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4 Mushroom (*Agaricus bisporus*) Revolution in Bihar: A Critical and Systematic

5 Review

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12 ABSTRACT

13 The mushroom farming revolution in Bihar represents a landmark in the ~~state's~~ agricultural and
 14 socio-economic transformation of Bihar state. Over the years, the adoption of mushroom
 15 cultivation has not only provided a viable livelihood alternative to small-scale farmers but also
 16 demonstrated the potential of sustainable agriculture. The movement's success stems from a
 17 combination of factors, including optimal climate conditions, technological interventions, and
 18 robust community engagement. Initiatives such as low-cost storage facilities, ~~value added~~different
 19 forms of products ~~products~~-like mushroom pickles and powders, and awareness programs have
 20 amplified the scope of ~~this mushroom~~ agricultural shift. Mushroom farming has not only offered
 21 economic benefits but also ~~addressed~~ addressed environmental challenges by recycling agricultural waste
 22 and promoting sustainable practices. ~~Bihar~~ There has ~~been~~ seen phenomenal growth in ~~its~~ mushroom
 23 production during the last two years. ~~At a~~ production level of 28,000 tonnes for 2021-22, ~~it~~
 24 grewincreased to 41,310 tonnes during 2023-24, having achieved a Compound Annual Growth
 25 Rate (CAGR) of nearly 21.46%. The high rate of growth was due to an increase in the adaptation
 26 of mushroom cultivation practices amongst growers, advancement in the ~~the~~ techniques of

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27 cultivation, and also due to increased demand for mushrooms in the state. Such a high CAGR,
28 though, really spells out Bihar's potential to play an important role in India's mushroom production
29 landscape, thereby contributing to agricultural diversification and rural income generation. This
30 underscores the importance of education, training, and local leadership in driving large-scale
31 socio-economic changes. Bihar's remarkable growth in mushroom production, from negligible
32 ~~levels production~~ to becoming India's top most ~~M~~mushroom ~~P~~producing state, showcases the
33 transformative power of innovation and community-driven approaches in agriculture. This success
34 serves as a model for other regions aiming to achieve agricultural sustainability and rural
35 empowerment ~~in the field of mushroom cultivation.~~

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36 **Keywords:** Case Study, Mushroom Revolution, Origin and History of Mushroom, RPCAU, Success
37 Story, Women Entrepreneurship.

38 1. INTRODUCTION

39 India is a ~~geographic~~ge-centric nation, that feeds approx. 15.5% of the global population with
40 merely 2.5% of cultivated land. With the surging rise in the global population, the fate of food
41 security is in jeopardy. To surmount this predicament, researchers and scientists are pioneering
42 avant-garde solutions and unconventional paradigms to confront this pressing issue, by producing
43 affordable, nutrient rich, quality foods. One of these paradigms are "Edible Fungi also known as
44 Mushroom- ~~can be~~conveniently cultivated and ~~is~~ abundant in ~~nutritio~~nutritive factors. Mushrooms are
45 distinguished by their discernible parasol-shaped fruiting body and is part of the *Agaricales* order
46 in the *Basidiomycetes* group of fungi. They are nucleated, sporiferous, chlorophyll-deficient and
47 they feed on dead decomposing matter. Mushrooms like *Agaricus biporus* can grow both above
48 the ground (i.e epigeous) and truffle (*Tuber species*) grow beneath the soil (i.e hypogeous). They
49 are extraordinarily pliable and can grow anywhere from open terrain to forested area. Throughout
50 ages, ~~M~~mushroom has seamlessly found their place in ~~our~~ human diet and has been revered not
51 only for their gastronomic versatility but also for their rich ~~and abundant~~nutritional value and
52 pharmacological ~~uses~~age. Mushrooms play a core role in nutrient turnover as they transform the
53 organic remnants and refine the nutrient profile of the soil. Mushroom production is gaining global
54 status due to easy production under controlled conditions, providing a sustainable and
55 economically viable source of food. ~~Also, t~~They play an ~~useful~~important role in scientific

