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Unlocking prosperity: Economic potential of Cordyceps mushroom cultivation as a promising agri-enterprise in India

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ABSTRACT

Modern agribusiness in India is beholding a major shift, driven by the need to address nutritional security, mitigate the risks of traditional agriculture, and provide viable opportunities for resource-constrained farmers. Cordyceps mushroom, also known as "soft gold", renowned for its exceptional medicinal and nutraceutical properties, offers immense potential as a lucrative enterprise in the country. It is important to analyse the economics of Cordyceps mushroom to boost its adoption among next-gen mushroom growers. Present paper helps in effective financial planning and provides acumens into the minimum viable scale required to establish a successful Cordyceps mushroom enterprise. The return over variable cost (ROVC) for small, medium, and large growers was Rs. 12000, Rs. 16000, and Rs. 22000 per Kg per crop cycle of Cordyceps mushroom. The BC Ratio is viable only for medium and larger units opposed to small units. The Break Even Point (BEP) for small, medium, and large units above which they should produce to earn positive returns were 7 kg, 15 Kg, and 12 Kg per cycle, respectively.

Keywords*: Cordyceps militaris*, soft gold, economics, ROVC, BC Ratio, BEP analysis

Recently, Indian agriculture has transitioned from traditional crops to a more commercial approach, driven by next-generation farmers taking on entrepreneurial ventures and shifting consumer preferences toward healthier, nutritionally rich foods (Shirur *et al*., 2014). According to Chandha and Sharma (1995), mushroom is an eco-friendly and sustainable crop. Mushroom farming requires minimal resources such as land and water, which are already scarce. Thus, a scientific mushroom cultivation offers economic and nutritional support to small and marginal farmers as a short-duration crop with significant health benefits (Marshall and Nair, 2009). Globally, mushrooms have been cultivated on commercial scale for long time; however, large-scale market-driven mushroom production in India is in its nascent stage only (Bijla and Sharma, 2023a). India generates more than 600 million tonnes of agri-residue annually (Singh and Sidhu, 2014). Hence, abundant agro-waste coupled with cheaper labour, and diverse climate make our country apt for mushroom cultivation. Although, mushrooms rank lower than animal meat for crude protein, yet, they are well above in protein as compared to milk (Chang and Miles, 1989; World Bank, 2004). They are one of the important foods containing all the essential amino acids needed by humans (Thakur, 2014). Mushrooms can be better nutritive options for the malnourished in the developing countries (Bell *et al*., 2022; Khan *et al*., 2024).

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World mushroom production has reached an all-time high of 48 million tonnes and is growing at a compounded growth rate of around 8 per cent (Bijla and Sharma, 2023B). Golden medicinal fungi, *i.e.* the medicinal mushrooms, are rich in bioactive compounds that boost immunity and are of great therapeutic value. Hence, mushroom research is getting growing emphasis from pharmacological and medical fields as a good source of bio-active compounds of commercial importance (Wasser, 2002). The genus *Cordyceps,* known since 2000 BC, involves fungi which hibernate on insects (Das *et al*., 2010). It is also known as Caterpillar mushroom/ winter worm/ summer grass, found at altitudes of 3400 to 5000 above mean sea level *i.e.* in the alpine grassland of the Himalayas and the Tibetan plateau. Herbal or non-allopathic medicines are an essential factor of traditional medicines , used commonly used in Southeast Asian countries. These have extensively been used as dietary supplements in India (Saggar *et al*., 2022). In Eastern Asia, mainly in China and Tibet, *Cordyceps militaris* is a traditional medicine, used as a drug and tonic due to various bio-active compounds such as cordycepin, adenosine, mannitol, ergosterol, etc. (Song *et al.*, 1998; Nag and Wang, 2005; Cannon *et al*., 2009).

This commercialization has resulted in the flourishing of national and global market with an international trade of around 10 billion USD yearly (Shrestha, 2012). It also has given rise to a profound surge in the price of Cordyceps. Due to its medicinal value, *Cordyceps* (*C. sinensis*) is considered one of the most expensive mushrooms in the world. In China, its price has increased by more than 900% since 1970s (Sheng and Gerasimova, 2025; Shrestha *et al.*, 2014). There has been a 350% hike in price since 1970s in Tibet (Winkler, 2008). In Bhutan also, *Cordyceps sinensis* has been an important part of traditional medicine, getting around 7000-10000 USD per kilogram (Singh and Wangmo, 2014). In Nepal, Shresta and Bawa (2013) reported a 2300% increase in prices between 2001 and 2011. Owing to its high market value compared to the same weight of gold, it is also termed as “organic gold” or “soft gold” (Pouliot *et al*., 2018). This mushroom is thus an important livelihood source for rural people in the South Asian sub-continent, particularly in China, the Himalayas, and Tibet. In Tibet, the fungus is found in the alpine grasslands, where it is the major income source for rural people, contributing around 40% to total rural income and around 70-90% of a household’s annual income (Winkler, 2008).

