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

ABSTRACT

The mushroom farming revolution in Bihar represents a landmark in the state's agricultural and socio-economic transformation. Over the years, the adoption of mushroom cultivation has not only provided a viable livelihood alternative to small-scale farmers but also demonstrated the potential of sustainable agriculture. The movement's success stems from a combination of factors, including optimal climate conditions, technological interventions, and robust community engagement. Initiatives such as low-cost storage facilities, value-added products like mushroom pickles and powders, and awareness programs have amplified the scope of this agricultural shift. Mushroom farming has not only offered economic benefits but also addressesed environmental challenges by recycling agricultural waste and promoting sustainable practices. There has been phenomenal growth in its mushroom production during the last two years. At a production level of 28,000 tonnes for 2021-22, it grew to 41,310 tonnes during 2023-24, having achieved a Compound Annual Growth Rate (CAGR) of nearly 21.46%. The high rate of growth was due to an increase in the adaptation of mushroom cultivation practices amongst growers, advancement in the techniques of cultivation, and also due to increased demand for mushrooms in the state. Such a high CAGR, though, really spells out Bihar's potential to play an important role in India's mushroom production landscape, thereby contributing to agricultural diversification and rural income generation. This underscores the importance of education, training, and local leadership in driving large-scale socio-economic changes. Bihar's remarkable growth in mushroom production, from negligible production to becoming India's top most mushroom producing state, showcases the transformative power of innovation and community-driven approaches in agriculture. This success serves as a model for other regions aiming to achieve agricultural sustainability and rural empowerment in the field of mushroom cultivation.

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

1. INTRODUCTION

India is a georgic-centric nation, that feeds approximately 15.5 per cent of the global population with merely 2.5 per cent of cultivated land. With the surging rise in the global population, the fate of food security is in jeopardy. To surmount this predicament, researchers and scientists are pioneering avant-garde solutions and unconventional paradigms to confront this pressing issue, by producing affordable, nutrient rich, quality foods. One of these paradigms are "Edible Fungi also known as Mushroom- conveniently cultivated and abundant in nutrition. Mushrooms are distinguished by their discernible parasol-shaped fruiting body and is part of the *Agaricales* order in the *Basidiomycetes* group of fungi. They are nucleated, sporiferous, chlorophyll-deficient and they feed on dead decomposing matter. Mushrooms like *Agaricus biporus* can grow both above the ground (i.e epigeous) and truffle (*Tuber species*) grow beneath the soil (i.e hypogeous). They are extraordinarily pliable and can grow anywhere from open terrain to forest area. Throughout ages, mushroom has seamlessly found their place in human diet and has been revered not only for their gastronomic versatility but also for their rich nutritional value and pharmacological usage. The white button mushroom (WBM, *Agaricus bisporus*) is well-known for its role as a nutritious food source and its notable medicinal benefits **[1]**.Mushroom plays a crucial role in nutrient turnover and act as symbiotic collaborators within the ecosystem **[2]**. Mushroom production is gaining global status due to easy production under controlled conditions, providing a sustainable and economically viable source of food. They play an important role in scientific research, primarily within the fields of biotechnology, medicine, and environmental science. Their unique biochemical properties make them stand out for scientific study. As the mycological studies advance, so do the fascinating discoveries drawing the scholars in ways that spark transformative breakthroughs both in food production and healthcare. The demand for edible fungi has soared up globally due to their fortified, curative characteristics and epicurean traits. The surge in production of edible varieties has been observed and it was noted that a production increased at the rate of 30 times spanning from 1978-2013 while the consumption rate per person escalated from one to four kilograms during the time period from 1997 to 2012 **[3] [4]**. The mushroom market is ruled by China globally, producing almost nine-tenths of the world's mushroom,

standing out in terms of elevated domestic demand and export opportunities **[4] [5]**. India ranks at 6th Position in terms of the global production of mushrooms surpassing more than 0.5% to the global production **[6]**. The nation's mushroom industry experienced a booming expansion in production and a strong yearly growth of 36 % was observed **[6]**. In the year 2021, 243 metric tons of edible fungi were produced by India **[7]**. The second advance estimate of 2023- 2024 released by Indiastat says the total production of mushroom in India stands at 336.17 metric tons where Bihar, Odisha, and Maharashtra are the top three states in mushroom production **[8]** . Bihar has recorded a production of 41.31 metric tons bagging the first position in India. Bihar's mushroom cultivation has seen remarkable growth in the last couple of years and it was possible due to the state's optimal climate, technological evolution, increased awareness and it has contributed to the state's economy and food supply. Button and Oyster mushroom are the most cultivated varieties by many small and medium scale farms spread across the region.