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56 research, primarily within the fields of biotechnology, medicine, and environmental science. Their
57 unique biochemical properties make them stand out for scientific study. As the mycological studies
58 advances, so do the fascinating discoveries drawing the scholars in ways that spark transformative
59 breakthroughs both in food production and healthcare. The demand for edible fungi has soared up
60 globally due to their fortified, curative characteristics and epicurean traits. The surge in
61 production of edible varieties has been observed and it was noted that a production increased ~~in~~
62 ~~the ballpark @~~ of 30 times spanning from 1978-2013 while the consumption rate per person
63 escalated from one to four kilograms ~~per~~ during the time period from 1997 to 2012 [1] [2]. The
64 mushroom market is ruled by China globally, producing almost nine-tenths ~~?~~ of worldwide
65 mushroom, standing out in terms of elevated domestic demand and export opportunities [2] [3].
66 India ranks at 6th ~~P~~position in terms of the global production of mushrooms surpassing more than
67 0.5% to the global production [4]. The nation's mushroom industry experienced a booming
68 expansion in production and a strong yearly growth of 36 % was observed [4]. In the year 2021,
69 243 metric tons of edible fungi were produced by India [5]. The second ~~advance~~ estimate of 2023-
70 2024 ~~in advance~~ released by ~~Indiastat~~ ~~India stat~~ says the total production of mushroom in India
71 stands at 336.17 metric ~~tonnes~~ where Bihar, Odisha, and Maharashtra are the top three states in
72 mushroom production [6]. Bihar has recorded a production of 41.31 metric ~~tonnes~~ bagging the
73 first position in India. Bihar's mushroom cultivation has seen remarkable growth in the last couple
74 of years and it was possible due to the state's optimal climate, technological evolution,
75 ~~expand~~ ~~increased~~ awareness and ~~it~~ has contributed to the state's ~~economy and mushroom and~~ food
76 supply. Button and Oyster mushroom are the most cultivated varieties ~~with~~ ~~by~~ many small and
77 medium scale farms spread across the region.

78 1.1 Insights on National Mushroom Day

79 National Mushroom Day is celebrated on 23rd December by ~~Indian Council of Agricultural~~
80 ~~Research (ICAR)~~ ~~ICAR~~ every year. It aims to raise the importance of mushrooms in the nutrition
81 and sustainability sectors along with the rural entrepreneurship opportunities in India. ~~It is~~ ~~ICAR~~
82 ~~has also started working in this~~ ~~also started in this sector.~~ ~~by the Indian Council of Agricultural~~
83 ~~Research as a means to~~ ~~This further marks~~ the progress ~~India has~~ undertaken towards the
84 development and research ~~of mushrooms~~ as an alternative protein-rich food source ~~in the area of~~
85 ~~mushroom cultivation.~~ ~~and~~ ~~It~~ also helps in encouraging income generation for farmers,

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86 entrepreneurs, and researchers. It focuses on the environmental ~~factor~~ impact of mushrooms, which
 87 involves recycling agricultural waste into nutritious food. On this day, there is a need for increase
 88 in foundation for economic and health-based awareness about these mushrooms within the
 89 country ~~to increase~~. Special focus is given ~~infor~~ promoti ~~on~~ g towards diversification of mushroom
 90 varieties like oyster, buttons, shiitake, and medicinal mushrooms to meet the various demands of
 91 the market ~~demands~~. Through this celebration ?, ICAR aims to inspire more farmers to adopt
 92 mushroom farming as a way to double their income and also practice sustainable farming that
 93 uplifts the rural communit economy.

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95 2. ORIGIN AND HISTORY

96 The Latin word "fungo," which meanings to flourish—that is, to sprout out of the earth or from
 97 trees—is one of the as indicated in many languages from which the word "mushroom" is derived.

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98 (ii) The Greek word "sphonggos" or "sphoggos" means "sponge," referring to species that resemble
 99 sponges; (iii) the French word "mousseron" (muceron), which means "mousse" or "moss."

