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Economic aspects of button mushrooms in Mid-Hills of Himachal Pradesh

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ABSTRACT
Button mushroom cultivation in Himachal Pradesh is economically significant, providing a profitable venture for farmers, contributing to rural income generation, and offering a valuable source of protein and other nutrients. The present study was designed with the primary objective of examining the economics of button mushroom cultivation in the study area. Primary data were collected from 60 mushroom growers residing in 7 randomly selected blocks of the purposively chosen Kangra district. The respondents were categorized into two groups, small and large, based on the number of compost bags they maintained, using the cumulative square-root frequency method. The results indicated that the fixed cost of production per 100 bags varied from 32.80% on small farms to 22.97% on large farms, while variable costs ranged from 67.20% on small farms to 72.21% on large farms. The gross return per 100 bags of button mushroom ranged from Rs. 40,587 to Rs. 47,109, whereas the net return over total cost per kilogram varied from Rs. 34.08 to Rs. 63.73 on small and large farms, respectively. The break-even output, where growers neither made a profit nor incurred a loss, was 100 kg overall, with 150 kg for small farms and 69 kg for large farms. Factors influencing mushroom production included the number of compost bags, human labor, expenditure on plant protection materials, and the management index, which are significant variables affecting production on the sampled farms.

Contribution/Originality: The study examines the output-input ratio, revealing how much profit farmers make for every rupee invested in mushroom cultivation. It also details the costs of various inputs such as compost, spawn, and labor, as well as the net returns per unit of production (e.g., per 100 bags). The research assesses the overall economic feasibility of mushroom farming in the mid-hills of Himachal Pradesh, using metrics like the benefit-cost ratio and break-even point. Additionally, the study highlights various significant factors that influence production and productivity. Estimates indicate that an adopter could generate a net income of Rs. 25,525 per 100 bags over variable costs.

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1. INTRODUCTION
Agriculture is the primary source of livelihood and employment for the majority of the rural population in Himachal Pradesh. The average size of landholdings in the state has been continuously decreasing, from 1.21 hectares in 1990-1991 to 0.98 hectares in 2015-2016. Under this situation, the scope for increasing the scale of operation and

diversifying cropping systems on a commercial scale becomes limited. Efforts are being made by various stakeholders to promote the intensification and diversification of cropping systems to make them more profitable and employment-generating; however, the expected benefits are not being fully realized, as the majority of landholdings in the state are marginal and small (86%). Considering that intense diversification of crop enterprises on a commercial level is not feasible under limited land resources, there is a need to adopt allied agro-based enterprises that do not compete with land and other farm resources. Such enterprises include mushroom production, small-scale dairy, poultry, etc. Himachal Pradesh, with its diverse agro-climatic conditions, is suitable for cultivating different types of mushrooms. The most commonly grown mushroom in the state is the button mushroom; however, in recent years, oyster and milky mushrooms are also being cultivated by farmers in relatively warmer climatic conditions (>25°C).

Studies indicate that button mushroom cultivation is a profitable venture in Himachal Pradesh, with farmers achieving a good net return on investment. Mushroom farming is a secondary source of income for many rural families, particularly for landless farmers or those with small landholdings, as it requires only a small area. Mushroom production creates employment opportunities in rural areas, contributing to the livelihoods of the local population. Button mushrooms are a good source of protein and other essential nutrients, making them a valuable food source, especially for vegetarians. The state's agro-climatic conditions are suitable for mushroom cultivation, including button mushrooms, which have the potential for export and earning foreign exchange. The cost of cultivation is relatively low, and the yield is high, making mushroom farming a cost-effective venture. The spent mushroom compost can be used as good manure for other field crops, further enhancing its economic value. Mushrooms are highly palatable and are very good for health as well. They contain rich amounts of various proteins, vitamins, minerals, etc. Mushroom production is gaining popularity among farmers, women, and youths in Himachal Pradesh. Thus, button mushroom cultivation in Himachal Pradesh is economically important, providing a profitable venture for farmers, contributing to rural income generation, and offering a valuable source of protein and other nutrients.

The raw materials required for its cultivation are easily available at both household and commercial levels from crop by-products, i.e., wheat straw and paddy straw. The spawn and compost are also readily accessible from institutional and commercial entrepreneurs operating within the state. To enhance technical skills in production, need-based training is being provided by the state department of agriculture/horticulture, SAU, KVK, etc.

With the increase in awareness among the people about the nutritive value of mushrooms, their demand is increasing continuously. As the demand side increases, farmers with fewer land resources are shifting towards this enterprise. Therefore, it is important to look after its economic feasibility, costs, returns, and factors affecting its production. Hence, a study was organized in Kangra Valley of Himachal Pradesh with the objective of examining the production and economics of button mushrooms in the mid-hill region.

2. LITERATURE REVIEW

Acharya and Tiwari (2021) noted the current state of mushroom cultivation and related businesses in the land areas of Kalika Municipality and Bharatpur Metropolitan City. Different analytical tools were used to analyze the data. The study found that spawn costs the highest percentage of investment, followed by straw costs and depreciation of equipment. The average production of oyster mushrooms in the Chitwan district was determined to be 4,307.71 kg per Kattha. The oyster mushrooms yielded a gross return of Rs. 808,966.61, with a total cost of production of Rs. 318,089.61. In the Chitwan district, mushroom cultivation was regarded as a lucrative agricultural endeavor with a BC ratio of 2.54. It was discovered that the majority of farmers sell their mushrooms to neighborhood whole vendors and collectors. According to the survey, farmers do not employ any value-adding strategies that would increase their profit.

Ahmed and Rahman (2008) carried out their research in Bangladesh and reported that 49.8 percent of the population lives below the poverty line. They found that increased population and reduced income are some of the causes of poverty, which can be alleviated through mushroom cultivation. By adopting this enterprise, the average net profit calculated was Tk. 29,300.00, which was higher than that from rice and wheat cultivation. They concluded that farmers have cultivated mushrooms on a modest scale and reaped direct benefits in various parts of Bangladesh. They succeeded in adopting the technology in a straightforward manner that allows for small-scale investments. Most farmers used agricultural waste, primarily straw from paddy and wheat fields.

