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Prospects of Paddy Straw Mushroom (*Volvariella volvacea*) in Meghalaya with Special Emphasis in West Garo Hills

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Abstract

Paddy straw mushroom (*Volvariella volvacea*) is an important tropical edible mushroom with considerable potential for agricultural diversification in warm and humid regions. In Meghalaya, the low-altitude and relatively warm areas of West Garo Hills provide favourable environmental conditions for seasonal cultivation of this species. The district also has substantial paddy cultivation, generating straw that can serve as an inexpensive lignocellulosic substrate. This article examines the biological requirements, agro-climatic suitability, cultivation methods, indicative economics, nutritional importance, livelihood opportunities, production constraints and development strategies associated with *V. volvacea* cultivation in West Garo Hills. Outdoor bed cultivation offers a low-cost option for smallholders and self-help groups, whereas indoor pasteurized systems may provide greater control over production conditions and contamination. Recent studies have further demonstrated the suitability of paddy straw and other locally available agro-wastes for *V. volvacea* cultivation. Strengthening local spawn availability, farmer training, substrate management, post-harvest handling, processing and market linkages will be essential for developing a viable and sustainable paddy straw mushroom enterprise in the region.

Keywords: Agro-waste utilization, Mushroom cultivation, Paddy straw mushroom, *Volvariella volvacea*, West Garo Hills

Introduction

Mushrooms constitute an important group of non-timber biological resources valued for their nutritional and economic significance and, in some species, their functional-food properties. Commercial mushroom cultivation also provides an opportunity to convert agricultural residues into edible biomass while generating supplementary income from relatively small areas of land. The use of agricultural wastes as mushroom substrates is particularly relevant to sustainable production because lignocellulosic materials can be converted into food and, subsequently, the spent substrate can be utilized in composting or other agricultural applications.

Among tropical cultivated mushrooms, *Volvariella volvacea*, commonly known as paddy straw mushroom, is particularly suited to warm environmental conditions and cellulose-rich agricultural residues (Ali *et al.*, 2024). It is an edible basidiomycetous fungus belonging to the family Pluteaceae and is commonly associated with paddy straw-based cultivation. It is also known as the rice straw or Chinese mushroom and is recognized for its rapid growth under favourable environmental conditions (Bisoyi and Chatterjee, 2020).

Meghalaya possesses considerable climatic diversity, ranging from cool high-altitude environments to warm and humid lowland areas. Mushroom production initiatives in the state have included infrastructure development, spawn availability, training, entrepreneurship, marketing and value addition under the Meghalaya Mushroom Mission (Government of Meghalaya, 2018). The warm conditions of

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the lower-altitude areas create additional scope for tropical mushroom species such as *V. volvacea*.

West Garo Hills is particularly relevant in this context. Its warm and humid lowland and valley areas, including the belts around Tikrikilla, Phulbari, Selsella and Rajabala, may provide favourable conditions for seasonal cultivation. The working assessment presented in the manuscript reports temperatures of approximately 28-38 °C and relative humidity of 75-90% during April-October. These conditions substantially overlap with the environmental requirements of paddy straw mushroom. The species also has a comparatively short production cycle, with first harvest possible within approximately two weeks under suitable conditions (Biswas and Layak, 2014; Ali *et al.*, 2024).

Thus, cultivation of *V. volvacea* in West Garo Hills has potential to combine agricultural-residue utilization, food production and livelihood diversification.

Biological and Physiological Requirements of Volvariella volvacea

Volvariella volvacea is a saprophytic tropical and subtropical mushroom that derives nutrients mainly from organic, cellulose-rich materials. It is commonly referred to as a "warm mushroom" because it performs well under comparatively high temperatures (Bisoyi and Chatterjee, 2020).

Temperature is one of the most important factors governing mycelial growth, pinhead initiation and fruiting. A temperature range of approximately 25-35 °C has been reported as favourable for growth, while higher temperatures, generally around 34-37 °C, can favour fructification. Relative humidity of about 70-90% is considered suitable for production (Bisoyi and Chatterjee, 2020). The present manuscript identifies approximately 32-35 °C as favourable for mycelial growth and 28-38 °C during fruiting, with relative humidity around 80-90% desirable for pinhead initiation and button development.

The mushroom possesses considerable cellulolytic capacity and can utilize cellulose- and hemicellulose-rich agricultural residues. Paddy straw is therefore an important conventional substrate, while other locally available materials such as banana leaves and selected crop residues can also be evaluated (Biswas and Layak, 2014; Ali *et al.*, 2024). Recent experimental evidence confirms that *V. volvacea* can grow on paddy straw, sawdust and banana leaves, although substrate performance varies with the material and production conditions (Ngom *et al.*, 2025).