It is the second largest livelihood source for mushroom collectors in Nepal with around 53% share in their gross income (Shrestha and Bawa, 2014). Along the similar lines, it contributes significantly to the revenue sources of collectors in India (Caplins and Halvorson, 2017) and Bhutan (Wu *et al*., 2016). However, the opposite aspect presents significant challenges associated with the commercial foraging of *C. sinensis*. There has been an 11-19% decline in the biomass in Tibet (Hu *et al*., 2005) and reduced production in Nepal (Shrestha and Bawa, 2014). Due to its high medicinal value, market rate, and threat to biomass sustainability in the Himalayan region, in-vitro production technology for *Cordyceps militaris* mushroom has been standardized in India using brown rice media supplemented with nutritional broth (Kumar *et al*., 2023). The literature on *Cordyceps* mushroom is majorly targeted on economic valuation at the community level in South Asian countries (Caplins and Halvorson, 2017; Wu *et al*., 2016). However, no such studies were found in Indian context. Moreover, commercial-scale in vitro production of *Cordyceps militaris* in India remains in its nascent stage, with limited technological advancements and no existing literature on its economics. Studying its economic potential is vital due to its high market value, livelihood prospects, and export opportunities. This paper addresses the economics and financial feasibility, of

Cordyceps militaris mushroom as an agri-business enterprise in the country.

MATERIALS AND METHODS

Data collection

The study consists of primary data (2023-24) taken from 10 *Cordyceps* mushroom farmers throughout the country using snowball sampling technique due to the nascent nature of this business-enterprise. Moreover, *Cordyceps* units are dispersed in India. A formal interview schedule was created to take first-hand data on initial investments and assets, variable expenses on medium, nutritional broth, spawn, labour, and other expenses, sales, price, etc. The growers were adopters of Standard artificial cultivation technology of *Cordyceps militaris* developed by ICAR- Directorate of Mushroom Research (Sharma *et al.,* 2020). Table 1 and Figure 1 provide the standardized raw material requirement for *C. militaris* in-vitro cultivation. The economics and financial feasibility analysis is conducted as per the standard technology developed by Kumar *et al*. (11). The growers are divided into small (<15 Kg dried per cycle), medium (15-50 Kg dried per cycle), and large (>50 Kg dried per cycle) using Cumulative Square Root Frequency (CSRF) Method.

Table 1. Raw material required for cultivation

Material	Quantity
Liquid spawn	
Distilled water	1 l
Dextrose	20 g
Yeast extract	10 g
Peptone	10 g
C. militaris culture	
Substrate preparation	
Basal medium: Brown rice	30 g
Nutrient solution	35 ml

Source: Sharma *et al.* (2020)

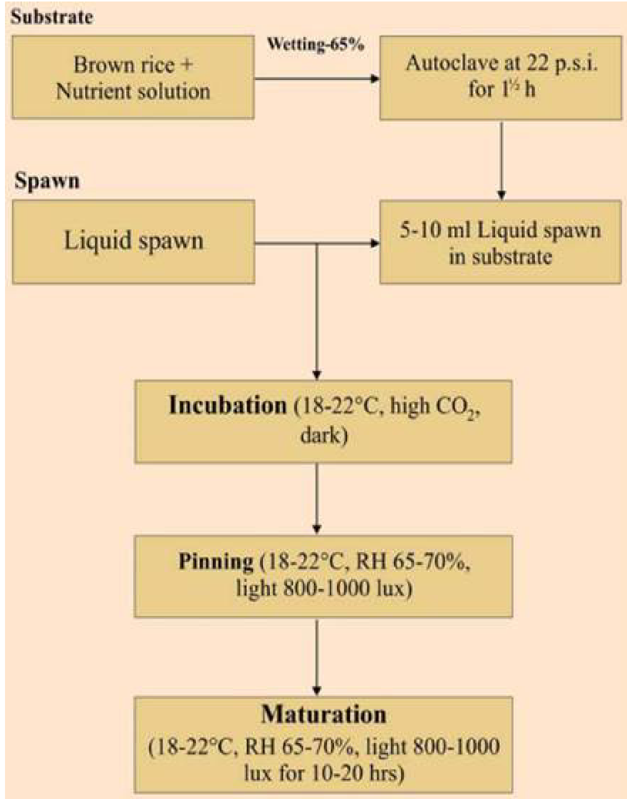

Fig. 1. Standardized technology for *Cordyceps militaris* production: Flow chart (Source: Source: Sharma *et al.*, 2020)