1.1 Insights on National Mushroom Day

National Mushroom Day is celebrated on 23rd December by Indian Council of Agricultural Research (ICAR) every year. It aims to raise the importance of mushrooms in the nutrition and sustainability sectors along with the rural entrepreneurship opportunities in India. It is also started by the Indian Council of Agricultural Research as a means to mark the progress India has undertaken towards the development and research of mushrooms as an alternative protein-rich food source, and also helps in encouraging income generation for farmers, entrepreneurs, and researchers. It focuses on the environmental impact of mushrooms, which involve recycling agricultural waste into nutritious food. On this day, there is a foundation for economic and health-based awareness about these mushrooms within the country to increase. Special focus is given in promoting towards diversification of mushroom varieties like oyster, buttons, shiitake, and medicinal mushrooms to meet the various demands of the market. Through this celebration of National Mushroom Day, ICAR aims to inspire more farmers to adopt mushroom farming as a way to double their income and also practice sustainable farming that uplifts the rural economy.

2. ORIGIN AND HISTORY

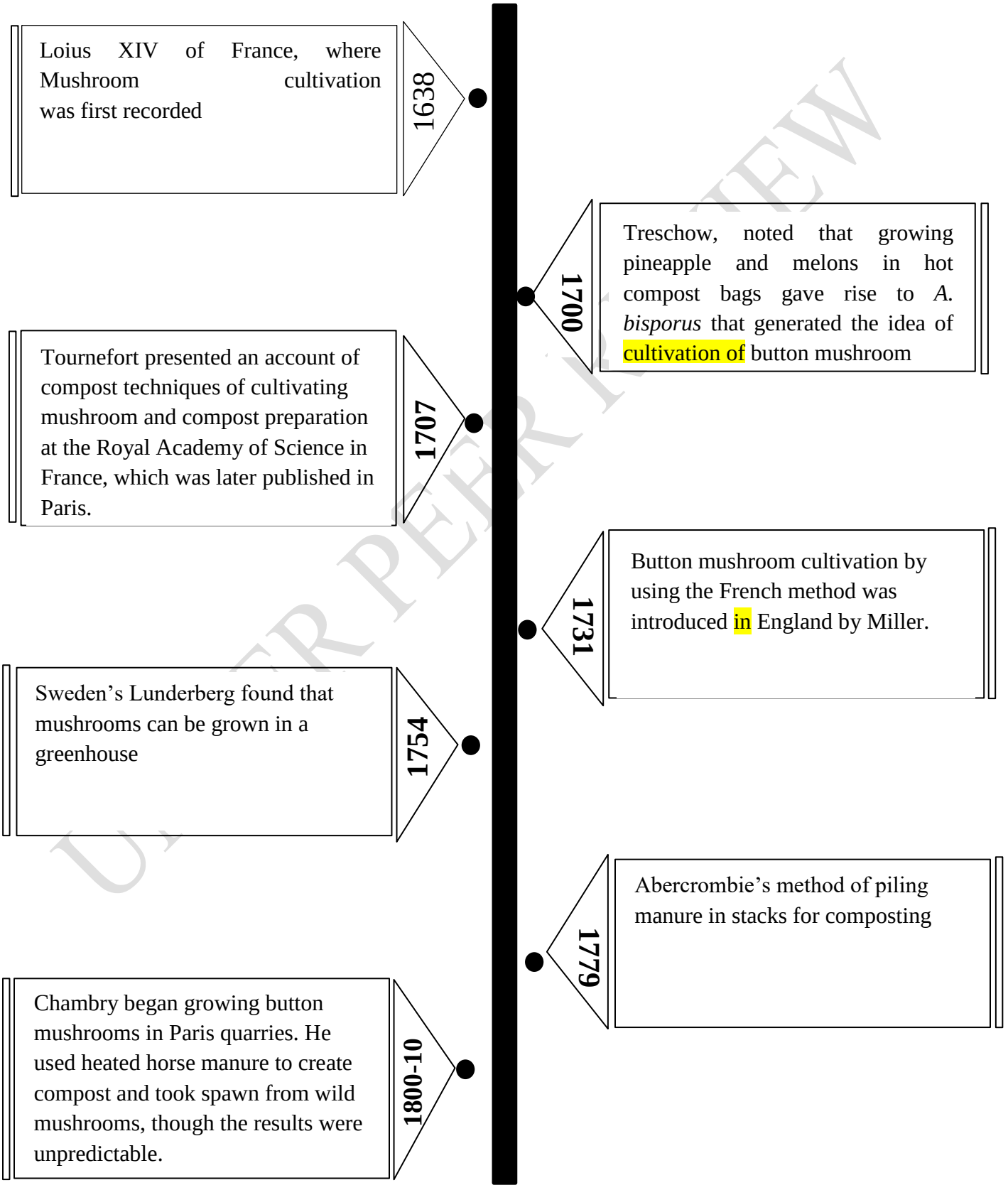
The Latin word "fungo," which meaning to flourish—that is, to sprout out of the earth or from trees as indicated in many languages from which the word "mushroom" is derived. (ii) The Greek word "sphonggos" or "sphoggos" means "sponge," referring to species that resemble sponges; (iii) the French word "mousseron" (muceron), which means "mousse" or "moss." 'Mouscheron' and'muscheron' are more possibilities. The terms "ksumpa" in Sanskrit, "khumbi or khumb" for button mushrooms in Hindi, "dhingri" for oyster mushrooms in Hindi, and "kathphula" in Assamese are some of the several names for mushrooms in various languages. Additional Sanskrit terms include bhoomi kavak, kavaka, bhustrna, kukurmutta, and chatra, which refers to the fleshy-capped fungus **[9]**.