100 'Mouscheron' and muscheron' are more possibilities please check spelling. The terms "ksumpa" in

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101 Sanskrit, "khumbi or khumb" for button mushrooms; "in Hindi, d hingri" for oyster mushrooms

102 in Hindi, and "kathphula" in Assamese, are some of the several names examples for mushrooms

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103 in various different languages. Additional Sanskrit terms include bhoomi kavak, kavaka, bhustrna,

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104 kukurmutta, and chatra, which refers to the fleshy-capped fungus [7].

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106 2.1 Chronological Events on Edible Mushroom

107 **Table 1. Historical events from Pre-historic Era: [7]**

Sl No.	Period	Events that took place
1.	Aryan's Role	Employed "Soma" an intoxicating drink in their holy rituals or rites.
2.	Rig Veda	Songs related to Soma referring to Amanita muscaria (Wasson, 1969)
3.	Stone carving	O'Heer <i>et al.</i> , 1886 found carvings on some stones portraying puffballs and various other fungi.

4.	Mayan Period	<ul style="list-style-type: none"> •In central America and Gauetemala, mushroom shapped carvings were found. •Mayan astrological paintings showed objects resembling to Amanita muscaria •Species like Agarikon, Amanita, and Boletes were named.
5.	Roman Period	<ul style="list-style-type: none"> •A field mushroom called Pratenses was labelled as the best by Poet Horace. •A Roman naturalist Pilny, noted that recipes made of Amanita caesaria and Boletus edulis were served to the masters and princesses on special occasion^s.

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109 Table 2. Historical Events of Button Mushroom: [7]

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Reign of King Loius IXV of France, where Mushroom cultivation was first recorded

1638

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Tournefort presented an account of compost techniques of cultivating mushroom and compost preparation at the Royal Academy of Science in France, which was later published in Paris.

1707

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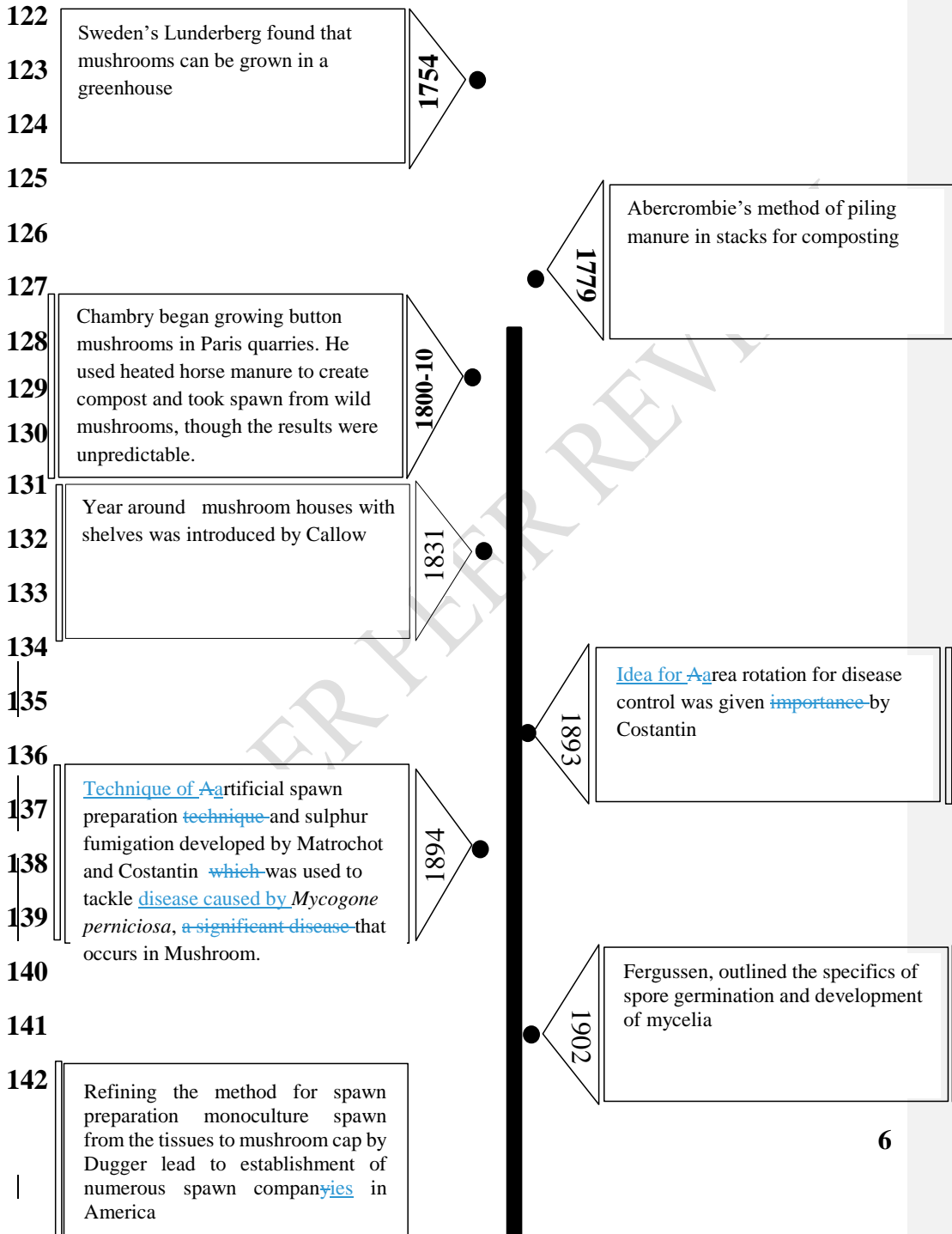
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Treschow, noted that growing pineapple and melons in hot compost bags gave rise to *A. bisporus* that generated the idea of cultivation of button mushroom

