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RESEARCH ARTICLE

FINANCIAL FEASIBILITY ANALYSIS OF PLEUROTUS MUSHROOM CULTIVATION USING DIFFERENT SUBSTRATES

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ABSTRACT

The study aims to evaluate the financial feasibility of cultivating Pleurotus mushrooms using various substrates including rice straw, maize stalk, banana leaves, and tree leaves. The financial analysis includes Gross return, Net return, IRR, B/C ratio, R/C ratio, and payback period followed by sensitivity analysis where the prices and gross returns are increased and decreased by 10%. Additionally, the study examines the BC ratio for each substrate. Benefit cost ratio is 1.23 indicates that mushroom cultivation is a profitable venture. The sensitivity analysis shows that the financial performance of mushroom cultivation is sensitive to changes in cost and gross return. So, increase or decrease in cost and gross return influence the outcomes of an investment. The cost was recovered in the first two harvests, which took approximately 2 months. Therefore, the payback period is determined to be two months. Among substrates evaluated, rice straw emerges as the most feasible option followed by maize stalk. On the other hand, banana leaves and tree leaves are less efficient in terms of economic return.

KEYWORDS

Mushroom, *Pleurotus* ostreatus, B/C ratio, Substrates

1. INTRODUCTION

Mushrooms are one kind of edible fungi belonging to the genus Pleurotus under the class Basidiomycetes (Mondal et al., 1970). Mushrooms are considered an excellent source of nutrition to alleviate malnutrition in developing countries due to their taste, texture, nutritional value, and high productivity per unit area (Pathmashini et al., 2009). Mushroom protein is intermediate between that of animals and vegetables, and it is of superior quality because of the presence of all the essential amino acids (HaThi and Wang, 2014). In 2021/22, fresh mushroom produced is 14,300mt and mushroom seed produced is 1,347,832 in Nepal (MoALD, 2023). Growing oyster mushrooms is becoming more popular around the world because of their ability to grow in a variety of climate settings and utilizing diverse lignocelluloses (Adebayo and Martinez-Carrera, 2015).

Pleurotus ostreatus mushroom called as ‘Kanya chyau’ is a widely cultivated mushroom in Nepal. *P. ostreatus* grows faster than other edible mushrooms. *Pleurotus ostreatus*, unlike other farmed mushrooms, prefers low-light circumstances during its growth phase (Sitaula et al., 2018). On a global scale, the oyster mushroom is ranked second among commercially cultivated mushrooms, following *Agaricus bisporus* and constitutes about one-fourth of total mushroom production (Kues and Liu, 2000). The substrate for cultivating it only needs pasteurization, not sterilization, making it more economical. Oyster mushrooms efficiently transform a considerable amount of the substrate into fruiting bodies, enhancing profits (Sánchez, 2010). It requires minimal environmental controls, its fruiting bodies rarely attacked by diseases, insects and pests, and it can be grown in a simple and cost effective (Ejigu et al., 2022). All this makes cultivating *P. ostreatus* is best choice for mushroom production compared to other varieties.

Agricultural waste is defined as residues that remain after agricultural activities prior or after processing (Mohd Hanafi et al., 2018). Many Asian countries generate huge amounts of agricultural waste such as palm oil waste, paddy straw, sugarcane bagasse, corncob, EFB, cottonseed hulls, wheat straw, hay, and cocoa hulls (Yadav and Samadder, 2018). Agricultural waste streams are now seen as valuable resources rather than liabilities. Mushroom production on these substrates could become more viable. This not only produce edible and/or medicinal mushrooms but also spent mushroom substrate (SMS) which has broad range of applications (Grimm and Wösten, 2018). Oyster mushrooms can be grown on various substrates including paddy straw, maize stalks/cobs, vegetable plant residues, bagasses and so on (Ashraf et al., 2013). This has been reported to affect its growth, yield and composition. However, an ideal substrate must contain nitrogen as a supplement and carbohydrates to promote rapid mushroom growth. Oyster mushroom cultivation helps to dispose of difficult-to-process organic waste. Irregular mycelium growth due to inappropriate substrate selection often results in low yield and reduced nutritive contents of mushrooms (Sathyaprabha and Panneerselvam, 2017).