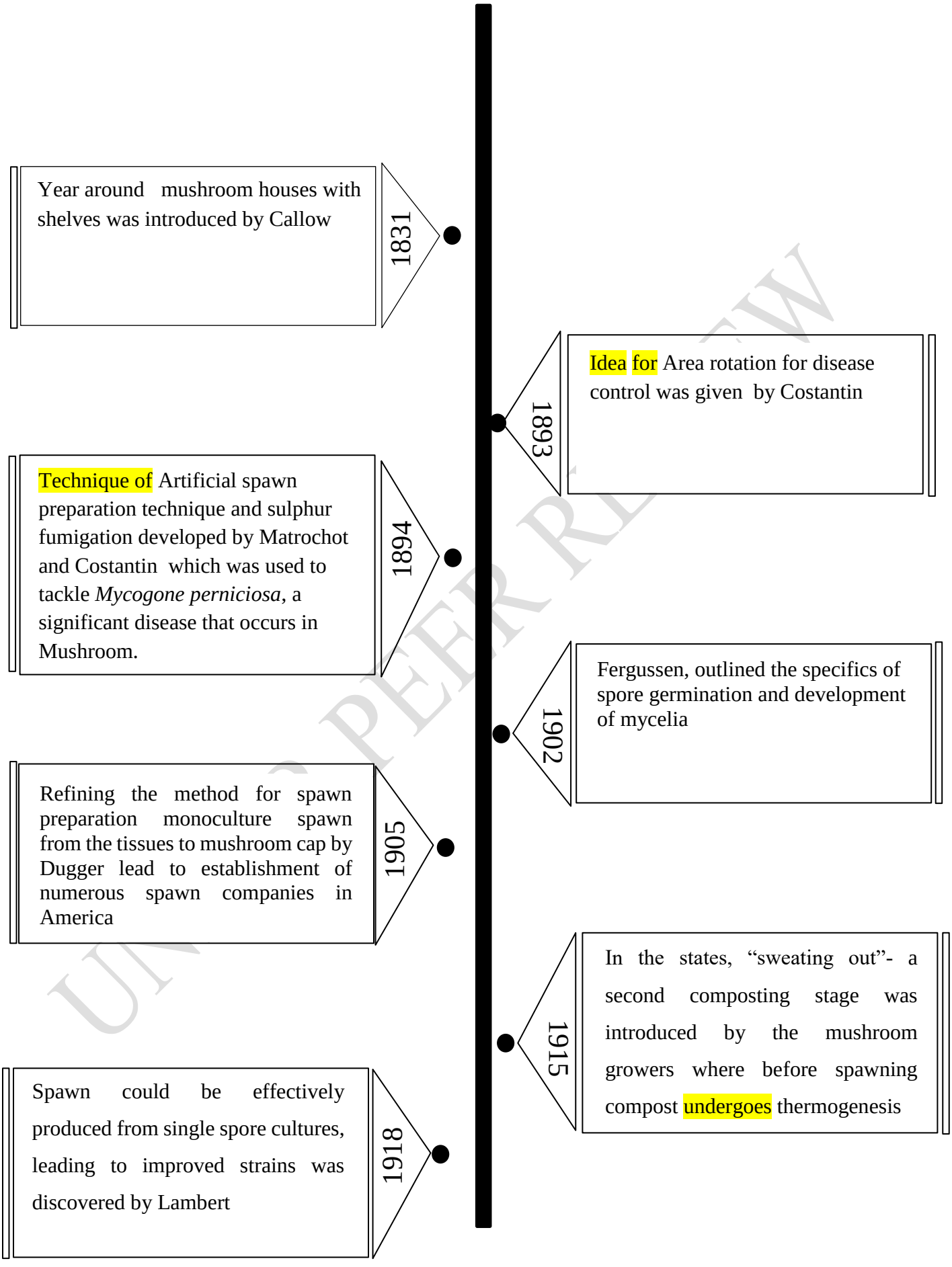
2.1 Chronological Events on Edible Mushroom