Agro-Climatic Suitability and Substrate Availability in West Garo Hills

The geographical landscape of West Garo Hills encompasses hill ranges as well as extensive lowland and alluvial areas adjoining Assam. The warmer lowland belts are particularly relevant for paddy straw mushroom cultivation. Tikrikilla, Phulbari, Selsella and Rajabala have been identified in the present manuscript as potentially favourable areas because of their warm and humid environment.

The most important advantage, however, is not climate alone but the combination of favourable climate and substrate availability. Rice is an important crop in the district and cultivation of Sali and Ahu rice generates substantial quantities of paddy straw. Such residues may otherwise remain underutilized, decompose in the field or, where burning occurs, contribute to localized air pollution and nutrient loss.

Utilization of paddy straw for mushroom cultivation therefore creates a useful circular agricultural pathway (Figure 1) in which crop residue becomes a substrate for food production and the resulting spent mushroom substrate can subsequently be directed towards composting or other agricultural applications. The availability of paddy straw and favourable temperatures has also been identified as a major basis for the potential of paddy straw mushroom cultivation in eastern and north-eastern India (Bisoyi and Chatterjee, 2020).

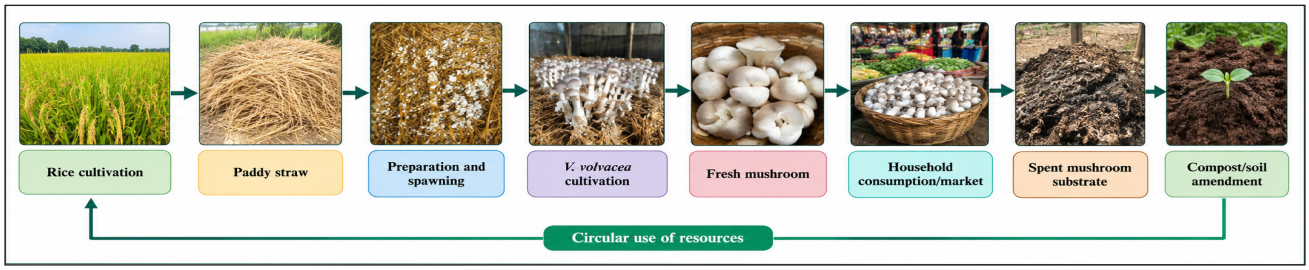

Figure 1: Conceptual pathway for paddy-straw-based mushroom production

Cultivation Methods

Two broad cultivation approaches are particularly relevant: the low-cost outdoor or semi-protected bed system and the more controlled indoor pasteurized system.

Outdoor Conventional Bed Method

The conventional outdoor bed method requires comparatively limited capital investment and can therefore be considered for smallholders, household producers and self-help groups. Clean, mature and mould-free paddy straw is tied into bundles of approximately 1-1.5 kg and about 60-80 cm in length. The bundles are adequately moistened before bed construction (Biswas and Layak, 2014).

The straw bundles are arranged crosswise in successive layers on a raised bamboo platform. Spawn is placed between the layers, particularly towards the margins and suitable organic supplements such as rice bran or gram powder may be used in limited quantities where recommended. The completed bed is covered with suitable material to conserve moisture

and maintain favourable temperature conditions.

Under suitable conditions, pinheads may appear approximately 6-8 days after spawning and harvestable buttons may be obtained within approximately 10-14 days. The exact duration varies according to strain, temperature, moisture, substrate condition and management (Biswas and Layak, 2014; Ali *et al.*, 2024). The total production cycle may extend beyond the first harvest, depending on the production system. Recent work reported first harvest at the egg stage around 14 days after inoculation on paddy straw, with harvesting continuing for several weeks (Ngom *et al.*, 2025).

Indoor Pasteurized Tray or Shelf Method

Indoor production provides greater control over environmental conditions and substrate hygiene, although it requires greater investment and technical skill. In this system, straw is chopped into smaller pieces, adequately moistened and prepared with suitable substrate amendments. The detailed working protocol in the manuscript describes the use of approximately 1% calcium carbonate and a target pH of about 7.5-8.0.

The prepared substrate may then be subjected to steam or hot-water pasteurization before conditioning and spawning. Hygienic spawning, suitable ventilation and proper moisture management are important for reducing contamination. Controlled indoor systems can be advantageous where more consistent production and improved hygiene are desired. Bisoyi and Chatterjee (2020) similarly noted that outdoor cultivation generally faces greater contamination and environmental risks than indoor production.