1700

Button mushroom cultivation by using the French method was introduced to in England by Miller.

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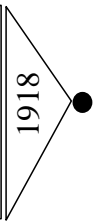
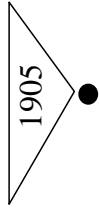
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1950-53

1915

In the states, “sweating out”- a second composting stage was introduced by the mushroom growers where before spawning compost undergoes thermogenesis

Spawn could be effectively produced from single spore cultures, leading to improved strains was discovered by Lambert

Sinden developed and patented an innovative method for producing grain spawn.

1936

Pizer found that on adding gypsum, a noticeable improvement was observed on the spawn’s growth was observed.

33.33% of pure spore culture of the species *A. Bisporus* is incompetent of producing spore bearing structures.

1941

Lambert found that primary area in a compost pile with an optimum temp. of approx. 50-60°C can with proper aeration can give result in better quality of compost.

Short method composting by Shinden and Hauaser

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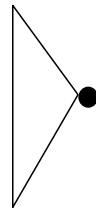
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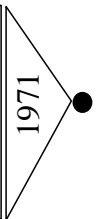
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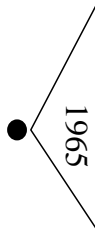
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A.bisporus hybridization method was demonstrated by Robert Miller



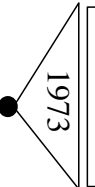
The invention of the container system for pasteurization by Block.
Pasteurization by container system was invented by Block.



Randle and Hayes utilized insulated metal drums mounted on motorized rollers for the agitation and mixing of the compost contents.



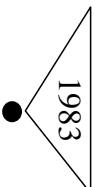
Commercially the first strain of *Agaricus bitorquis* as strain No. 2017, was launched by a French company Somycel, later was followed by Le Lion



Eicker engineered a well ventilated and insulated bin designed for composting small quantities of material.



Smith chronicled the formulation of mushroom compost within an expedited duration, accomplished without employing steam.



Leendertsee pioneered indoor composting technologies to address specific difficulties linked to external composting methods.