Integrating mushroom cultivation into the existing market garden systems can be highly beneficial. It allows for the production of nutritious food at a profit, utilizing materials that would otherwise consider a “waste” (Beje et al., 2013). Over the past 15 years, the demand for readily available lignocellulosic waste for biofuels and other energy-related applications has posed a challenge for mushroom growers, who previously were able to obtain raw materials at reasonable prices (Estrada & Pecchia, 2017). As a result, mushroom researchers are constantly searching for and testing alternative substrates like office paper, cardboard, tea leaves, and so on. The utilization of low value agricultural waste for improving nutritional

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quality of mushrooms has become a key research priority in the recent past (Sardar et al., 2017).

The study aims to evaluate the financial feasibility of cultivating *Pleuroteus* mushrooms using various substrates including rice straw, maize stalk, banana leaves and tree leaves.

2. Materials and Methodology

We conducted *Pleurotus ostreatus* mushroom cultivation using different substrates in a controlled environment (plastic house) in Bhairahawa, Nepal. Different substrates such as straw, maize stalk, banana leaves and tree leaves were used for mushroom cultivation. Temperature between 22-30^0 C and humidity of 80-90% were maintained with well-ventilated conditions. Substrates were chopped into 2–3-inch lengths. After that, the chopped substrates were filled into a gunny bag and soaked in water for an hour after which the excess water was allowed to drain out. Substrates were boiled in a drum for 30 minutes at 90^{0}C. The sterilized substrate was filled into perforated poly bags by slightly pressing to form about 3-inch thickness of the first layer. Then, 20g of spawn was spread uniformly over the entire substrate layer and repeated the process till 5 layers of substrate ensuring proper pressing for every layer. The mouth of the poly bag was then tied with a binding rope and punctured it for 5-6 places. The spawned bags were kept in a poly house for incubation at a temp between 22 and 30^{0}C. After 3 weeks, the whole substrate turned white which indicated the completion of the spawn run. The plastic cover was removed and the bags were placed by tying in bamboo poles inside the growing room. Watering was done 2 days after opening the bags. The first harvest of mushrooms was done in 6 days of pinhead formation by giving a gentle twist to the fruiting body. Light watering was given on a daily basis.

2.1 Materials requirement

- Paddy straw, Banana leaves, Tree leaves
- Perforated Poly bags (12"x18")
- Spawn
- Poly house with bamboo racks
- Equipment like chaff cutter and boiling drum
- Buckets and sprayers
- Formaldehyde
- Rope

2.2 Observation

The total cost of cultivation, net return, B: C ratio, IRR and R:C ratio were calculated based on current market price of the products in the local market. To decide whether the business is worth it, the financial calculation should be analyzed using IRR, R/C Ratio, B/C Ratio and payback period (Imroni et al., 2023).

2.2.1 Cost of cultivation

The cost of production was calculated by combining the general cost of mushroom production and variable cost. The calculation was based on the prevailing market price in the Rupandehi district.

Gross return = Total quantity of mushrooms sold * Selling price per unit

Net return: It was calculated by deducting the cost of cultivation from the gross return.

Net return = Gross return – Cost of cultivation

B: C ratio: It was calculated by following formula,

$$\text{B: C ratio} = \frac{\text{Gross return}}{\text{Total cost of cultivation}}$$

R: C ratio: It was calculated by following formula,

$$\text{R: C ratio} = \frac{\text{Net return}}{\text{Total cost of cultivation}}$$

2.2.2 Sensitivity analysis

It is a financial tool used to assess how different values of an independent variable affect a certain dependent variable under a set of assumptions. Price sensitivity analysis is used because price is a variable that often changes in response to market developments which causes uncertainty regarding the changes that will happen in the future.

2.2.3 Internal rate of return (IRR)

It is a rate of return on investment. The IRR of an investment is the interest rate that results in a zero net present value.

$$\text{IRR} = \frac{\text{future value}^{1/\text{periods}} - 1}{\text{Present value}}$$

2.2.4 Payback period

The length of time it takes to recover the cost of an investment, or the length of time investors need to reach a breakeven point.