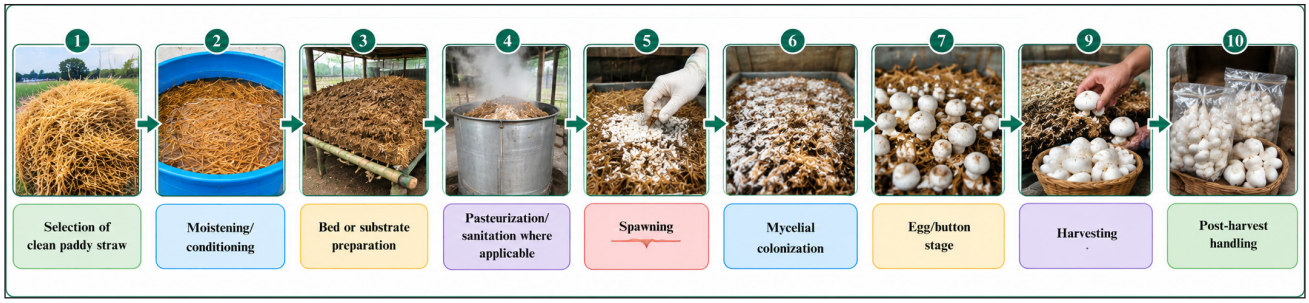

Figure 2: General cultivation sequence of *Volvariella volvacea*

Table 1: Comparative characteristics of two cultivation systems

Parameter	Outdoor/semi-protected bed	Indoor pasteurized system
Capital requirement	Low	Moderate to high
Environmental control	Limited	Relatively high
Technical skill	Low to moderate	Moderate to high
Indicative biological efficiency	10-15%	22-28%*
Approximate crop period	12-16 days*	18-22 days*
Contamination risk	Relatively high	More controllable
Suitable production group	Smallholders/SHGs	Entrepreneurs/FPOs

*The biological-efficiency and crop-period ranges are indicative values presented in this article and should not be interpreted as fixed production standards. Productivity depends on strain, substrate quality, spawning rate, temperature, humidity and hygiene (Biswas and Layak, 2014; Ali *et al.*, 2024).

Economic Potential for Smallholders

The short production cycle of *V. volvacea* is an important economic advantage because it can allow relatively rapid turnover of production inputs. The crop can also be integrated with existing agricultural activities without requiring large areas of land.

The article presents an illustrative 10-bed outdoor production model (Table 2). Each bed is assumed to utilize 12 kg of dry straw, giving a total substrate requirement of 120 kg. At an assumed biological efficiency of 12%, fresh mushroom production is estimated at 14.4 kg per cycle. At an illustrative selling price of ₹ 250 kg^{-1}, gross revenue would be ₹ 3,600, against an estimated operating cost of ₹ 890, giving an indicative surplus of ₹ 2,710.

The above calculation should be regarded strictly as an illustrative enterprise model rather than a guaranteed return. It does not fully account for family labour, transport, packaging, market losses, infrastructure depreciation or seasonal variation in mushroom prices. Field-level cost-benefit studies are therefore required before recommending commercial-scale adoption.

Biological efficiency can vary considerably according to substrate and production practice. Ngom *et al.* (2025) recorded a 7.41% biological efficiency on paddy straw and 12.63% on sawdust under their experimental conditions, with no statistically significant difference among the tested substrates. Biswas and Layak (2014) also demonstrated that cultivation method can influence biological efficiency, with

the cage method performing better than the bed and spiral methods in their study.

Table 2: Illustrative economics of a 10-bed outdoor unit

Component	Indicative amount
Dry paddy straw	120 kg
Assumed biological efficiency	12%
Expected fresh mushroom yield	14.4 kg
Assumed selling price	₹ 250 kg^{-1}
Straw cost	₹ 240.00
Spawn	₹ 300.00
Supplements and miscellaneous inputs	₹ 150.00
Polythene/bamboo-frame amortization	₹ 200.00
Total estimated operating cost	₹ 890.00
Gross revenue	₹ 3,600.00
Indicative surplus	₹ 2,710.00

Nutritional and Socio-Economic Significance

Paddy straw mushroom has considerable nutritional value and contains proteins, carbohydrates, dietary fibre, minerals, vitamins and various amino acids. Ali *et al.* (2024) reviewed its nutritional composition and reported numerous essential and non-essential amino acids and biologically active compounds. The manuscript reports crude protein values of approximately 28-35% on a dry-weight basis, together with B-complex vitamins and minerals such as potassium, phosphorus and iron. Such values should be considered as reported ranges because nutritional composition can vary with strain, substrate, maturity and analytical methodology.

The nutritional significance of *V. volvacea* is particularly relevant where dietary diversification is desirable. It can provide an additional nutritious food option, although mushroom cultivation alone should not be represented as a solution to protein-energy malnutrition.