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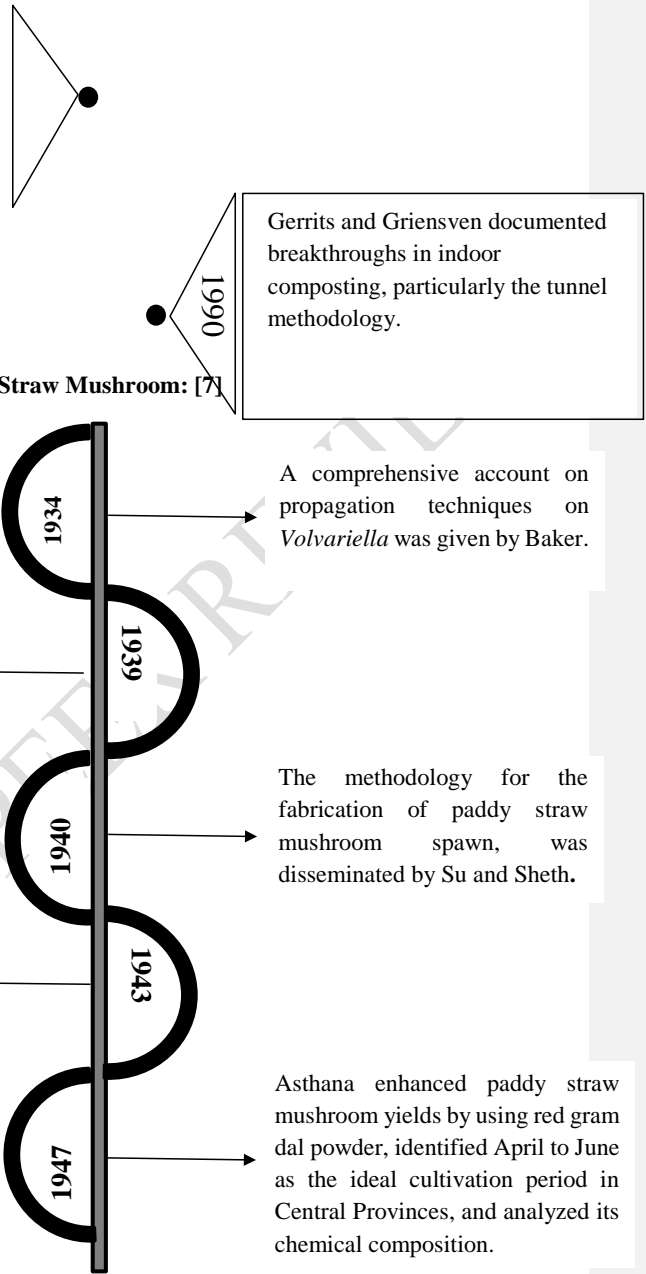


Table 3. Historical Events of Paddy Straw Mushroom: [7]

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Table 4. Historical Events of oyster mushroom: [7]

1917



The inaugural successful cultivation of *Pleurotus ostreatus* on arboreal stumps and timber segments was initiated by **Falck**

1951



Cultivation on *Pleurotus* on amalgamations of sawdust was experimented by **Lohwag**

1959



Scholars **Block, Hau and Tsao** achieved prolific production of fruiting structures on aseptic sawdust and oatmeal substrates