Methodology

1. Economic analysis

Total Cost (TC) can be divided into two parts *i.e.* Fixed Costs (FC) and Variable or Recurring Costs (VC)

i. Initial Investment or Fixed Expenses: Fixed costs are expenses that remain constant irrespective of the production level and do not change in the short term. They include depreciation and interest on fixed capital. Depreciation was calculated using the Capital Recovery Cost (CRC), which is the annual payment needed to recover the fixed cost over the useful life of fixed assets while warranting economic returns on investment. It may be given as:

$$R = Z \left[\frac{(1+r)^n r}{(1+r)^n - 1} \right]$$

Where
R = CRC,
Z = Initial value of asset,
n = useful life of assets,
r = market interest rate

Variable cost (VC): These costs fluctuate based on the capacity or the production level of the mushroom unit. They include the raw material costs, labour wages, and other sundry expenses, etc.

Total Returns (TR): Output x Price (output)
Total cost (TC): FC + VC
Net Profit (NP): TR - TC
Profit on Variable Cost (POVC): TR- VC

2. Financial viability

An analysis of the financial performance of the sample units was employed to evaluate the feasibility of various mushroom unit sizes. The operating ratio indicates the enterprise's efficiency in managing operating expenses while generating ample revenue by associating variable costs to total returns, as below

$$\text{Operating Ratio} = \frac{\text{Total recurring costs (VC)}}{\text{Total Returns (TR)}}$$

Further, in order to assess the profitability and viability of the unit, Benefit-Cost Ratio (BCR) was computed as a financial metric that by comparing the present worth of total returns from mushroom cultivation to current value of total costs incurred during production. It is calculated as:

$$BCR = \frac{\text{PW (Discounted Benefits)}}{\text{PW (Discounted Cost)}} = \frac{\sum_{t=0}^{N} \frac{CF_t \text{ (Benefits)}}{(1+r)^t}}{\sum_{t=0}^{N} \frac{CF_t \text{ (Costs)}}{(1+r)^t}}$$

Where,
BCR = Benefit-Cost Ratio
CF = Cash inflows & outflows in a given period
PW = Present Worth
r = Rate of discount
t = Year during which the cash flows occur
N = Time period.

3. Assessment of economic feasibility: Break-Even Point (BEP) and Safety Margin (MoS)

Every enterprise must determine the minimum output quantity required to cover its costs. This helps in handling risks, setting accurate short long-run targets, and determining an appropriate financial plan for the enterprises. The breakeven quantity of units was computed as:

$$BEP = \frac{TFC}{AP - AVC}$$

where,
TFC = Total Fixed cost (Rs.)
AVC = Variable cost per unit of output (Rs/kg dried)
AP = Average sales price of Cordyceps (Rs/kg dried)

$$MoS = \frac{\text{(Actual Sales – Break Even Sales)}}{\text{Actual Sales}}$$

Cultivation of *Cordyceps militaris,* just like any other agribusiness, is prone to risks and uncertainties. Hence a break even analysis defines the minimum level of economic viability and margin of protection or safety (MoS) *i.e.* how much the cultivator can stand decreased sales before reaching BEP. The cultivation of *Cordyceps militaris*, just like any other agro based enterprise, is subject to market and production based risks and uncertainties. Therefore, an assessment of the required break-even quantity determines the minimum acceptable level of viability and the safety margin i.e. the difference between the actual sales and the sales at breakeven point, which indicates the quantity by which the sales can be reduced before reaching the break-even point, when there us neither profit nor loss. A higher MoS indicates reduced losses and better financial stability for the enterprise.

RESULTS AND DISCUSSION

Cordyceps militaris mushroom cultivation: Economic assessment

Table 2 shows the fixed costs (depreciation & interest on fixed capital) associated with Cordyceps mushroom production units at different scales/ unit sizes—S: Small scale units, M: Medium scale units and L: Large scale units, on the basis of amount of dried mushrooms produced per crop cycle. The average fixed cost is Rs. 18171/ kg (small units), Rs. 7774/ Kg (medium units), and Rs. 5210/ Kg (large units).