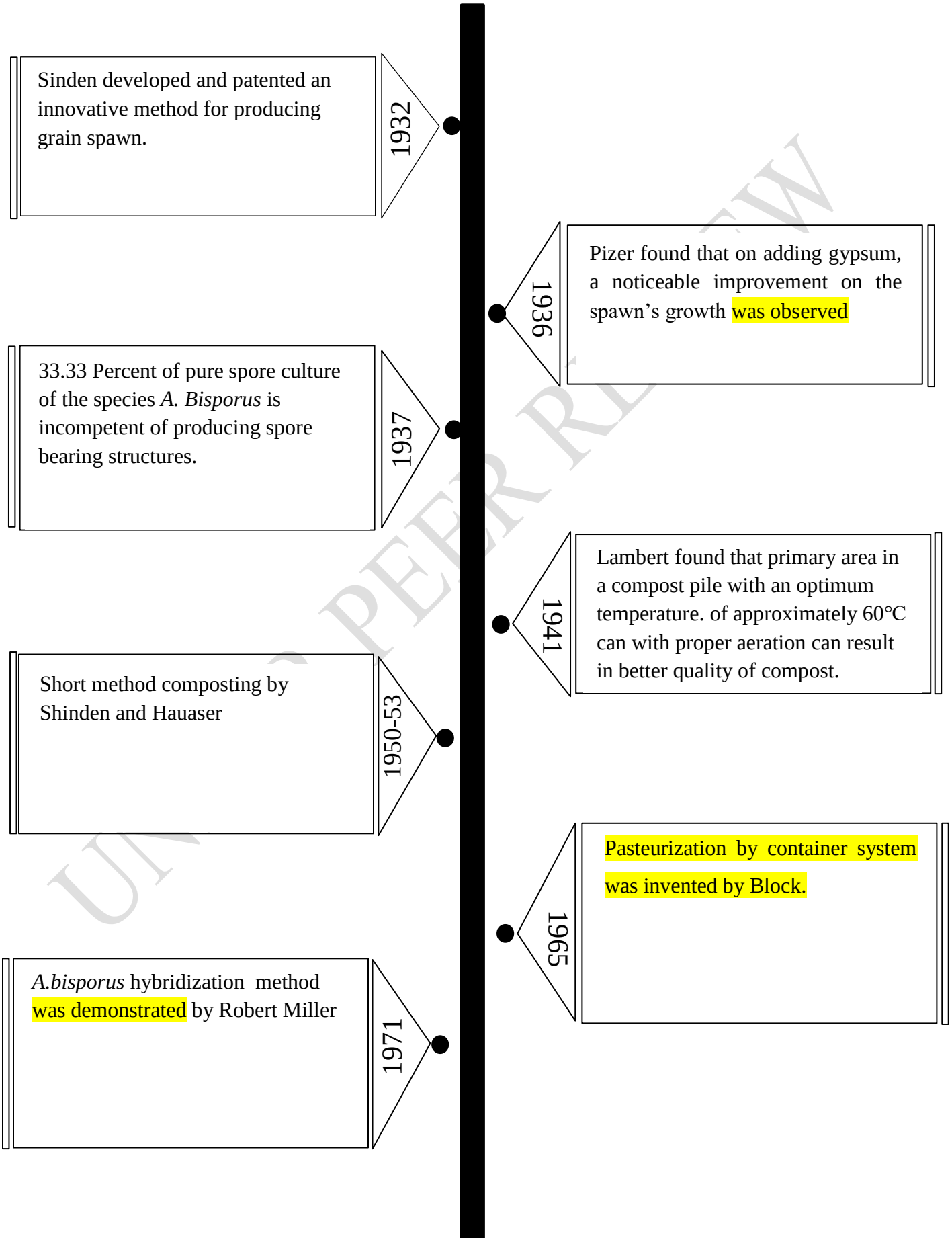
Table 1. Historical events from Pre-historic Era: **[9]**

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 *et al.*, 1886 found carvings on some stones portraying puffballs and various other fungi.
4.	Mayan Period	•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	•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 occasions.

Table 2. Historical Events of Button Mushroom: [9]




1831
Year around mushroom houses with shelves was introduced by Callow
1893
Idea for Area rotation for disease control was given by Costantin
1894
Technique of Artificial spawn preparation technique and sulphur fumigation developed by Matrochot and Costantin which was used to tackle *Mycogone perniciosa*, a significant disease that occurs in Mushroom.
1902
Fergussen, outlined the specifics of spore germination and development of mycelia
1905
Refining the method for spawn preparation monoculture spawn from the tissues to mushroom cap by Dugger lead to establishment of numerous spawn companies in America
1915
In the states, “sweating out”- a second composting stage was introduced by the mushroom growers where before spawning compost undergoes thermogenesis
1918
Spawn could be effectively produced from single spore cultures, leading to improved strains was discovered by Lambert


1932
Sinden developed and patented an innovative method for producing grain spawn.
1936
Pizer found that on adding gypsum, a noticeable improvement on the spawn's growth was observed
1937
33.33 Percent 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 temperature. of approximately 60℃ can with proper aeration can result in better quality of compost.
1950-53
Short method composting by Shinden and Hauaser
1965
Pasteurization by container system was invented by Block.
1971
A.bisporus hybridization method was demonstrated by Robert Miller

