

Original Research Article

Gender friendly Technologies Mushroom cultivation for Farm Women in Meghalaya

Anupama Mishra¹ and Jelang Jelku D. Sangma^{2*}

¹Professor and Head, Department of Textile and Apparel Designing, College of Community Science, Central Agricultural University (Imphal), Sangsangre, Tura, Meghalaya – 794005, India

²Young Professional II, AICRP-WIA, College of Community Science, Central Agricultural University (Imphal), Sangsangre, Tura, Meghalaya – 794005, India

Corresponding Address: Jelang Jelku D. Sangma

Email: jelang.jelku3@gmail.com

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Abstract

Meghalaya, a resource-rich yet economically challenged state in Northeast India, presents a compelling case for inclusive and sustainable agricultural innovation through mushroom cultivation particularly oyster mushrooms. This paper explores the socio-economic potential of mushroom farming in enhancing rural livelihoods, especially for women, by analyzing studies, case reports, training programs, and government interventions. With low land requirements, high returns, and nutritional benefits, mushroom cultivation emerges as a gender-sensitive, climate-resilient agri-enterprise ideal for smallholders. Case studies from West Garo Hills and Ri Bhoi highlight how women farmers benefit from targeted training, digital tools, and support infrastructure. The study also identifies challenges such as post-harvest perishability, limited access to credit and digital platforms, and gender-based resource disparities. It recommends a multi-pronged approach scaling up nanotechnology and cold storage innovations, fostering women-led cooperatives, and integrating ICT tools for training and market linkage. The research underscores the importance of embedding gender equity into policy and technology frameworks to transform mushroom farming into a vehicle for rural transformation and women's empowerment in Meghalaya.

Keywords: Mushroom cultivation, Oyster mushroom, Sustainable Agriculture, Women's empowerment, Rural livelihoods

1. Introduction

Meghalaya, one of the State in India, faces numerous challenges, including a low per capita GSDP, inadequate infrastructure, and limited access to markets. Despite these obstacles, the state has significant strengths, such as its salubrious climate, abundant natural resources, and high literacy rates, which can be leveraged for sustainable development. The state government aims to foster human development by focusing on education, healthcare, and rural livelihoods in sectors like agriculture, food processing, and eco-tourism. Key strategies include improving secondary education, expanding healthcare coverage, and addressing infrastructure gaps to propel Meghalaya towards becoming a middle-income state in the next decade (Meghalaya Vision Document, 2020-21 to 2024-25).

Oyster mushroom farming is a profitable agri-business that can enhance farm income, create employment, and improve nutritional security. A study conducted in Rongram block, West Garo Hills, Meghalaya, on 60 oyster mushroom growers revealed that larger farm sizes benefited from economies of scale, with costs per 5 polybag units decreasing as farm size increased. The returns from mushroom cultivation were positively correlated with farm size, with small farms earning 58/kg, medium farms 76/kg, and large farms 120/kg. On average, every rupee invested in mushroom farming yielded 1.55, with the highest input-output ratio observed in large farms (1.82). To further improve productivity and profitability, the study suggests fostering collaboration between the state government, financial institutions, researchers, and mushroom growers to facilitate advanced technologies and better market access (Hatai, 2021).

Mushroom cultivation offers an ideal agricultural innovation for women in Meghalaya requiring minimal land, flexible timing, and yielding high returns. Meghalaya's agricultural sector is dominated by women, mushroom cultivation emerges as a viable, low-cost, high-margin option. Farm women often bear the brunt of agricultural labour but face limited access to resources, training, or markets. Gender-friendly technologies in this agro-sector can foster empowerment and socio-economic upliftment. Technologies both traditional (straw-based methods) and innovative (nanotechnology, digital tools) play a key role in empowering women farmers and enhancing livelihoods.

2. Review of Literature

Mushrooms are a nutritious food, rich in protein, fiber, vitamins, and minerals, while being low in fat and calories, making them ideal for those with diabetes and hypertension. Their historical use as both a medicinal and culinary item has earned them the title “Elixir of Life.” Successful mushroom farming requires factors like proximity to water, affordable labor, access to raw materials, and good sewage management (Chaudary and Mishra, 2021).