Table 3 presents the economics *i.e.* costs and returns from cultivation of Cordyceps mushroom. On an average, fixed costs account for 31% of the total cost on average, being highest for small units (Rs. 18,000/kg), followed by medium (Rs. 7,000/kg) and large units (Rs. 5,000/kg). Variable expenses, including liquid media, liquid spawn, brown rice, man power, and electricity, were also highest for the small-scaled units (Rs. 27,000/kg), followed by medium (Rs. 21,000/kg) and large units (Rs. 17,000/kg). This reflects economies of scale in the cultivation of Cordyceps mushroom. The law of economies of scale states that with the increase in production scale, average costs decline, thus, leading to higher net profit for large scale units.

Financial viability assessment

Due to high initial investment on building and machinery, it is crucial to evaluate the economic sustainability of Cordyceps cultivation units. Table 4 provides an analysis of their financial viability. The operating ratio reflects how well the units control their recurring expenses while earning profits. All units fall within the optimal operating ratio range. The Benefit-Cost Ratio (BCR) is highest for larger units, indicating a return of Rs. 4.36 for every rupee invested.

Evaluation of economic viability: BEP and MoS analysis

Operational size of the sample mushroom units plays a vital role in determining their break-even point (BEP). Figure 2 illustrates the BEP for all the units,

Table 2. Fixed Cost of Cordyceps mushroom production across unit size: CRC method

Unit	Fresh production (Kg)	Dried (Kg)	Fixed cost of infrastructure (Rs./ Kg/ crop cycle)	Fixed cost of machinery (Rs./ Kg/ crop cycle)	Total fixed cost per cycle (Rs./ Kg/ crop cycle)
S (3-10 Kg dried)	25	3	12780.51	17383.15	29141.23
S	51	6	7987.819	8691.58	8691.58
S	25	3	14058.56	2317.75	11903.14
S	50	6	4792.692	8691.58	19874.52
S	25	3	19170.77	13906.52	21245.33
Average	35.2	4.2	11758.07	10198.12	18171.16
M (11-50 Kg dried)	180	21	9585.38	4966.62	14704.78
M	130	15	11182.95	5794.38	5794.38
M	200	25	7338.81	3893.83	6949.17
M	250	32	10845.53	3259.34	6134.96
Average	97.12	11.82	9738.17	4640.94	7774.76
L (>50 Kg dried)	700	80	3055.34	5290.53	5290.53
L	750	90	2875.61	2172.89	5228.24
Average	193.72	23.08	2965.48	2245.32	5210.8

Table 3. Economic assessment: Cordyceps mushroom cultivation

Particulars	**Classes per unit scale (Rs 000/ Kg/ cycle)**			
	S	**M**	**L**	**Overall**
Dried production Kg/ cycle	**<15**	**15-50**	**>50**	
Total Fixed Cost (CRC)	18.17 (40.57%)	7.77 (27.11%)	5.21 (23.18%)	10.39 (30.28%)
Variable Cost				
Raw material	4.86 (10.84%)	4.37 (15.22%)	4.25 (18.91%)	4.99 (14.99%)
Liquid media	10.39 (23.19%)	10.58 (36.88%)	10.09 (44.88%)	10.35 (34.98%)
Liquid spawn	0.96 (2.14%)	0.90 (3.15%)	0.89 (3.94%)	0.92 (3.08%)
Energy cost	5.42 (12.09%)	2.29 (7.99%)	0.76 (3.40%)	2.82 (7.83%)
Labour cost	2.86 (6.38%)	1.86 (6.49%)	1.06 (4.71%)	1.93 (5.86%)
Other costs	2.14 (4.78%)	0.91 (3.16%)	0.22 (0.97%)	1.09 (2.97%)
Total Variable Cost	26.62 (59.43%)	20.91 (72.89%)	17.27 (76.82%)	21.60 (69.72%)
Gross Cost	44.79 (100.00%)	28.68 (100.00 %)	22.48 (100.00%)	31.98 (100.00%)
Gross Returns	39.00	37.00	40.00	38.67
Net Returns	-5.79	8.32	17.52	6.68
ROVC	12.38	16.09	22.73	17.07

Figures in parenthesis show corresponding share in total expenses

Table 4. Measures of economic feasibility of Cordyceps mushroom units

Parameters	**Optimum**	**Small**	**Medium**	**Large**	**Overall**
Operating ratio	<1	0.68	0.57	0.43	0.64