Barmon, Sharmin, Abbasi, and Mamun (2012) determined mushroom profit, BCR, and household income as benefits while developing some problems associated with mushroom production in Bangladesh. The results show that the average production cost of a mushroom per farm was Taka 41,948, and the revenue was Taka 64,826. The mean BCR per mushroom unit was approximately 1.55. It was analyzed that marketing costs and profit margins are fairly higher than those in the case of any other agricultural product. Following the study, producers faced a wide range of production-related problems, including high costs of spawn, infestation of flies and cockroaches, as well as high-temperature marketing, technical, and awareness challenges.

Bashir, Vaida, and Dar (2018) analyzed that over 33 types of mushrooms are cultivated commercially around the globe, with three of them being widely grown in India: white button, oyster, and paddy straw mushrooms. White button mushrooms account for 90–92 percent of India's total mushroom production; the remaining portion is supplied by paddy straw mushrooms and oyster mushrooms. The study was organized in three districts of Kashmir, and it was found that 90 percent of women in the district of Anantnag and 1 percent of women in Kulgam and Pulwama felt that the increased income from mushroom farming had improved their standard of living. The majority of women in the districts of Anantnag, Kulgam, and Pulwama have achieved financial independence as a result of mushroom farming. 99 percent of women in district Pulwama and 100 percent of women in districts Anantnag and Kulgam were able to fully support their families and provide their children with a healthy diet and good education because of improved revenue from mushroom cultivation.

Boin and Nunes (2017) conducted a study in Portugal where data was collected on the basis of the rate of consumption, consumption by form (fresh, canned, frozen, and dried), and consumption by species (five farmed and four wild mushrooms). Regression models were used to determine the results. The results indicated that there was a higher (81.9%) consumption of canned than fresh and dried/frozen mushrooms. The characteristics that had the greatest impact on consumption were gender, degree of education, and size of the household.

Bringye, Tóth, and Nagy (2021) conducted to investigate various aspects of mushroom-related consumer behavior in Hungary. A total of 1,768 samples were collected, and groups of connecting variables describing mushroom consumption were identified using exploratory factor analysis. The study revealed four aspects of Hungarian consumer behavior: (1) medicinal and functional qualities; (2) enjoyment-based consumption; (3) additional food source; and (4) unfavorable evaluation of the product line. Additionally, three categories of consumers were distinguished through cluster analysis: typical consumers, indifferent consumers, and health-conscious consumers. The results indicated that socio-demographic attributes such as age, educational attainment, marital status, and place of residence significantly influence consumers' mushroom consumption behavior.

Celik and Peker (2009) examined the advantages, disadvantages, and SWOT of mushroom growing as a means of diversifying rural income in a study carried out in Konya. The average production area was 1135.1 m^2 and the average yearly income was 45.4 kg/m^2 and compost output was 256.6 kg/ton. The study showed that the average cost of 1 kg of mushrooms was USD 1.36 and the average sales price was USD 1.54. The study concluded that boosting mushroom production is crucial for maintaining the health and growth of the rural economy, expanding and diversifying business and employment opportunities in rural areas, and providing small family farms and underprivileged groups with income opportunities.

Chrishti, Muhammad, Ashfaq, and Hassan (2000) investigated the financial position of mushroom producers in the Rawalpindi and Islamabad region of Pakistan.The findings indicated that there were statistically significant differences in the variable costs between small and medium farms as well as between small and large farms.The larger farm holdings, which comprised medium and large farms, had the power to lower costs by bargaining on the purchase of bulk and by reinvesting money that could have been otherwise used on handling and shipping.Net profits per unit area of large farms (3000 sq. ft.) were higher than those of small farms.The study suggested that mushroom farming cannot be carried out successfully as a viable business unless the private sector builds large farms instead of small ones.

Kangotra and Chauhan (2014) revealed in their research that the majority of the sampled mushroom farmers, who were largely middle-aged and typically between the ages of 40 to 60, had 6-7 years of experience, with the rest having 5 years of experience. The results of the financial test ratios indicated that growing mushrooms on a large scale was more economically feasible and profitable due to larger investments and improved marketing connections with suppliers, which guaranteed a sufficient and consistent supply of produce. The major limitations reported were scarcity of spawned compost bags, poor quality spawned compost material, absence of remunerative prices, and the prevalence of diseases. The study proposed growing at least two crops annually with timely delivery of high-quality spawned compost bags at reasonable prices to their doorsteps to increase the output.

Kamra and Bhatt (2013) conducted a study on *Ganoderma lucidum* species of mushroom to create an organic farming method using polypropylene bags in a subtropical environment. The study showed that the spawn run took 51 days to complete, and after that, spawn sacks were exposed to 90–95 per cent relative humidity and 30°C. It took 67 days to complete the vegetative phase and 92 days to finish the fruiting phase. The crop was planted for a total of 224 days, with a 65-day interval between each flush. The results indicated a total yield of 570 grams, and no pest attack was seen during cultivation. The study recommended growing *Ganoderma lucidum* species under a subtropical climate.

Mohd, Hairazi, and Rozhan (2013) carried out a study in Malaysia to examine the problems and difficulties faced by growers that could slow down its development. Focus group discussions were conducted to learn about participants' perceptions, expectations, and experiences with fresh mushroom cultivation and commercialization in Malaysia. The results of the study showed that government policies, marketing, and production were the three primary areas of concern for this industry. The problems with production included controlling the hot water, obtaining low-quality seeds, and raising production costs. Demand exceeded supply as oyster mushroom growers could not meet the increased demand, which conversely led to an increase in prices in the Klang Valley area. The study recommended some government initiatives in the form of training, subsidies for the production houses, and research and development on the production system to address environmental issues.

Mülazımoğulları and Ceylan (2023) conducted a study in Turkey where the production reported was 55,455 tonnes in 2020. The average producer profit per unit was estimated to be Rs 24.98, whereas the average profit inefficiency was identified as 44 percent. The stochastic profit frontier method was used to estimate the inefficiency score. The results highlight the factors that reduce profit inefficiency, including the producer's gender, level of education, and level of contentment, whereas factors contributing to inefficiency were identified as the farmer's age, the usage of composted manure in the garden, and the sale of mushrooms through middlemen.