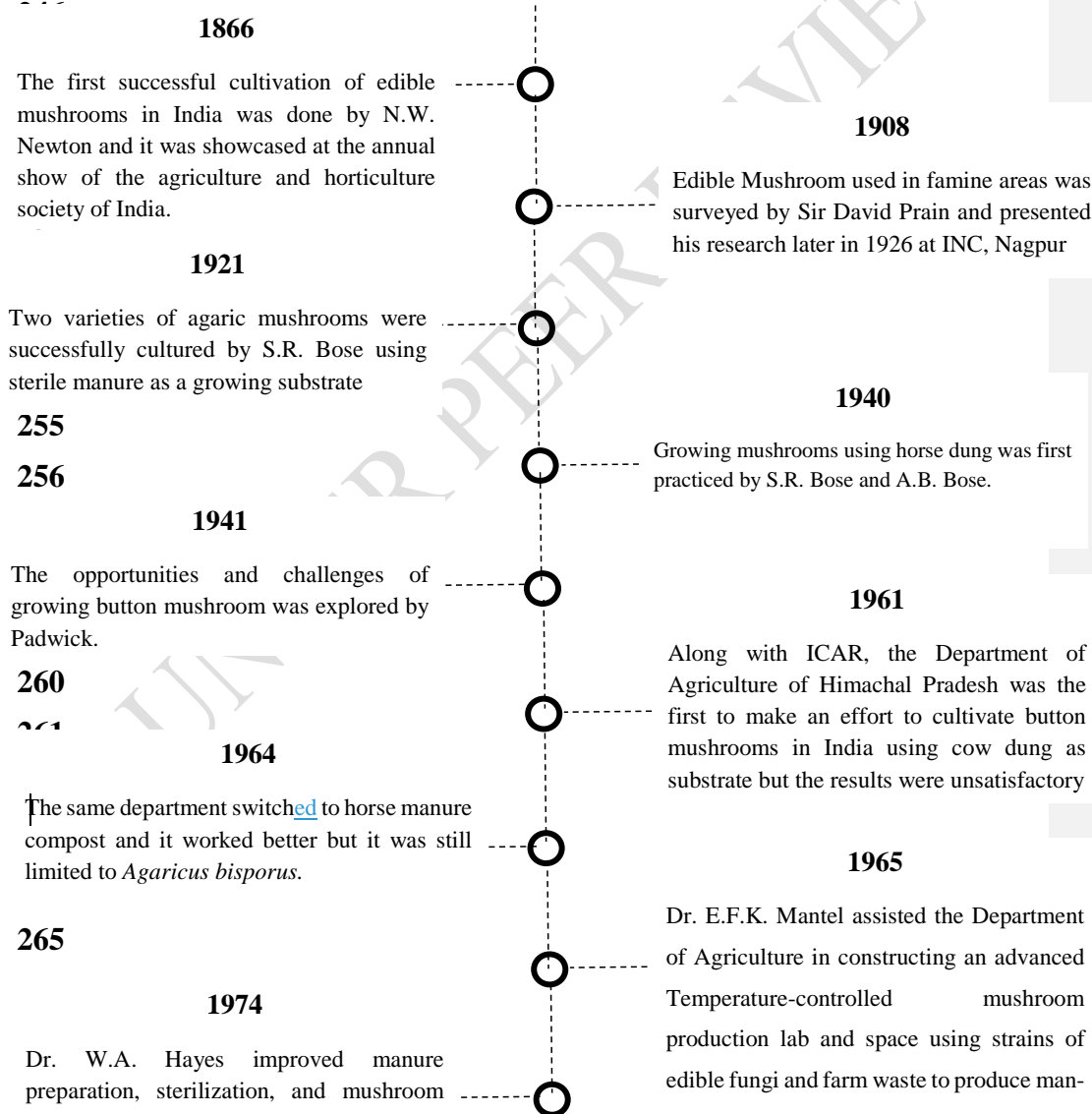
1962



Bano and Srivastava revolutionized large-scale cultivation through the implementation of straw-based growth media, specifically utilizing rice straw, thereby facilitating extensive commercial exploitation and augmenting yield efficiencies.

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245 **Table 5: Sequence of events that took place in India: [7]**



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1977

Under the UNDP, the Mushroom Development Project was initiated in Himachal Pradesh, aided by Mr. James Tunney, and eventually run by the Department of Horticulture, where Dr. R.L. Munjal made major contributions in manure formulations and insect management using used compost as covering material.

1983

The NCMRT (now NRCM) began operations, and the AICMIP was launched with six centers across India, later replacing two with Indira Gandhi Krishi Vishwa Vidyalaya (Raipur).