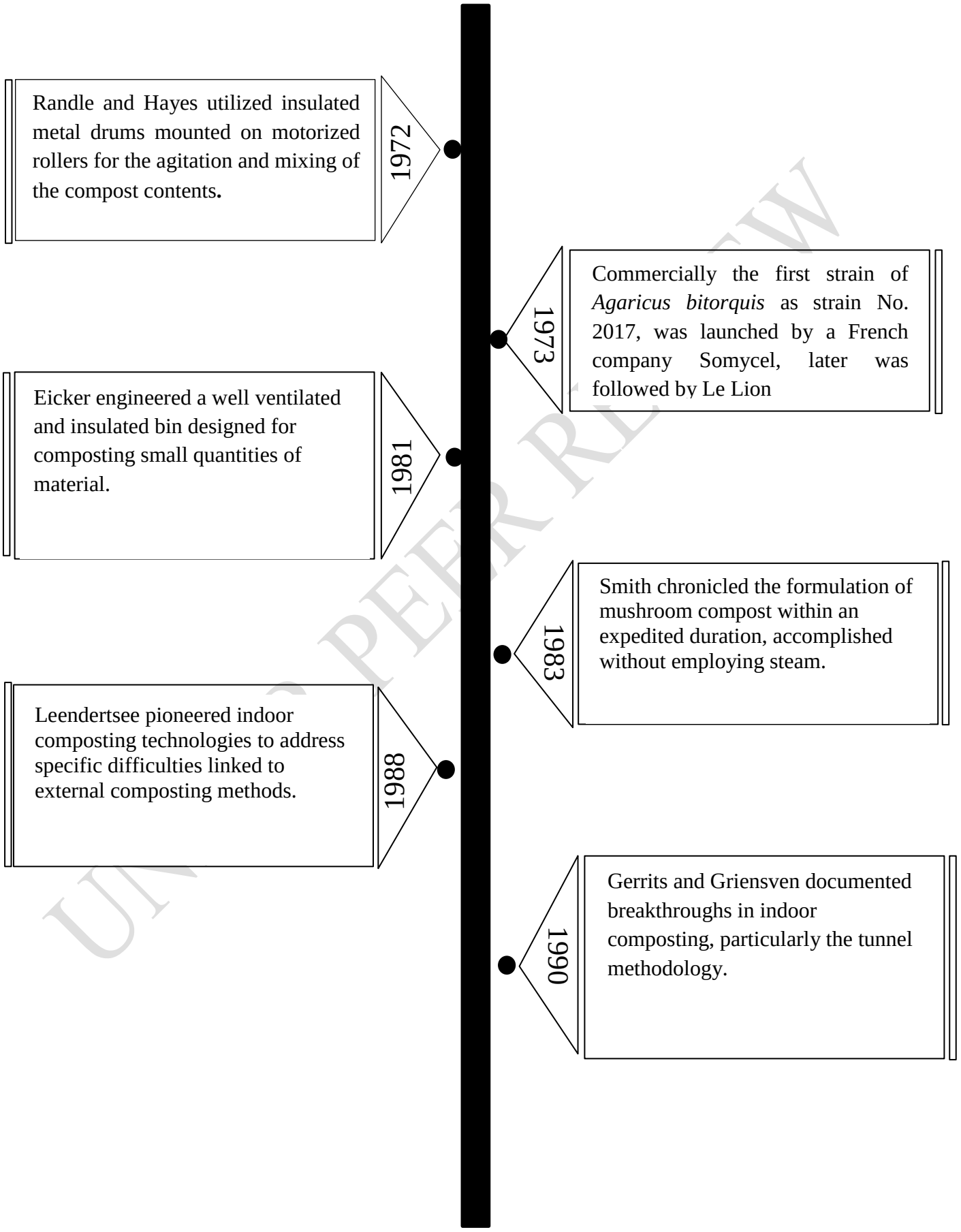

1972
Randle and Hayes utilized insulated metal drums mounted on motorized rollers for the agitation and mixing of the compost contents.
1973
Commercially the first strain of *Agaricus bitorquis* as strain No. 2017, was launched by a French company Somycel, later was followed by Le Lion
1981
Eicker engineered a well ventilated and insulated bin designed for composting small quantities of material.
1983
Smith chronicled the formulation of mushroom compost within an expedited duration, accomplished without employing steam.
1988
Leendertsee pioneered indoor composting technologies to address specific difficulties linked to external composting methods.
1990
Gerrits and Griensven documented breakthroughs in indoor composting, particularly the tunnel methodology.