Pandey, Rajan, Sarsaiya, and Jain (2020) conducted on the substrate of the mushroom. It examined how commercial mushrooms are supplied with bio-waste, including wood chips, straw, and sawdust. Spent mushroom substrate (SMS) was regarded as a waste product. The study concluded that encouraging research and development is necessary to provide significant advancements that enable the efficient utilization of mushroom bio-resources.

Radhakrishnan, Balan, Indulekha, Simi, and Krishnan (2021) the study was conducted in the Krishi Vighan Kendra laboratory, Wayanad, and involved gathering information from farmers who participated in the mushroom cultivation training course. The research revealed how mushroom experiments were carried out as front-line demonstrations and on-farm testing. *Pleurotus cystidiosus* species of mushroom was preferred after conducting experimental trials due to its higher yield and shorter duration for bud initiation. The results indicated that banana pseudostem waste was considered a suitable substratum for mushroom cultivation in the study area, and the unorganized market structure was identified as the primary challenge faced by farmers.

Ram and Ram (2007) carried out the study in the Gurgaon and Sonepat districts of Haryana to calculate the cost-benefit ratio of mushroom farming. The study found that the fixed capital investment was more than double when comparing large and medium farms to small farms. It also revealed that compost usage and farm size had a positive relationship. Large farmers produced mushrooms at the lowest cost compared to small and medium farmers because they made the best use of their fixed farm resources. The study suggested that mushroom farming requires significant capital and tends to grow as farms increase in size.

Raut (2019) did a study in Nepal to examine the current situation and various problems faced by mushroom growers. He pointed out that lack of improved technology, poor quality of raw materials, pest and disease attacks, insufficient investments, lack of well-organized marketing channels, and high prices of raw materials are some of the main problems faced by mushroom growers. The study also showed the increasing trend of mushroom cultivation output, which was only 30 kg in 1974 and reached 9,300 tonnes in 2016.

Sachan, Gohain, Jawla, Maisnam, and Yadav (2019) the analysis focused on the breakeven point, various costs and their returns, marketing systems, and marketing efficiency in Haryana. The study observed that fixed costs and investments were twice as high for large and medium-sized farms compared to small farms, primarily due to the limited availability of capital among mushroom growers. The size of the farm was closely correlated with the costs of spawn and compost. The largest share of consumer prices was found in Channel I (consumer – mushroom grower), whereas most produce was distributed through Channel IV (mushroom grower – wholesaler – retailer – consumer). The study recommended upgrading infrastructure to extend the crop's shelf life.

Saikia and Bora (2023) in their study, it was revealed that mushrooms provide significant nutritional and functional value, medicinal attributes, nutraceutical importance, and organoleptic potential. The study primarily focused on various challenges faced by mushroom growers in Jorhat district of Assam. A snowball sampling approach was used to select 60 samples. Nineteen problem statements were formulated to investigate the issues encountered by the participants in mushroom cultivation. Respondents were classified as having a low, medium, or high level of problems based on the mean scores and standard deviation. The results showed that approximately 60.00 percent of the participants experienced a medium level of problems.

Sharma, Chauhan, and Thakur (2016) conducted an investigation in Himachal Pradesh district of Mandi where it was found that 80 percent of the mushroom growers cultivate button mushrooms exclusively. The results indicated that for every 100 bags, the fixed cost of production ranged from 44.47 percent to 22.42 percent on small farms to large farms, respectively, whereas on large farms, the variable cost ranged from 77.58 percent to 55.53 percent on small farms. The benefit-cost (BC) ratio calculated was 1.87:1. It was estimated that both small and large farmers had different break-even outputs, ranging from 279 kg to 147 kg. The study concluded that mushroom growers faced many problems, but production issues were more severe than other problems.

Sharma, Vaidya, Dixit, and Sood (2021) in his study, 60 mushroom growers were selected through a simple random sampling method. The mushroom producers were categorized into three groups based on the quantity of bags they produced: Small Group (600 or fewer), Medium Group (601–1200), and Large Group (more than 1200).The literacy rate of all households was 2.69, and 88.25 percent of their members were literate overall.The results revealed that mushroom yield contributed the highest share to overall farm income (43.44%) in the medium and large categories (72.18%), respectively.It is evident from the conducted studies that mushroom was the most contributing crop among all other farm crops, accounting for 49.42 percent of the total income.

Shipra, Kumari, and Kumari (2018) conducted a study on 75 rural women of Samastipur district of Bihar to investigate the effects of mushroom farming on rural women's economic position through skill development. The results of the study indicate that, as a result of training, rural farm women's knowledge of all the subcomponents of mushroom production had improved, which empowered women to raise the standard of life for themselves and their families. It was concluded from the study that the development of entrepreneurship was the best option for rural farm women to achieve economic independence.

Shirur and Chandregowda (2017) analyzed the constraints in mushroom entrepreneurship in the Karnataka state. Sixty mushroom growers were selected, and SWOT analysis was conducted. It was concluded from the case study and SWOT analysis that mushroom entrepreneurs require unique characteristics of entrepreneurial activity, and for success in mushroom entrepreneurship, it requires an understanding of the nuances of mushroom biology, calculating profitability based on the scale of economy, developing creative packaging and marketing ideas, finding ways to reduce energy costs for temperature modulation during cropping, and being personally involved in the business.

Shirur and Shivalingegowda (2016) conducted a research on consumer behavior among people. The study examined the degree of fluctuation in the average selling price across all mushroom kinds, ranging from Rs. 27 to Rs. 40, when sold to consumers, merchants, and wholesalers. No skilled workers, processing facilities, and the high rate of perishability were the main drivers of the surge in prices. The study revealed that the majority of consumers preferred button mushrooms even though they have similar nutritional and therapeutic qualities to other mushrooms because they were inexpensive to grow.