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3. MUSHROOM REVOLUTION IN BIHAR

289 The Mushroom Renaissance in Bihar is characterized by its notable socio-economic impact
290 predominantly for the small and marginal farmers. Research shows that the cultivation of oyster
291 mushrooms increases the producer's gross margins by a significant amount due to the effective
292 marketing channels, where direct sales to consumers give a bigger part of the market price to
293 producers than conventional retail sales. When sellers avoid middlemen, more value is retained

1982

The ICAR founded the National Centre for Mushroom Research and Training (NCMRT), Solan, Himachal Pradesh with the aim of conducting research on mushroom production, preservation, and use, as well as providing training to scientists, educators, extension workers, and mushroom growers.

1996-97

Dr. B.C. Roy from Calcutta Medical College carried out studies on the chemical examination of indigenous edible fungi collected from caverns and quarries.

294 and redistributed into the producer's hands, allowing smallholders to [see procure](#) more income
295 ~~from thei by~~ selling and potentially remain [sustainable](#) in business [8]. This industry not only
296 ensures a stable source of livelihood ~~while by~~ making use of agricultural byproducts, enhancing
297 food security and promoting environmental sustainability [9]. Females are the principal ~~actors~~
298 [contributors](#) in ~~this~~ [mushroom](#) revolution and numerous studies have reported improved
299 household income and better nutritional outcomes [10]. Additionally, mushroom farming has
300 become an essential income stream contributing significantly to domestic earnings to a great extent
301 in Bihar's Samastipur district [11]. In general, the possibility of mushroom farming in Bihar
302 remains underutilized highlighting elevated awareness and efficient training programs to fully
303 realize its advantages [12] [11].

304 3.1 Harvesting Dreams: Dr Dayaram's Role in Bihar's Mushroom Boom

305 "Dr. Dayaram, inspirational scientist from Dr. Rajendra Prasad Central Agricultural University,
306 played an important role in supporting the emergence of Bihar as one of the leading states in the
307 country ~~is for~~ mushroom production. The mushroom production reached 28,000 tons during 2021-
308 22."This aspiration ~~began was way~~ back in 1991, when he realized that there was so much
309 potential for mushroom cultivation within the State. He ~~has~~ also educated over 200, 000 farmers
310 in the last thirty years regarding the [cultivation of](#) button and oyster mushrooms that can grow in
311 the region's climatic conditions. His strategies focused on 24-hour harvesting and industrialized
312 the processed forms of the mushrooms, for example, the powdered mushrooms and mushroom
313 pickles. ~~Improvement of ing the~~ [technique ology](#) of mushroom farming has significantly increased
314 production and made it economically viable for small and marginal farmers. Other than equipping
315 women with training and inputs in mushroom farming, ~~and encouraging ed~~ them to be
316 entrepreneurs, his programs are also targeted ~~at for~~ women. The huge contributions from the
317 government, and subsidies on the capital such as the spawn units for compost preparation enabled
318 mushroom farming to evolve into a viable model. Not because of the ~~cash earning~~, but the social
319 impact that comes with it [by through](#) creating job opportunities and helping people move away
320 from the reliance on conventional agriculture-based means of earning [13]."

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326 3.2 Success Stories of Entrepreneurs of Bihar

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"Bihar's Mushroom Man: From Sleeping on Apple Boxes to Building a Million-Dollar Empire"

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Shashi Bhushan Tiwari, the "Mushroom Man of Bihar" revolutionized his future by turning his passion for **M**mushroom **F**farming into a booming business. After struggling in Delhi, doing odd jobs for years he returned to his hometown, Muzaffarpur. He decided to get financial help from the Bank to start his enterprise. Today he sells around 2000 kg of mushrooms on daily basis making a profit of 50-60lakhs per month. His success story is an attestation to hard work and strong determination [18].



"Small Space, Big Dreams: Bihar Woman's Mushroom Venture Redefines Success"

Nisha from Begusarai, has managed to break the barriers of having a small space. She began her mushroom business from her bedroom and makes more than **Rs.** 2000**Rs.** **P**per day. She was trained by Krishi Vigyan Kendra and she started her enterprise with the help of Jeevika. She makes small packets, ties them on strings, and hangs them on the wall of her bedroom. Her expedition is proof of innovation: that even space as small as this can lead to big profits [17].



