encouraged the use of paddy straw for mushroom cultivation to reduce crop residue burning, with grants of up to 80% on crop residue management equipment.
2023	Mushroom Kit Vitaran Scheme	• Launched by the Department of Agriculture, Bihar, providing high-quality mushroom kits at a 90% subsidy and training programs to encourage mushroom cultivation among farmers and individuals.
2023	Integrated Horticulture Development Mission	• Introduced a 50% subsidy scheme, offering up to ¹ 10 lakh to farmers for mushroom cultivation, aiming to promote it as a profitable venture for low-income farmers.
2023–2028	Bihar Agriculture Roadmap (Phase IV)	• Continue to promote sustainable agricultural practices. Includes mushroom cultivation as a key enterprise for income generation, employment, and nutrition improvement • Promotion of medicinal mushrooms and support for integrated mushroom units.
2023-2024	Mushroom Hut Production Scheme	• Aimed at encouraging farmers and budding entrepreneurs to venture into mushroom production • Reduce the financial burden on farmers and entrepreneurs by offering a 50% subsidy on the cost of mushroom huts.

Source: Bihar Economic Survey, 2024; Khetivyapar (a), 2024; Khetivyapar (b), 2024; myScheme, 2024; Directorate of Horticulture, 2024.

Future plans focus on advanced processing, storage, and establishing farmer clusters to enhance production and market bargaining power. Bihar's mushroom kranti has not only transformed farming but also created new opportunities for income generation. The state has leveraged its agro-climatic advantages, particularly for oyster and button mushrooms, while initiatives like capacity-building workshops and women-led farming cooperatives have further contributed to its success. Smt. Binita Kumari, from Chutia, Bihar, transformed her life by training in mushroom cultivation and spawn production at KVK Banka. She established a marketing system, motivating other women to form a group and set up a village sale counter, enabling members to earn ₹ 3,000–4,000 monthly. Her dedication has earned her the "Mushroom Production Growers Award," inspiring women in her district (KVK, Banka, 2018).

C) Contribution of RPCAU, Pusa in mushroom kranti in Bihar

Dr. Rajendra Prasad Central Agricultural University has played a pivotal role in revolutionizing mushroom farming in Bihar, enhancing livelihoods, meeting dietary requirements, and empowering numerous individuals in rural areas (Fig 3). A key figure in this revolution is Dr. Dayaram, a principal scientist from RPCAU, Pusa who has tirelessly trained over 15,000 farmers in modern mushroom cultivation techniques (Krishnan, 2022). His efforts have empowered farmers, particularly women, to produce mushrooms efficiently, ensuring higher yields and better incomes. Dr. Dayaram's hands-on training programs and research-backed insights have played a pivotal role in sustaining this growth and diversifying mushroom farming practices in Bihar. To address the short shelf life of mushrooms, efforts have been made to teach farmers processing techniques, including drying and creating value-added products like biscuits and pickles.

CONCLUSION

Mushroom cultivation in Bihar has undergone a transformative journey, evolving from a nascent activity into a thriving industry with significant economic, social, and ecological benefits. Bihar's rise

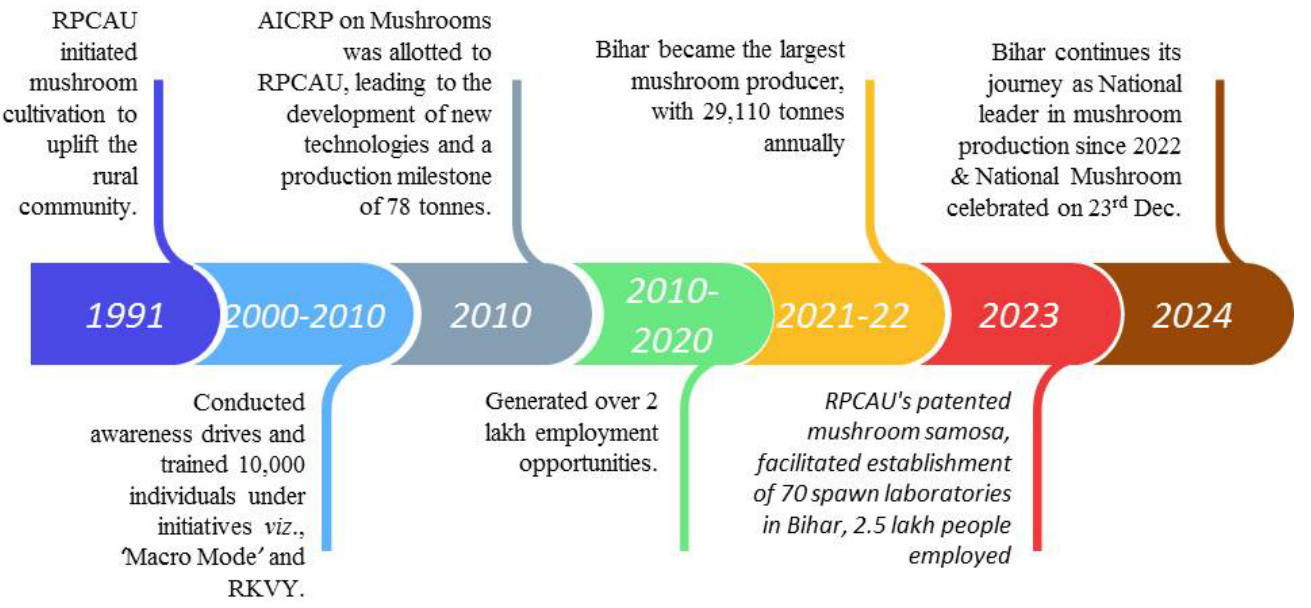

Fig. 3. Timeline of RPCAU journey of mushroom kranti (RPCAU, 2024)

to the top position in India's mushroom production, with a remarkable Compound Annual Growth Rate (CAGR) of 92.62% over a decade, underscores its potential as a hub for sustainable agriculture and rural livelihood development. The analysis revealed that despite the high instability in production, as indicated by the Cuddy-Della Valle Index, Bihar has managed to achieve consistent growth, supported by the introduction of modern cultivation practices, subsidies, and capacity-building programs. The support from state agricultural department, contribution of institutions like Dr. Rajendra Prasad Central Agricultural University and the efforts of progressive farmers and women-led cooperatives have further bolstered the state's position. However, challenges such as the short shelf life of mushrooms, market linkages, and production instability must be addressed to sustain this growth. The adoption of advanced processing, storage solutions, and the establishment of farmer clusters can enhance productivity and profitability. The success of Bihar in mushroom cultivation serves as a model for other states and highlights the transformative potential of integrating technology, policy support, and grassroots innovation in agriculture. In conclusion, Bihar's "mushroom kranti" not only exemplifies the state's capacity to lead in sustainable agricultural practices but also provides a blueprint for leveraging local resources and capabilities to achieve national and global agricultural goals. If the government continues its support in the coming Bihar Krishi Roadmap, the University and other extension functionaries will continue to give training to landless and marginal farmers then the production is expected to be continued in the same exponential trend.

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