Shirur, Shivalingegowda, Chandregowda, and Rana (2017) studied the impact of the identified variables on the entrepreneurial behaviour of the Karnataka farmers. Four extension variables, six socio-psychological trait features, and five characteristics of farmers and their units were examined to see how they affected the respondents' entrepreneurial activity. Regression analysis model was used in the study. The results of the regression analysis revealed that the respondents' entrepreneurial activity was substantially influenced by their academic background.

Singh (2014) carried out a study by selecting an equal number of wholesalers and retailers from Amritsar and Gurdaspur districts of Punjab to ascertain the marketing structure of mushrooms. The cumulative cube root frequency technique was used to divide the mushroom growers into different categories. The marketed surplus was about 99 percent. The marketing pattern showed that the producer-consumer channel had the greatest net price paid to growers, although the marketing agency that handled the majority of the produced goods was the wholesaler. The study focused on the necessity of refrigeration and canning facilities for mushroom growers in the event of increased production to prevent distressed sales and raising public awareness of the nutritional value of mushrooms to promote their use. Singh et al. (2016) indicated that in the study area, Jammu province four marketing channels were used by the mushroom growers. The study showed that marketing efficiency was highest in the case of the fourth channel (mushroom grower-consumer), followed by the third channel (mushroom grower- wholesaler – consumer), the second channel (mushroom grower – retailer- consumer), and the first channel (mushroom grower – wholesaler – retailer – consumer), with the estimated figures of 1.75, 1.25, 1.16, and 1.06 respectively. It was concluded that, with enough infrastructure and supportive government policies, marketing could have been done more effectively.

Singh and Singh (2018) conducted a study in Amritsar and Gurdaspur districts of Punjab to determine the cost and return structure of white button mushrooms by analyzing 80 samples. The study revealed that as farm size increased, both recurring and non-recurring expenditures per square meter of bed area decreased due to economies of scale. The mushroom farms were categorized based on the input-output ratio, with large farms (1.81) being more productive, followed by medium-sized (1.47) and small-sized (1.35) farms. The results indicated that, owing to higher average price realization, medium-sized farms achieved better gross returns, while large farms had higher net returns due to lower costs. The study recommended farmer training in canning and refrigerated storage facilities, mechanized compost preparation plants, and disinfection of mushroom growing sheds.

Tahir and Hassan (2013) conducted a study on the profitability of button mushroom production on a small scale at the National Agricultural Research Centre in Islamabad, Pakistan, in 2010. For this analysis, the cost of production methodology was applied. Estimates for mushroom output and gross returns were 155.6 kg ha^{-1} and Rs 77,800 ha^{-1}, respectively. The findings indicated that mushroom production is highly profitable for growers, as it can maximize net returns by reducing production costs due to the crop's reliance on inexpensive agricultural raw materials.

Thakur (2014) studied the characteristics of mushrooms and analyzed that enzymes secreted by mushroom mycelia degrade substances including cellulose and lignin, which are subsequently taken up by the hyphae. The study indicated that India and several other developing nations have significant potential for mushroom production because the necessary raw materials are readily available at low cost. Mushroom cultivation functions as a vehicle for creating jobs, especially for young people and women from remote areas, thereby improving their social standing. Tropical mushrooms, such as oyster (Pleurotus spp.), paddy straw (Volvariella volvacea), and milky mushroom (Calocybe indica), are produced using agricultural wastes that are readily available in the area, such as paddy straw, wheat, soybean, chickpea, mustard, lathyrus, cotton wastes, and lignocellulosic wastes. An estimated 15–20,000 metric tonnes of oyster mushrooms are produced in India. However, only about 10,000 tonnes of milky mushrooms and paddy straw are produced each year. The study found that, on a small to medium scale, oyster mushroom farming is mostly carried out by women in self-help groups, which is a significant source of revenue for them.Thakare et al. (2006) conducted a study on sixty-four growers selected from three districts in the plains of Chhattisgarh: Raipur, Durg, and Bilaspur. The results indicated that the proportion of fixed costs to overall production costs was relatively low (33.58%), with variable costs accounting for 66.42% of the total, and the net return per kilogramme was, on average, Rs. 24.04. Larger farms were found to have the highest input-output ratio, indicating they benefit more than other growers. Lack of spawn and other acceptable mushroom species, as well as lower productivity resulting from a lack of technical know-how, were reported as the main obstacles to mushroom cultivation.

Thus, a review of the economic aspects of mushroom production reveals that it presents a promising opportunity for income generation, particularly for small-scale farmers, due to its high yield per unit area, ability to utilize agricultural waste as a substrate, and relatively low production costs; however, challenges like market volatility, technical requirements, and limited access to quality spawn can hinder its full economic potential, requiring targeted support and infrastructure development to maximize its benefits for rural communities and economies.

3. METHOD AND MATERIALS

The base of any scientific investigation is systematic methodology, which enhances the validity, precision, and reliability of the findings in relation to the research problem. It is essential for conducting quality research work, as it has a direct impact on the reliability of the research findings. Future researchers in the same or similar fields will find it useful to have an elaborative picture of the material and methods used in the study when assessing the data requirements. The methodology used and the various tools that were utilized to obtain and analyze the findings of the research are given hereunder:

3.1. Selection of Study Area

The study was conducted in Kangra district of Himachal Pradesh. This district was selected purposively because the Indo-Dutch Mushroom Project Palampur, which is run by the State Directorate of Horticulture and located at CSKHPKV Palampur, provides spawned compost to mushroom producers in several districts. Secondly, the Centre for

Mushroom Research and Training (CMRT) CSKHPKV, Palampur also provides spawned compost bags and spawn of different kinds of mushrooms, i.e., button and oyster mushrooms. Thirdly, training on many different aspects of mushroom farming is also provided by the Directorate of Extension Education CSKHPKV Palampur. And lastly, a large number of mushroom growers are also present in the district, and no study was conducted in recent years, which is why Kangra district was selected purposively.