Oyster mushrooms (*Pleurotus* spp.), commonly known as “Dhingri” in India, are grown across the country, especially in states like Orissa, Maharashtra, and Assam. They provide a cost-effective, protein-rich livelihood option for farmers, including landless ones, and can significantly increase income through modern farming techniques, value addition, and sustainable practices. The intervention of organizations like KVK has helped farmers like Mr. Luingaingam expand their production, leading to substantial income growth from both fresh mushrooms and spawn sales (Jyotsna *et al.*, 2024).

Women's empowerment and gender equality are crucial for global progress, with entrepreneurship offering a key solution. Mushroom farming, as a profitable and sustainable venture, provides rural women with opportunities for economic independence while addressing issues like malnutrition. Organizations like Krishi Vigyan Kendra support this growth by offering training and resources, though challenges such as limited knowledge and market fluctuations remain (Aditya and Bhatia, 2020).

The study found that training, demonstrations, and extension materials significantly enhanced rural farmwomen's knowledge of mushroom production, fostering economic empowerment through entrepreneurship. Mushroom farming proved economically viable, with yields generating a net profit of Rs. 4,650 to Rs. 12,000 in six months. Over 60% of participants accepted mushroom production as a sustainable income-generating activity, highlighting its potential for rural women's empowerment (Singh *et al.*, 2018).

Mushrooms offer sustainable solutions to global challenges like food scarcity, health issues, and environmental degradation. They provide high-quality protein, essential nutrients, and medicinal benefits while supporting bioremediation by breaking down agricultural waste. Their cultivation is environmentally friendly, and the by-products can be used for animal feed and soil enrichment. Key varieties such as button, shiitake, and oyster mushrooms make up most of global production (Kumari and Baskaran, 2015).

This study aimed to examine the participation of male and female farmers in the Integrated Farming System (IFS) in Meghalaya's North-East region. IFS is a holistic farming approach that integrates various agricultural practices to improve income and employment opportunities for smallholders, while promoting sustainability through recycling crop residues. The study focused on the West Garo Hills and South Garo Hills districts, surveying 20 respondents. Findings showed that most respondents (40%) were aged 30–40 years, with 80% being female and 20% male. The farmers typically integrated at least three components, including fish farming, agricultural crops, and poultry (Bliss *et al.*, 2022).

Mushroom cultivation is generally classified into two main methods, wood-log and non-wood-log cultivation. Non-wood-log cultivation can be further divided into non-aseptic methods, like composting with or without casing, used for species such as *Agaricus bisporus* and *Volvariella volvacea*, and aseptic methods that require sterilized media and precise control of environmental factors, suitable for fungi like *Flammulina velutipes* and *Grifola frondosa*. Advanced techniques, including casing, scratching, flooding, and the use of either solid or liquid spawn, have been developed to enhance fruiting and synchronize production. Modern indoor cultivation systems often rely on automation and are increasingly using LED lighting during fruiting stages to improve energy efficiency (Thuy and Suzuki, 2019).

A study conducted in Demando and Baliapada villages of Odisha's Cuttack district examined gender roles in mushroom farming, focusing on awareness, role performance, skill gaps, and training needs. It found that all women participated in core activities like compost preparation, production, watering, and harvesting, while a majority of women (66.5%) managed income and men handled marketing. Although women had access to resources like irrigation and spawn, their control over these and financial resources like bank credit was limited. The study highlighted key training needs in post-harvest management, marketing, and spawn production, leading to the development of a gender-sensitive entrepreneurship model aimed at empowering women farmers and boosting their skills and income (Das *et al.*, 2020).

India, being an agriculture-centric nation, relies heavily on this sector for both employment and economic stability, especially in rural areas where most farmers are marginal or landless. To boost income and improve the socio-economic status of these communities, especially women, small-scale mushroom farming

offers a viable solution due to its low input cost and high returns. Using agricultural by-products and requiring minimal land, mushroom cultivation not only supports rural livelihoods but also meets growing urban demand due to its nutritional value. This approach serves as a sustainable, income-generating activity that empowers rural women, enhances food security, and contributes to overall rural development (Dey *et al.*, 2020).