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"From Crisis to Growth: Bihar's Mushroom Farmer Earns Rs. 1 Cr and Supports Her Team"

Manorama Singh, a mushroom farmer from Lalganj, Bihar, navigated the challenges of the COVID-19 lockdown by innovating new sales methods, ensuring the survival of her business and employees. With an annual turnover of Rs 1 crore, she employs 65 women and has trained thousands of farmers in mushroom farming. This brought her great success in terms of running a small venture into an active and big business in the local community. For this, she was also recognized as the district ambassador in 2019 [19].



Harvesting Dreams: Nalanda's 'Mushroom Lady' Sparks a Movement

Anita Devi, commonly known as the "Mushroom Lady of Nalanda," empowered hundreds of women in Bihar through her mushroom farming business. After starting this small venture from 2010, she started a movement inspiring the village women and the neighboring towns to cultivate mushrooms for economic emancipation. She also constituted a producer company, laid down a seed production house, and transformed her whole village into a "Mushroom Village" which created a new boost in livelihoods of the rural populations and empowered the women also [16].

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Mushroom Farming Magic: How a Rs 500 Vision build a 20,000-Strong Entrepreneurial Network



In 2010, Pushpa Jha started growing mushrooms in Darbhanga with only ₹500, despite the fact that there was no demand or awareness for them in the area. She gave away free samples, demonstrated cooking techniques and slowly developed a market. By 2015, she started training women to become entrepreneurs with little investment. Today, Pushpa has trained more than 20,000 women, men and even prisoners — encouraging them to be financially independent. She makes ₹2 lakh in a year and **transforms** **makes dishes of** mushrooms **into like**, pickles, powders, and snacks where not even the stem goes **to** waste [20].

Tech Meets Agriculture: Engineer Boosts Farmer Incomes for 25,000 Families



When engineer Prabhat Kumar returned to Gaya, Bihar in 2015 with his non-profit SumArth to revolutionize farming. From just 10 farmers, he rolled out high-yield crops such as onions, mushrooms and baby corn plus low-cost storage and training that doubled incomes for 25,000 farmers in 500 villages. In the last ten years, his projects have earned them ₹100 crore **as** combined income. Earnings are forecasted to improve further from value-added products and advanced farming practices [21].

395 **4. CONCLUSION:**

396 Mushroom farming has become a cornerstone of Bihar's agricultural revival, bringing about
397 significant socio-economic benefits. By integrating innovation with traditional practices, the state
398 has turned its challenges into opportunities. This transformation has been driven by visionaries
399 like Pushpa Jha and Prabhat Kumar, who recognized the untapped potential of mushroom
400 cultivation. Their efforts to train and support local farmers, particularly women, have created a
401 sustainable and inclusive agricultural model. Beyond the economic benefits, mushroom farming
402 has an ecological impact. It has enabled rural communities, curbed immigration to urban areas and
403 given women a springboard for financial independence. The initiative has also tackled the problem
404 of perishability – a core challenge in traditional Agro-horticulture systems, which affects market
405 accessibility and income consistency - by promoting value-added products including mushroom
406 powders and pickles. Mushroom farming's dependence on agricultural by-products also adds to
407 its environmental sustainability and nutrient recycling. The success story of Bihar portrays how
408 many innovative interventions on the hand strategic planning can change rural livelihoods. But the
409 process is not over yet. Setting up infrastructure, enhancing training programs and pushing policy
410 receptiveness will be key to scaling this revolution. With its current thrust, it has the potential to
411 become a case study for backward states in the country as well as on a global platform.

412 **DISCLAIMER**

413 (ARTIFICIAL INTELLIGENCE) Author(s) hereby declare that NO generative AI technologies
414 such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have
415 been used during the writing or editing of this manuscript.

416 **References**

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