3.2. Sampling Design

The primary data for the study was collected from seven randomly selected blocks of the district, namely Nagrota, Sullah, Palampur, Bhawarna, Jaisinghpur, Panchrukhi, and Baijnath, as these blocks are located around Palampur, which is a hub of training and technical know-how on mushroom cultivation and supplying spawned compost bags and spawn of different kinds of mushrooms. Data were collected on various aspects of costs, returns, and production of button mushrooms. A simple random sampling design was employed for the selection of 60 mushroom growers, who were selected randomly from the above-mentioned seven blocks. The selected mushroom growers were categorized into two groups, small and large, based on the number of compost bags they placed, using the cumulative square root frequency method. According to this method, those mushroom growers who kept fewer than 300 compost bags are classified as small, with a total of 40 growers, while those who placed 300 or more compost bags are classified as large, with a total of 20 growers. The rationale behind categorizing mushroom farmers as small or large based on the number of compost bags used is that this serves as a proxy for the size of their operation and production capacity, which impacts resource allocation and support programs. The number of compost bags directly correlates with the volume of mushrooms a farmer can cultivate, and consequently, their potential output and income. Categorizing farmers allows for targeted support and resource allocation. Small farmers may have access to inputs such as compost and spawn, technology, and training, whereas large farmers might benefit from programs focused on market access and expansion. This classification helps policymakers understand the structure of the mushroom farming sector and tailor interventions to meet the needs of different farmer groups. For instance, a farmer using a few hundred compost bags might be considered a small-scale producer, while someone using thousands could be classified as a large-scale farmer. The method for growing button mushrooms follows the guidelines described by the Directorate of Mushroom Research (DMR), Solan, Himachal Pradesh. The complete list of mushroom growers in the district was prepared, and a sample of 60 growers was selected randomly using the simple random sampling method. The distribution of sample mushroom growers is given in Table 1.

Table 1. Distribution of mushroom growers among different categories using the square root frequency method.

Sr.No.	Category	Number of compost bags	Number of mushroom growers	Percentage of mushroom growers
1.	Small	< 300	40	66.67
2.	Large	≥ 300	20	33.33
	Total		60	100.00

3.3. Data Collection

In order to meet the specific requirements of the study, both primary and secondary data were collected. Primary data were collected from 60 mushroom growers, and secondary data were obtained from annual reports of government departments and related websites. A survey schedule was prepared for the collection of detailed primary data, which was pre-tested in two villages within the study area to examine the relevance of questions on different aspects of mushroom cultivation. The primary data were collected through a survey method. The data were gathered using well-designed and pre-tested schedules from the selected mushroom growers via personal interviews. The data pertained to the agricultural year 2023-24. Secondary data were also collected from the statistical outline of Himachal Pradesh, Indo-Dutch Mushroom Project, Palampur, Department of Horticulture, Shimla, and Department of Horticulture, Kangra.

3.4. Analytical Framework

The collected data was compiled properly and analyzed by employing appropriate mathematical and statistical tools. In order to meet the objective, tabular analysis using averages, ratios, and percentages was used to study the input use, costs, and returns. To examine the determinants which affect mushroom productivity, functional techniques such as production functions were also employed.

3.4.1. Cost and Return Analysis

The costs and net returns from mushroom production were calculated in order to determine the economic viability of the mushroom.

(i) Cash variable expenses (recurring expenditure) include the items:

1. Spawned compost bags
2. Packing material
3. Crop protection material
4. Electricity charges
5. Transportation charges
6. Miscellaneous charges (crop washing material, other chemicals, etc.).

7. Interest on variable capital for half of the growth period of the crop, i.e., 1.5 months, at the rate of 12 percent per annum.

(ii) Total Recurring Expenditure (Totals Variable Cost) - Cash variable expenses + Human labor.

(iii) Fixed Cost (Non-Recurring Expenditure).

1. Interest on fixed capital at the rate of 12 percent per annum.
2. Depreciation charges on the mushroom unit at the rate of 2 percent per annum.
3. Depreciation charges on implements at the rate of 10 percent per annum.

(iv) Total Cost.

Total Cost = Recurring Expenditure + Non-Recurring Expenditure.

3.4.2. Returns

3.4.2.1. Computation of Gross Returns

The gross returns were calculated as follows:

$GR=TP_M*P_M$

Where,

GR= Gross Returns from mushroom crop (Rs./100 bags)

TP_M= Total Production of the mushroom (kg)

P_M =Price of the mushroom per kilogram (Rs.)

3.4.2.2. Computation of Net Returns

1. Net returns over variable cost= Gross Returns- Variable Cost
2. Net returns over total cost= Gross Returns- Total Cost

$$3.\ \text{Net returns per rupee of investment} = \frac{\text{Gross returns}}{\text{Total costs}}$$

3.4.2.3. Computation of Benefit-Cost ratio

Benefit-cost ratio implies the amount gained per rupee invested in the inputs used in the production process.

$$\text{Benefit} - \text{Cost ratio} = \frac{\text{Gross returns}}{\text{Total costs}}$$

3.4.3. Break-Even Analysis

The amount of production needed to cover all production costs is known as the break-even output, and output below this level would lead to a net loss for the producer. The break-even output is calculated using the following formula:

$$\text{Break} - \text{even output} = \frac{\text{TFC}}{\text{Py} - \text{AVC}}$$

Where,

TFC = Total fixed cost in rupees.

Py = per unit price of mushroom.

AVC =Average Variable cost in rupees.

AVC = TVC/TP_M.

TVC = Total Variable Cost.

TP_M = Total mushroom production in kilogram.

3.4.4. Functional Analysis

Both linear and Cobb-Douglas functions were tested to examine the factors affecting mushroom output, but it was found that the Cobb-Douglas production function provides more reliable results based on the number of significant variables. The functional form of the Cobb-Douglas production function is given below:

$$Y = \beta_0 X_1^{\beta 1} X_2^{\beta 2} X_3^{\beta 3} X_4^{\beta 4} e^u$$

The above function is linear zed double log form as below:

$$\ln Y = \ln\beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + u$$

Where,

Y= Yield of mushroom (kg/100 bag).

X_1= Number of spawned compost bags.

X_2= = Human labour (man days/100 bags).

X_3= Crop Protection material expenses (Rs./100 bags).