The paper reviews 26 studies (1970–2022) on mushroom cultivation, highlighting five key benefits, nine therapeutic properties, and medicinal uses with bioactive compounds. It also covers nutritional value, cultivation methods, and challenges. While global research is extensive, the paper calls for more studies in neotropical regions like Guyana, where data is scarce despite rich biodiversity (Bhagarathi *et al.*, 2023).

The paddy-straw bag method is widespread due to its simplicity and affordability. In a case study, Jacinta Lyngdoh from Ri Bhoi started mushroom farming in 2015 using just four spawn packets on paddy straw; within 25–30 days, she saw a profitable harvest, attributing success to clean medium and proper ventilation (Thebetterindia.com, 2024). This model uses agricultural residue, fits in household settings, and is replicable across regions. The paddy-straw bag method is a simple, low-tech setup using plastic bags and straw, ideal for women with limited land and resources; it uses leftover straw as substrate (eco-friendly) and forms compact units suitable for homesteads or backyards, with clear, replicable protocols (e.g., Jacinta Lyngdoh started with four spawn packets and within 25–30 days realized returns) (Zizira.com, 2024). A case study in West Bengal showed an 88% rise in production and 89% productivity increase after training (Biswas, 2024).

Capacity-building and training initiatives in Sangsan-gre village in December 2024 comprised a five-day program that trained 15 women in paddy straw methods, residue use, value-addition, and nutrition (Syllad.com, 2024). At Resubelpara (February 2024), 49 participants (including 20 women) received hands-on training under ICAR-NIBSM scientists, learning substrate preparation, disease control, and yield methods, resulting in one bag yielding approximately 3 kg and Rs. 40–50k income per cycle (Highland Post, 2025). In February 2024, a one-day training of 20 women SC participants in North Garo Hills was led by CCS scientists, with emphasis on spawn use, pest/disease management, and yield enhancement (Highland Post, 2025). A NEHU-led TSP workshop in Ri Bhoi (February 2021) covered species differentiation, spawn use, and preparation of approximately 25

oyster mushroom beds per farmer (NEHU.ac.in, 2025). Assam's Aaranyak workshop emphasized hands-on preparation of cultivation bags, substrate mixing, and species identification (Nenews.in, 2024). Chhattisgarh women's SHG workshops covered technical requirements (temperature/humidity/disinfection), yield optimization, and financial literacy (Ojs.pphouse.org, 2024).

Nanotechnology interventions were also demonstrated: an NEHU program on 19 March 2025 showed how nanotechnology boosts shelf life, safety, and productivity, directly engaging local growers to explore practical benefits (NEHU.ac.in, 2025). While Meghalaya lacks direct digital literacy studies, national models (e.g., Bihar's "Mushroom Mahila" Bina Devi training over 700 women in phone usage) underscore the impact of combining tech training with cultivation (Syllad.com, 2024). The Han Agrocare model trains women first in digital basics, including MS Office and smartphone apps, to engage with e-learning, market networks, and coordination (Han Agrocare, 2024). Digital tools reduce mobility constraints, enabling women to access training from home.

The Megha Food Cooperative Society (MFCS) operates a cohesive cluster-based model across North Garo Hills, backed by MoMSME and the Government of Meghalaya. It includes spawn labs, dehydration units, training centers, and value-add facilities focused on tribal women's economic participation (Meghamushroom.com, 2024). Meghalaya's Regional Training Centre in Shillong, operating since 1982, promotes spawn quality, training, and dehydration/marketing support for oyster and button mushrooms, yielding approximately 5 t/year of fresh mushrooms (Thebetterindia.com, 2024). Government schemes provide Meghalaya's 50% subsidy on spawn, compost, and shed construction, along with financial aid of 22,000 per unit, accessible to resident farmers with at least 0.2 ha of land (Govt. of Meghalaya, 2024). NECTAR (Shillong) supports agri-tech dissemination, including mushroom spawn production and rural training initiatives (En.wikipedia.org, 2025).