Table 3. Historical Events of Paddy Straw Mushroom: [9]

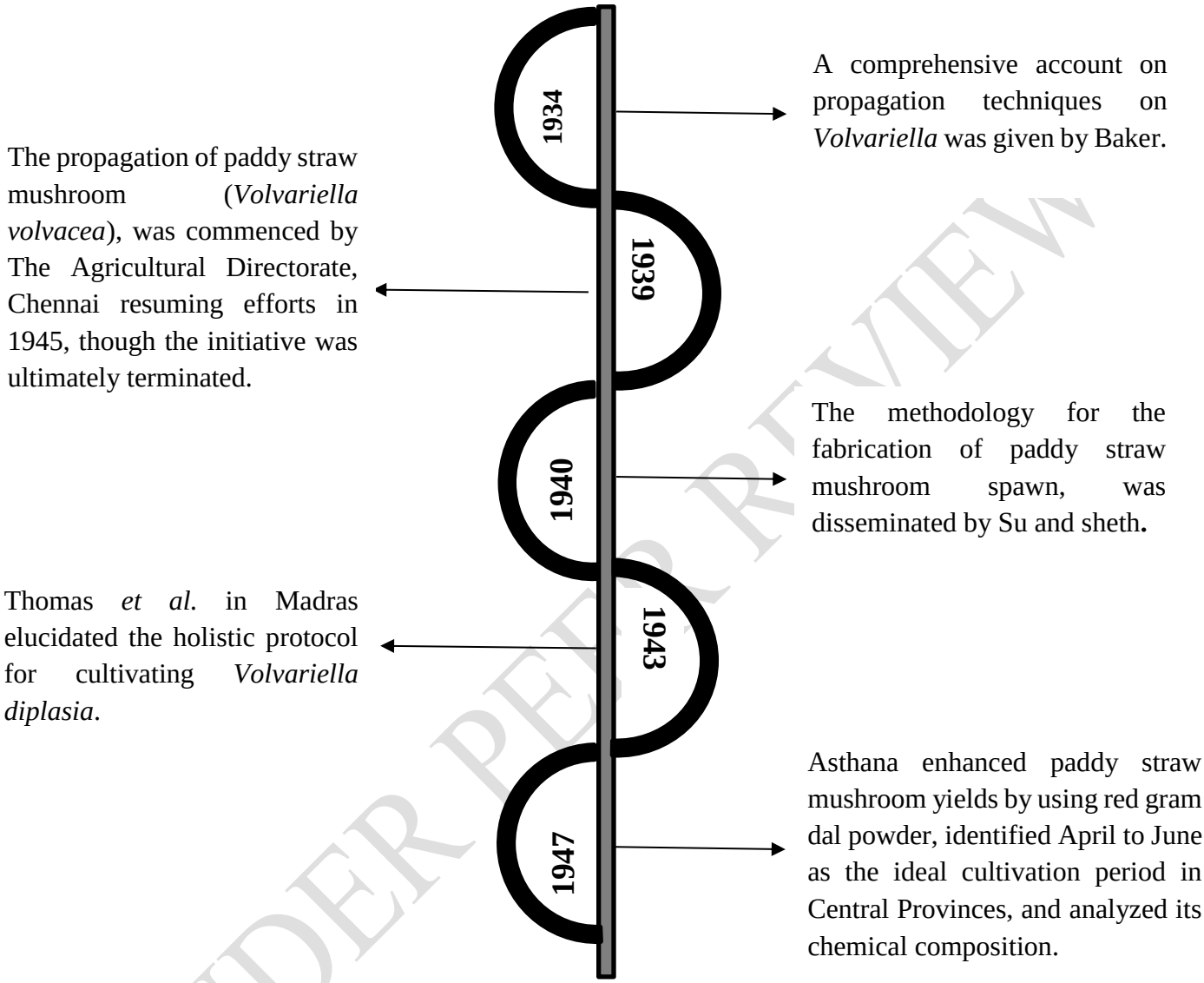