X_4= Management index which includes factors such as temperature, relative humidity, maintaining hygiene, and formalin spray.

β_0 = Constant term.

u = Random term.

$\beta_1 - \beta_4$ = Elasticity coefficient.

3.4.5. Marketable Surplus

The marketable surplus is the residual left with the producer after meeting their requirements for family consumption, kind payment to labour, and gifts. The marketable surplus of the mushroom crop was estimated as follows:

$MS_i = TP_i - TRi$(i =1, 2, 3…60 growers).

Where,

MS_i = Marketable surplus of mushroom with i^{th}grower.

TP_i = Total production of the mushroom with i^{th}grower.

TRi = Total requirements of the i^{th} mushroom grower.

3.4.6. Marketed Surplus

Marketed surplus was the actual quantity of mushrooms that the producer sold in the market, irrespective of its requirements, and it was estimated as follows:

$MT_i = MS_i - LM_i$.

Where,

MT_i= Marketed surplus by the i^{th}producer.

MS_i=Marketable surplus of the i^{th}producer.

LM_i= Losses incurred by the i^{th} producer.

4. RESULTS AND DISCUSSIONS

4.1. Input use Pattern of Button Mushroom

The various inputs which were used in mushroom production have been presented in Table 2. It can be observed from the table that on the overall farm, 100 compost bags of each category weighing 20 kg were used. The total packing material used for 100 bags on the overall farm was 2.43 kg, with large farms using more packing material than small farms due to higher mushroom production. Plant protection is a crucial step in mushroom production, as it is used to control various diseases and thereby enhance yield. Formalin was primarily used for sterilizing the room before placing the bags. The total quantity of formalin used was 173.45 milliliters per 100 bags, with small farms using 160.30 milliliters and large farms using 186.6 milliliters. Transportation costs were also incurred, totaling Rs 488 across all farms, with small farms incurring higher transportation costs than large farms. Human labor is indispensable in mushroom production. The total labor used for 100 bags was 20 man-days, with small farms using 18 man-days and large farm using 20 man-days. Miscellaneous charges, which include crop washing materials and other plant protection materials, amounted to Rs 380 on the overall farm. Small farms incurred higher miscellaneous expenses (Rs 411) compared to large farms (Rs 366).

Table 2. Input use pattern of button mushroom on sampled farms. (Per 100 bags).

Sr. No.	Particulars	Units	Farm size		
			Small	Large	Overall
1.	Compost bags (20 kg)	Number	100	100	100
2.	Packing material	Kg	2.06	2.59	2.43
3.	Plant protection				
i)	Formalin	Millilitre	160.3	186.6	173.45
ii)	Bavistin	Grams	102.2	100.38	101.29
4.	Electricity charges	Rs.	406	272	312
5.	Transportation charges	Rs.	592	444	488
6.	Human labour (Man days)	Man days	18	21	20
7.	Miscellaneous	Rs.	411	366	380

4.2 Labor Utilization

Mushroom cultivation is a labor-intensive activity as it requires labor from cultivation to harvesting for various purposes such as putting bags into the racks, watering, maintenance, harvesting, washing, and packing, etc. Efficient management by the labor will directly impact the production and profitability of mushrooms. The labor duration engaged in different operations in mushroom production has been converted into man-days in order to calculate labor employment. In this context, Table 3 provides the information on the labour utilization pattern of button mushroom.

It can be seen from the table that the total labor required for performing various operations in button mushroom production varied from 18 man-days on small farms to 19 man-days on large farms per 100 bags. It can also be observed from the table that labor used in the overall farm per 100 bags was highest for harvesting operations, followed by washing and packaging, which accounted for 34.97 percent and 28.47 percent, respectively. The next highest labor usage was found in watering and medicine spray, accounting for 24.83 percent and 8.98 percent. When a comparison was made between small and large farms, it was found that a higher percentage of labor in large farms was used only in the case of watering (26.66%) and washing and packaging (29.62%) than in small farms. The overall family labor used was approximately 16 man-days, with small farms having more man-days (17 man-days) than large farms (15 man-days). Very little hired labor was used on the overall farm for mushroom production, with large farms using more hired labor than small farms.

Table 3. Labour utilization Pattern of button mushroom on sampled farms. (Man days/100bags).

Sr. No.	Particulars	Farm size		
		Small	Large	Overall
1.	Putting bags in rack	0.64 (3.53)	0.47 (2.44)	0.52 (2.75)
2.	Watering	3.67 (20.23)	5.14 (26.66)	4.70 (24.83)
3.	Medicine spray	1.78 (9.81)	1.67 (8.66)	1.70 (8.98)
4.	Harvesting	7.40 (40.79)	6.29 (32.62)	6.62 (34.97)
5.	Washing and packing	4.65 (25.63)	5.71 (29.62)	5.39 (28.47)
	Total Labour	18.14 (100)	19.28 (100)	18.93 (100)
i)	Hired Labour	0.95	4.5	3.43
ii)	Family Labour	17.19	14.78	15.50

Note: Figures in parentheses indicate the percentage to the total in each category.

4.3 Cost Component

The cost required to produce 100 compost bags of button mushroom has been calculated and presented in Table 4. The total cost components were divided into fixed and variable cost components. The fixed cost components include factors such as depreciation charges on the mushroom building and implements, and interest on fixed capital, whereas the variable costs include factors such as outlays on compost bags, packing material, crop protection material, electricity, transportation, labor charges, and miscellaneous charges.

Table 4. Cost of production of button mushroom on sampled farms. (Rupees/100 bags).