Income generation examples include farmers like Rajdip Koch, who now produce approximately 300 kg/cycle across 100 bags, selling at Rs. 160–200/kg for Rs. 40–50k per cycle (Highland Post, 2025). More broadly, Meghalaya farmers can earn approximately 200/kg, or Rs. 40k–50k per cycle from 100 bags (Nenews.in, 2024). Mushrooms provide protein, vitamins, minerals, and antioxidants, adding dietary diversity and potential health benefits to diets (Megagriculture.gov.in, 2024).

In terms of empowerment, women gain self-reliance,

leadership, and respect in households and communities, mirroring Bina Devi's impact in Bihar. Increased decision-making control correlates with income and gender-sensitive interventions (Ojs.pphouse.org, 2024). Mushroom initiatives across India, with examples like Bina Devi's "Mushroom Mahila" movement and Meghalaya's Jacinta Lyngdoh, showcase how women adopt these ventures to gain income, autonomy, and respect (Dmwsc.in, 2024). However, farm women's participation remains constrained: they engage heavily in subsistence agriculture but lack access to capital, markets, and training.

3. Challenges

Technical knowledge related to proper substrate sterilization and disease control remains a weak linkage, with disease and spoilage arising from poor hygiene and a need for clean, lab-grade substrates. Post-harvest longevity is another challenge, since mushrooms perish quickly and there is a need for accessible cold-storage and drying solutions to address their short shelf life. Digital equity is a further concern, as tools and platforms remain underutilized and policy must bridge digital divides to ensure fair access to subsidies, markets, and digital platforms. Finally, access barriers persist, as gender norms may limit women's access to subsidies, capital, and markets.

4. Recommendations and Future Pathways

Training programs should be scaled and tailored, including digital, financial literacy, and agro-processing modules, and hands-on training should be expanded with modules on nanotechnology, post-harvest technology, and digital literacy. Technology-led innovation should be promoted by expanding nanotechnology solutions and simple drying/cold-chain models, and infrastructure such as MFCS cluster centers offering labs, cold storage, and value-add units should be scaled up. Support systems should be strengthened by enhancing subsidy awareness and facilitating women's cooperatives to aggregate harvests, fostering women-led cooperatives for market aggregation and bargaining power. ICT tools should be integrated for advisory services, peer networking, and market linkage, encouraging mobile apps and e-advisory platforms tailored to women's needs. Research and monitoring should establish impact indicators covering income, health, empowerment, and gender norms, monitoring gender-sensitive outcomes across income, empowerment, and food security metrics. Finally, gender impact should be mainstreamed by embedding gender equity in technol-

ogy projects to balance workload and nutrition goals.

5. Conclusion

Meghalaya's mushroom sector demonstrates a promising template for integrating gender-friendly technologies, low-cost traditional methods, nanoparticle interventions, infrastructural support, and digital training. Holistic scaling can not only boost livelihoods but also advance gender equity in rural communities. Mushroom cultivation in Meghalaya offers a promising pathway for farm women's empowerment through low-tech solutions, capacity building, emergent technologies, and enabling policies. Scaling this model with gender-responsive design will amplify both livelihoods and equity.

Mushroom cultivation in Meghalaya offers a replicable and scalable model for rural development, economic upliftment, and gender empowerment. By leveraging local resources, traditional knowledge, and emerging technologies, the state can transform mushroom farming into a robust livelihood option for farm women. The integration of training programs, digital literacy, value-addition technologies, and cooperative models has already demonstrated tangible benefits in income, autonomy, and community leadership. However, to fully realize this potential, systemic challenges such as limited access to post-harvest infrastructure, gendered access to capital, and digital inequity must be addressed.

A gender-responsive approach, rooted in supportive policies, inclusive training, and scalable innovations, can ensure that mushroom farming not only boosts income and nutrition but also redefines the socio-economic landscape for rural women in Meghalaya. As the state advances toward becoming a middle-income region, empowering its women through mushroom-based agri-preneurship may prove to be one of its most transformative strategies.

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