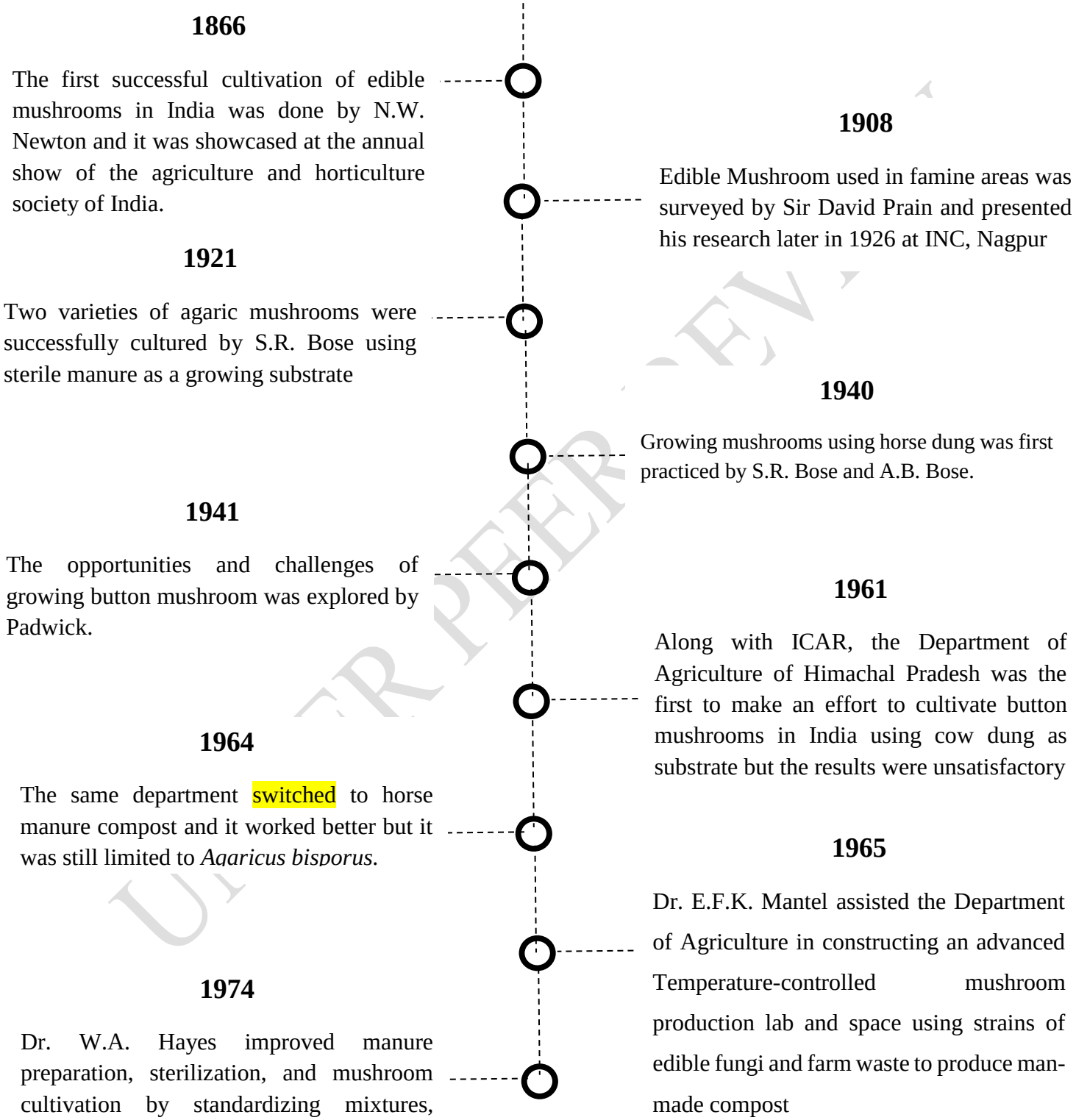
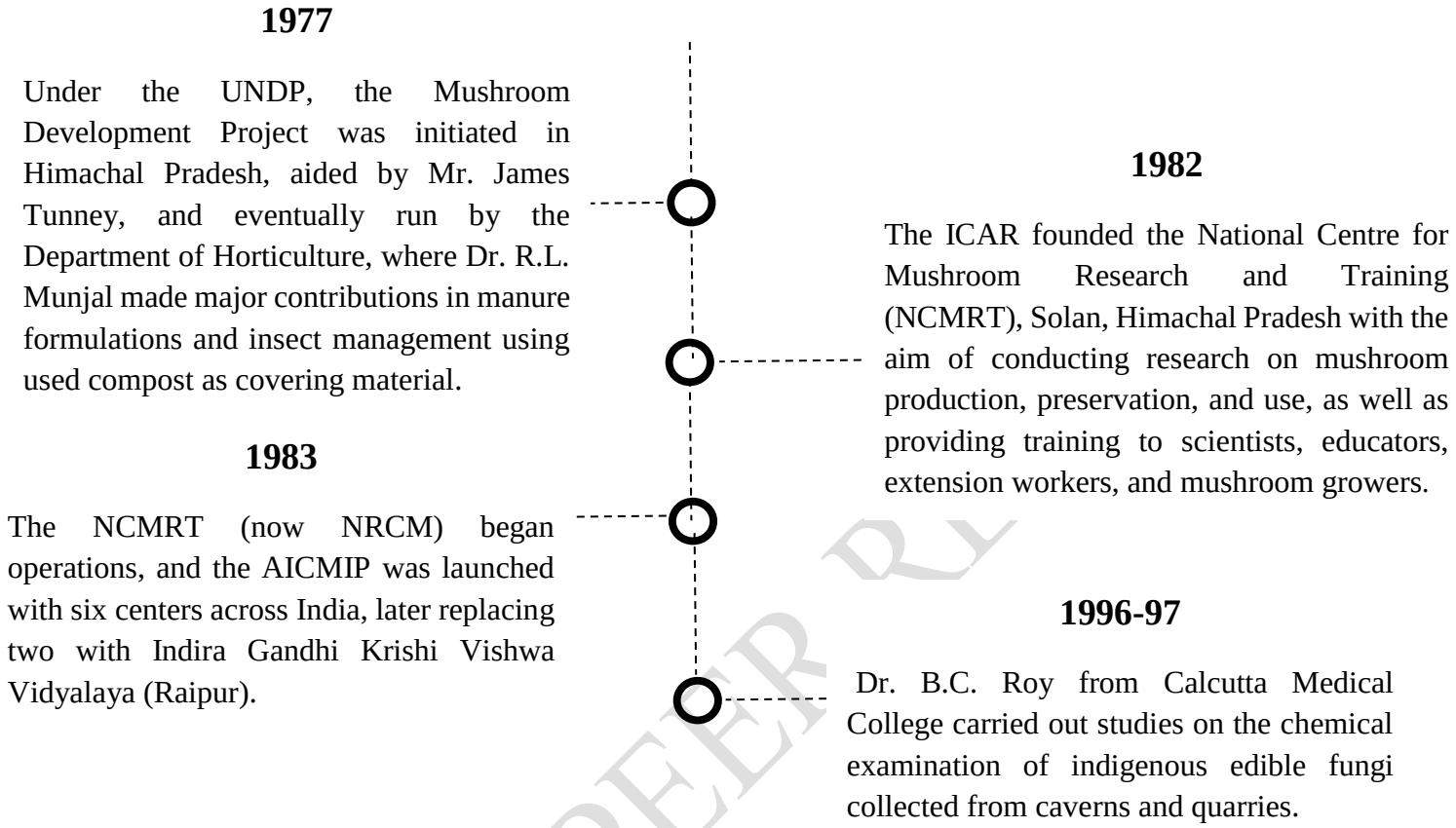