From a livelihood perspective, mushroom cultivation requires relatively little land and can be integrated with household agricultural activities. Production, harvesting, grading and packaging may provide additional employment opportunities, particularly for organized farmer groups and self-help groups. Community-based production clusters could facilitate collective procurement of straw, spawn and packaging materials while improving aggregation and market access. The broader Indian mushroom sector is similarly being promoted in relation to food, employment, agro-waste utilization and value-added products (Thakur *et al.*, 2025).

Major Constraints

Despite its potential, cultivation of *V. volvacea* faces several technical and commercial constraints.

1. High Perishability

Fresh paddy straw mushroom is highly perishable and undergoes rapid deterioration after harvest. Therefore, harvesting, grading, packaging and marketing must be closely coordinated. Where fresh mushrooms cannot be marketed immediately, drying, pickling and canning may provide potential value-addition options. Strengthening post-harvest technology has also been identified as an important requirement for the development of India's mushroom sector (Thakur *et al.*, 2025).

2. Availability and Quality of Spawn

The availability of vigorous and contamination-free spawn is a major determinant of successful production. Dependence on distant suppliers may increase transport time and create difficulties in maintaining production schedules. Strengthening local or regional spawn-production facilities would therefore be advantageous (Government of Meghalaya, 2018).

3. Competitive Moulds

The warm and humid conditions that favour *V. volvacea* can also favour competitor moulds. Coprinus, Aspergillus, Penicillium, Rhizopus and other contaminants have been reported from paddy straw mushroom beds. Bisoyi and Chatterjee (2020) reported higher contamination in outdoor cultivation than in indoor production and highlighted competitor moulds as an important cause of production loss.

Proper substrate preparation, sanitation, suitable moisture management, heat treatment where feasible and removal of contaminated material are therefore essential. Older literature has also described chemical and botanical approaches to competitor-mould management; however, their application under present-day production systems should follow current safety recommendations and approved practices.

4. Post-Harvest Infrastructure

Limited access to appropriate processing, packaging and aggregation facilities can reduce the market value of this highly perishable crop. Development of small-scale drying, pickling and other value-addition facilities near production clusters could help reduce losses and broaden market opportunities (Government of Meghalaya, 2018; Ali *et al.*, 2024).

Strategic Development Framework

The development of *V. volvacea* cultivation in West Garo Hills should follow an integrated and phased approach involving farmers, self-help groups, extension agencies, research institutions, producer organizations and markets (Figure 3).

First, spawn-production and distribution systems should be strengthened. The Meghalaya Mushroom Mission provides an institutional framework for mushroom-sector development, including infrastructure, training and entrepreneurship (Government of Meghalaya, 2018).

Second, capacity building should focus on practical skills, such as strain selection, spawn handling, straw preparation, pasteurization, bed construction, moisture and temperature management, contamination identification, harvesting, grading, packaging and enterprise management.

Third, local substrate research should be encouraged. Paddy straw should remain the principal substrate, while other locally available agricultural residues, including banana and maize residues, may be experimentally evaluated for growth, yield and biological efficiency. Recent experimental findings demonstrate that substrate selection can influence mushroom performance and therefore deserves location-specific evaluation (Ngom *et al.*, 2025).

Fourth, post-harvest and value-addition facilities should be developed close to production clusters. Solar or mechanical drying, pickling and other processing methods could reduce losses during periods of high production, provided appropriate food-safety and quality-control measures are followed.

Finally, collective marketing through self-help groups, farmer groups and producer organizations could help synchronize production, aggregate daily harvests and improve access to markets in Tura and other regional centres. Demonstration units and pilot clusters should be established before large-scale expansion, with production and profitability monitored under the actual West Garo Hills conditions.

Figure 3: Field-level assessment and technical interaction by KVK scientists during inspection of paddy straw mushroom cultivation

Conclusion

Volvariella volvacea represents a promising tropical mushroom crop for the warmer and humid areas of Meghalaya, particularly the lowland and valley regions of West Garo Hills. The convergence of favourable climatic conditions, availability of paddy straw and the species' relatively short production cycle provides a sound basis for exploring its potential as a smallholder-oriented enterprise (Ahlawat and Tewari, 2007; Ali *et al.*, 2024).

Its importance extends beyond mushroom production itself. The crop can contribute to agricultural-residue utilization, dietary diversification and supplementary household income, while also creating opportunities for farmer groups and rural enterprises. Nevertheless, successful commercialization will depend on overcoming constraints related to quality spawn, contamination, production hygiene, perishability, processing and market access.

A phased development strategy involving research-based demonstrations, decentralized spawn supply, farmer training, scientific substrate evaluation, post-harvest management and collective marketing would therefore be appropriate. With coordinated institutional and community participation, paddy straw mushroom cultivation could become a meaningful component of agricultural diversification and sustainable rural enterprise development in West Garo Hills.

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