Sr. no.	Particulars	Farm size		
		Small	Large	Overall
A.	**Non-Recurring expenditure (Fixed cost)**			
i)	Interest on fixed capital @12%	4,015 (13.41)	2,342 (9.75)	2,845 (10.54)
ii)	Depreciation Charges			
a)	Buildings (@2% p.a.)	2,463 (8.22)	1,178 (4.91)	1,564 (5.79)
b)	Depreciation on implements (@10%)	3,346 (11.17)	1,952 (8.13)	2,963 (10.98)
	Total Fixed cost	9824 (32.80)	5472 (22.79)	7372 (27.31)
B.	**Recurring expenditure (Variable cost)**			
i)	Compost Bags	10,650 (35.56)	9,000 (37.48)	10,100 (37.41)
ii)	Packing material	308 (1.03)	259 (1.08)	274 (1.01)
iii)	Plant protection	203 (0.68)	214 (0.89)	208 (0.77)
iv)	Electricity charges	406 (1.36)	272 (1.13)	312 (1.16)
v)	Transportation charges	592 (1.98)	444 (1.85)	488 (1.81)
vi)	Labour charges	7256 (24.23)	7712 (32.12)	7572 (28.05)
vii)	Miscellaneous	411 (1.37)	366 (1.52)	380 (1.41)
viii)	Total (i to vii)	19,826 (66.20)	18,267 (76.07)	19,334 (71.62)
ix)	Interest on recurring expenditure (variable cost) (@12 % for 1.5 months)	297 (0.99)	274 (1.14)	290 (1.07)
	Total recurring expenditure (Total variable cost)	20,123 (67.20)	18,541 (77.21)	19,624 (72.69)
C.	**Total cost (A+B)**	29,947 (100.00)	24,013 (100.00)	26,996 (100.00)

Note: Figure in parentheses indicates the percentage of the total in each category.

It can be seen from the Table 4 that fixed cost on the overall farm constitutes 27.31 percent of the total cost, with small and large farms constituting 32.80 and 22.79 percent of the total cost, respectively. The table also reflects that the variable cost constitutes 72.69 percent of the total cost, with large farms (77.21%) investing more in variable costs than small farms (67.20%). Similar results were presented by Sharma et al. (2016) from Mandi district of Himachal Pradesh (2016). The investment in compost bags was the major component of the variable cost, amounting to Rs 10,100 per 100 bags, i.e., 37.41 percent of the total cost. The next highest investment on the overall farm was made in human labor, followed by transportation charges, with percentages of 28.05 percent and 1.81 percent of the total cost, respectively. When comparing small and large farms, it can be observed that the percentage of investment in compost bags and labor was higher in large farms than in small farms. The investment in crop protection material accounted for 0.77 percent of the total investment.

4.4 Costs and Returns Analysis

The costs and returns of button mushroom have been presented in Table 5. It can be seen from the table that the total production of mushrooms per 100 compost bags was higher on large farms (362.38 kg) than on small farms (312.21 kg). The gross returns showed a positive relation with the size of the farm. The gross returns of large farms were Rs. 47,109, whereas for small farms, it was Rs. 40,587. Similarly, net returns also increase with the increase in farm size. The net returns over total cost and variable cost per 100 bags of small farms amount to Rs. 10,640 and Rs. 20,464, respectively, whereas for large farms, they were Rs. 23,096 and Rs. 28,568, respectively. The net returns per kg over total cost and variable cost were Rs. 52.27 and Rs. 73.50, respectively. The benefit-cost ratio of button mushroom on the overall farm was 1.67, with small farms having 1.36 and large farms 1.96, respectively.

Table 5. Return and benefit cost analysis of button mushroom on sampled farms.

Sr. No.	Particulars	Units	Farm size		
			Small	Large	Overall
1.	Total cost	Rupees/100 bags	29,947	24,013	26,996
i)	Fixed cost	Rupees/100 bags	9,824	5,472	7,372
ii)	Variable cost	Rupees/100bags	20,123	18,541	19,624
2.	Total production	Kilograms/100bags	312.21	362.38	347.3
3.	Gross Returns	Rupees/100bags	40,587	47,109	45,149
4.	Net returns over total cost	Rupees/100bags	10,640	23,096	18,153
5.	Net return over total cost	Rs/kg	34.08	63.73	52.27
6.	Net returns over variable cost	Rupees/100bags	20,464	28,020	25,525
7.	Net return over variable cost	Rs/kg	65.55	78.83	73.50
8.	Net returns per rupee of investment	Rupees	0.36	0.96	0.67
9.	Benefit-Cost ratio	Ratio	1.36	1.96	1.67

4.5 Break-even Analysis

Break-even output is the level of output at which the mushroom grower will neither face profit nor loss. The break-even analyses of button mushroom under different categories of farms have been presented in Table 6. Break-even output for small and large units in the table reveals that if small units receive 150 kg of mushrooms valued at Rs. 19,500, then these units will be at a no-profit-no-loss situation under the given input and output. Similarly, the large farms will be at a no-profit-no-loss situation when they produce 69 kg of mushrooms valued at Rs. 10,350. The large farms had less break-even output because of low average variable cost of production of Rs. 51.16 per kg. At the overall level, the break-even output was achieved at 100 kg of mushroom production. The break-even output in terms of the number of compost bags placed reveals that the small and large farms will be at a no-loss-no-profit situation if they place at least 50 and 23 compost bags, respectively.

Table 6. Break-even analysis of button mushroom on sampled farms. (Rupees per 100 bags).

Sr. no.	Particulars	Farm size		
		Small	Large	Overall
1.	Cost of production			
i)	Fixed cost	9,824	5,472	7,372
ii)	Variable cost	20,123	18,541	19,624
iii)	Total cost	29,947	24,013	26,996
2.	Average variable cost	64.45	51.16	56.50
3.	Total production (kg)	312.21	362.38	347.3
4.	Selling price of mushrooms (Rs/Kg)	130	130	130
5.	Break-even output(mushrooms in kg)	150	69	100
6.	Break-even point (No. of compost bags)	50	23	33

4.6 Production Function Analysis

In order to determine the input-output relationship in mushroom cultivation under different categories of farm sizes, regression analysis was carried out. The Cobb-Douglas production function was shown to be a better fit based on its adjusted coefficient of multiple determination value and the number of significant variables. The factors affecting mushroom yield and used in the regression analysis were the number of compost bags (X1), labor used in man-days (X2), expenditure on crop production material (X3), and management index (X4), which includes maintaining temperature, relative humidity, hygiene, and formalin spray. The regression coefficients, their standard errors, degrees of freedom, and the value of the adjusted coefficient of multiple determinations for mushrooms are provided in Table 6.