Table 4. Hisorical Events of oyster mushroom: [9]

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.

Table 5: Sequence of events that took place in India: [9]





3. MUSHROOM REVOLUTION IN BIHAR

The Mushroom Renaissance in Bihar is characterized by its notable socio-economic impact predominantly for the small and marginal farmers. Research shows that the cultivation of oyster mushrooms increases the producer's gross margins by a significant amount due to the effective marketing channels, where direct sales to consumers give a bigger part of the market price to producers than conventional retail sales. When sellers avoid middlemen, more value is retained and redistributed into the producer's hands, allowing smallholders to procure more income by selling and potentially remain sustainable in business **[10]**. This industry not only ensures a stable source of livelihood by making use of agricultural byproducts but also enhances food security and promoting environmental sustainability **[11]**. Females are the principal contributors in

mushroom revolution and numerous studies have reported improved household income and better nutritional outcomes **[12]**. Additionally, mushroom farming has become an essential income stream contributing significantly to domestic earnings to a great extent in Bihar's Samastipur district **[13]**. In general, the possibility of mushroom farming in Bihar remains underutilized highlighting elevated awareness and efficient training programs to fully realize its advantages **[14] [13]** .

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

"Dr. Dayaram, inspirational scientist from Dr. Rajendra Prasad Central Agricultural University, played an important role in supporting the emergence of Bihar as one of the leading states in the country for mushroom production. The mushroom production reached 28,000 tons during 2021-22."This aspiration was way back in 1991 when he realized that there was so much potential for mushroom cultivation within the State. He has also educated over 200, 000 farmers in the last thirty years regarding the cultivation of button and oyster mushrooms that can grow in the region's climatic conditions. His strategies focused on 24-hour harvesting and industrialized the processed forms of the mushrooms, for example, the powdered mushrooms and mushroom pickles. Improvement of technique of mushroom farming has significantly increased production and made it economically viable for small and marginal farmers. In addition to providing women with training and resources in mushroom farming and encouraging them to become entrepreneurs, his programs are specifically designed to focus on empowering women. The huge contributions from the government, and subsidies on the capital such as the spawn units for compost preparation enabled mushroom farming to evolve into a viable model. Not because of the earning, but the social impact that comes with it through creating job opportunities and helping people move away from the reliance on conventional agriculture-based means of earning **[15]**".

3.2 Success Stories of Entrepreneurs of Bihar

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

Shashi Bhushan Tiwari, the "Mushroom Man of Bihar" revolutionized his future by turning his passion for mushroom 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 **[20].**

"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 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 **[19]**.

"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 **[21]**.

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 **[18]**.

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 makes dishes of mushrooms like pickles, powders, and snacks where not even the stem goes waste **[22]**.

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 **[23]**.

4. CONCLUSION:

Mushroom farming has become a cornerstone of Bihar's agricultural revival, bringing about significant socio-economic benefits. By integrating innovation with traditional practices, the state has turned its challenges into opportunities. The transformation has been driven by visionaries such as Pushpa Jha, Prabhat Kumar and others **[2]**. Their efforts to train and support local farmers, particularly women, have created a sustainable and inclusive agricultural model. Beyond the economic benefits, mushroom farming has an ecological impact. It has enabled rural communities, curbed immigration to urban areas and given women a springboard for financial independence. The initiative has also tackled the problem of perishability – a core challenge in traditional Agro-horticulture systems, which affects market accessibility and income consistency - by promoting value-added products including mushroom powders and pickles. Mushroom farming's dependence on agricultural by-products also adds to its environmental sustainability and nutrient recycling. The success story of Bihar portrays how many innovative interventions on the hand strategic planning can change rural livelihoods. But the process is not over yet. Setting up infrastructure, enhancing training programs and pushing policy receptiveness will be key to scaling this revolution. With its current thrust, it has the potential to become a case study for backward states in the country as well as on a global platform.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

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

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