Calculation of BCR			
Cash inflows/ out flows	**Small**	**Medium**	**Large**
Initial investment	3420000	8060000	13500000
Annual cash flows	660000	3484000	13600000
Years	5	5	5
Discount rate	5%	5%	5%
PW of cash outflows (sum)	3420000	8060000	13500000
PW of cash inflows (sum)	2,857,454.60	15,083,896.72	58,880,882.72
BCR	0.84	1.87	4.36

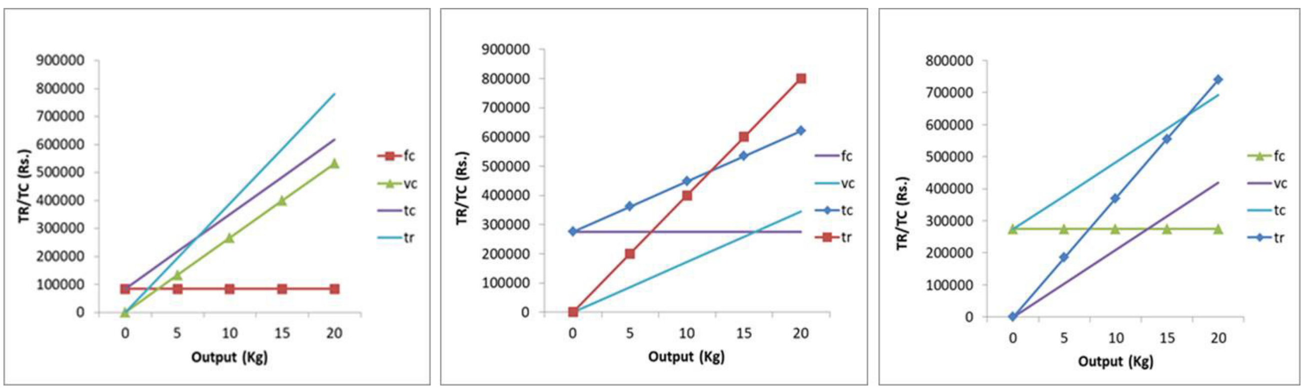

Fig. 2. BEP of Cordyceps militaris cultivation across different production scale classes

Table 5. Break Even output and MoS analysis

Parameters	Unit	S	M	L	Overall
Actual production	Kg	4	23	85	37.00
Break even production	Kg	7	15	12	11.00
Actual Sales	Rs lakhs	1.64	8.58	34.00	14.74
Break Even sales	Rs 000	2.69	5.47	4.83	4.33
MoS	%	-64.44	36.24	85.78	19.20

which is 7 kg for small, 15 kg for medium, and 12 kg for large *Cordyceps* mushroom units. At this production level, total returns cover all the costs, resulting in neither profit nor loss. Hence, these quantities represent minimum threshold the units can work at without incurring any loss. Smaller units have lower BEP due to relatively high costs, while medium and large units benefit from economies of scale, reducing the production quantity required to break-even.

Table 5 shows the specifics of BEP assessment. The total income is around 14 lakh as opposed to the break-even revenue of Rs. 4 lakh. Small-scaled units have a negative MoS (-64.44%), signifying that their actual output is way below their BEP. This suggests that these units face substantial challenges in terms of high initial investment requirements, capacity underutilization, and augmented financial risk. These units should scale up production and improve their operational efficiency to become economically viable. On the contrary, medium and large units have positive MoS *viz.* 36% and 86%, respectively, showing better profitability and financial stability.

CONCLUSION AND WAY FORWARD

The economic viability of Cordyceps mushroom cultivation in India is contingent on achieving an optimal production scale due to its high initial investment requirements. Its exceptional medicinal worth and high market price makes it a lucrative agribusiness enterprise. India has lately initiated *in vitro* cultivation of *Cordyceps militaris* mushroom, bestowing significant potential for economic and nutritional benefits. To speed up its adoption, directed and targeted interventions such as practical training, financial inducements, and supportive policy frameworks are need of the hour. Though the adoption is still in a nascent stage, it is important to study its technical efficiency, allocative efficiency, constraints, supply and value chain, which are a few untouched research problems in Indian mushroom cultivation. Thus, establishing an integrated value chain, fostering backward and forward market linkages, and promoting research and development will further augment the profitability sustainability of this “soft gold” mushroom.

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