Table 7. Factors affecting mushroom production: Results of Cobb-Douglas production function.

Sr. no.	Particulars	Regression coefficient	Standard error	t-value
1.	Compost bags (X1)	1.0528*	0.0620	16.98
2.	Labor (X2)	0.1091*	0.0406	2.69
3.	Expenditure on crop plant protection material (X3)	-0.0753	0.0547	-1.37
4.	Management index (x4)	0.5169*	0.2584	2.02
5.	Constant term	-0.9196		
6.	Adjusted coefficient of multiple determination	0.9786		
7.	T table	2.004		
8.	Degree of freedom	55		

Note: *Significant at 5 percent level of significance.

The Table 7 revealed that the most important variables influencing mushroom production were the number of compost bags (X1), labor (X2), and management index (X4). A 1 percent increase in the number of compost bags (X1) would result in a 1.0528 percent increase in mushroom yield. Similarly, a 1 percent increase in labor (X2) and the management index (X4) would increase mushroom yield by 0.1091 and 0.5169 percent, respectively. The table further indicated that expenditure on crop protection material had a significantly negative impact on mushroom production. This suggests that reducing this input could potentially increase profit from mushroom cultivation. The adjusted coefficient of multiple determinations at the farm level was 0.9786, implying that nearly 97 percent of the variation in mushroom production was explained by these three independent variables, while the remaining 3 percent was attributable to variables not included in the model.

4.7 Production and Disposal Pattern

The production and disposal pattern of button mushroom on sampled farms has been presented in Table 8. The table revealed that the overall production of button mushrooms was 8.36 quintals per farm, with small and large farms producing 3.39 and 18.3 quintals per farm, respectively. Out of the total production, the overall self-consumption was 1.91 percent, with small farms having a higher self-consumption rate than large farms. Approximately 1 percent of the total production was given to relatives, neighbors, and friends as gifts. When comparing small and large farms regarding payments made to labor, it was higher in large farms (0.38%) than in small farms (0.09%). There was a positive relationship between the marketed surplus and farm size, as evidenced by the table. The marketed surplus of large farms (95.19%) exceeded that of small farms (91.45%). The overall marketed surplus was found to be 94.26 percent. It was concluded that, out of the total production, about 94 percent was available for sale, while the remaining 3 percent was used for other purposes such as home consumption, gifts to relatives, friends, and neighbors, as well as kind payments. Additionally, there was an approximate 3 percent loss across all farms.

Table 8. Production and disposal patterns of button mushrooms on sampled farms (Quintal/Farm).

Sr.no.	Particulars	Farm size		
		Small	Large	Overall
1.	Production	3.39 100	18.3 100	8.36 100
2.	Self-consumption	0.14 (4.13)	0.22 (1.2)	0.16 (1.91)
3.	Payment in kinds	0.003 (0.09)	0.07 (0.38)	0.02 (0.24)
4.	Gifts	0.04 (1.18)	0.08 (0.44)	0.05 (0.6)
5.	Marketable surplus	3.21 (94.69)	17.93 (97.98)	8.13 (97.25)
6.	Losses	0.11 (3.24)	0.51 (2.79)	0.25 (2.99)
7.	Marketed surplus	3.1 (91.45)	17.42 (95.19)	7.88 (94.26)

Note: Figures in parentheses indicate the percentage to the total in each category.

5. CONCLUSION

With the ever-increasing demand for quality foods, mushroom cultivation is emerging as an important activity in different parts of the country, as was evident from the ever-proliferating research studies. This activity requires very little land and can be a source of employment for small and landless farmers, educated youth, and women. With this background in view, the study was undertaken with the objective of examining the cost of production and their returns, benefit–cost ratio, break-even analysis, parameters affecting mushroom productivity by employing Cobb-Douglas production function, and the pattern and disposal of button mushrooms in Kangra district of Himachal Pradesh, which were selected purposively. In this study, first the farmers were categorized into two categories, small (<300 bags) and large (> 300 bags); based on the number of compost bags they kept by using cumulative square-root frequency method. 60 respondents were selected purposefully from 7 randomly selected blocks of the district for primary data collection on various aspects of button mushroom production. The results revealed the following points:

a. The fixed cost of production per 100 bags was higher in small farms than in large farms, varying from 32.80 percent in small farms to 22.79 percent in large farms. Large farms had a lower total cost of production, i.e., Rs. 24,013, compared to Rs. 29,947 in small farms, due to more efficient utilization of resources by the large producers.
b. The gross return of button mushrooms per 100 bags ranged between Rs. 40,587 and Rs. 47,109 on small and large farms, respectively.
c. The overall net return over total cost and variable cost per kg of mushroom showed a positive relation with the size of the mushroom unit.
d. The benefit-cost ratio on the overall farm was 1.67, with small farms at 1.376 and large farms at 1.96, respectively.
e. At the overall level, the break-even output for button mushroom was achieved at 100 kg of production by placing 33 compost bags.
f. The marketable surplus of button mushroom was 3.21 q/farm on small farms and 17.93 q/farm on large farms, whereas the marketed surplus was 3.10 q/farm and 17.42 q/farm, respectively.
g. In relation to factors affecting mushroom production, Cobb Douglas's Production Function was run, which indicated that the number of compost bags, labor used, expenditure on crop protection materials, and management index are the significant determinants of mushroom production and productivity, suggesting that these factors would lead to increased mushroom production and productivity of button mushrooms if any one or all of these variables are increased simultaneously.

5.1. Limitations

As every research study has its own limitations, so was this study. The findings are specific to the Kangra valley and may not be generalizable to other regions. However, a scientific approach was used to conduct this investigation. Like with every socio-economic survey, there are bound to be some limitations that cannot be ignored. The study was based on only 60 mushroom growers selected randomly from the list of mushroom growers, due to limited time and other constraints. Since the sample mushroom growers did not maintain any records, the information was only collected through personal interviews, and they provided the information based on memory and prior experiences. The possibility of some slips from the memory of the respondents cannot, however, be ruled out.

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Transparency: The authors state that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics.
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