3. Result and Discussion

Benefit cost ratio is 1.23 indicates that when there is Rs 100 investment in mushroom cultivation then it will be Rs.123 as a return. The result also shows that mushroom cultivation is a profitable venture. Simply, we can say benefits exceed the costs by 23% demonstrating a positive run-in investment. Profitability is attributed to various factors such as efficient cultivation techniques, favorable market prices and lower input costs. Analysis looks into specific factors which affect BC ratio like costs of inputs (substrate, spores and labor) and income from selling the mushrooms. Knowledge of these factors helps to improve the cultivation process and make it more profitable. Market conditions knowledge, demand trends and potential challenges can provide a clear picture of the sustainability and potential of mushroom cultivation. Benefit cost ratio of tomato is higher than mushroom so that most of the tunnels constructed for mushroom cultivation purpose, later convert into tomato tunnels (Acharya and Dev Dhungel, 2021).

The total cost of Rs.3420.375 is efficiently compensated by the gross return of Rs.4211.5 resulting in a net return of Rs.791.125. This positive net return indicates that mushroom cultivation not only covers its expenses but also produces a surplus. The cost was recovered in the first two harvests, which took approximately 2 months. Therefore, the payback period is two months.

Table 1: Total cost of cultivation

S. N	Particular	Unit	Quantity	Rate (RS.)	Amount (Rs.)
1	Spawn	Kg	1.5	175	262.5
2	Poly bags		20	5	100
3	Substrate				
	Rice straw	Kg	25	5	125
	Maize stalk	Kg	25	6	150
	Banana Leaves	Kg	25	5	125
	Tree leaves				
4	Equipment				
	Chaff cutter	Hour	1	50	50
	Boiling drum	Day	1	50	50

Table 1 (Cont.): Total cost of cultivation					
5	Wood	Kg	12	50	600
6	Formaldehyde			70	70
7	Rope		1	25	25
8	Tunnel rent	per month	3	500	1500
9	Labor cost(food)	per person	2	100	200
	Total				3257.5
	Overhead cost@5%				162.875
	Grand total				3420.375

Table 2: Gross return

Substrate	1st harvest(kg)	Amt @ Rs.170	2nd harvest(kg)	Amount @Rs.140	3rd harvest (Kg)	Amount @Rs.160	Total (RS.)
Rice Straw	4.75	807.5	2.5	350	1.5	240	1397.5
Maize Stalk	4	680	2.25	315	1.2	192	1187
Banana leaves	3	510	1.7	238	1	160	908
Tree leaves	2.5	425	1.3	182	0.7	112	719
Total	14.25	2422.5	7.75	1085	4.4	704	4211.5

Table 3: Calculation of financial feasibility

S. N	Particular	Amount (Rs.)
1	Cost	3420.375
2	Gross return	4211.5
3	BC ratio	1.23
4	Net Return	791.125
5	IRR	23.1%
6	R/C ratio	0.23

The sensitivity analysis shows that the financial performance of mushroom cultivation is sensitive to changes in cost and gross return. If costs go up by 10%, it leads to a reduction in B/C ratio from 1.23 to 1.12 and R/C from 0.23 to 0.12 which reflects a drop in profitability and cost-effectiveness (Table 4). On the other hand, 10% decrease in costs improves both ratios which show the importance of cost management in increasing profitability. An increase in cost results in lower IRR while a decrease in cost enhances IRR.

Table 4: Sensitivity analysis when prices increase and decrease by 10%

Variable	New cost	Net return	R/C ratio	B/C ratio	IRR
Prices (+10%)	3762.4125	449.0875	0.12	1.12	12%
Prices (-10%)	3078.3375	1133.1625	0.37	1.37	37%

Similarly, an increase in gross return by 10% raises the B/C ratio to 1.36 and maintains the R/C ratio at 0.36 demonstrating improved profitability (Table 5). However, a decrease in gross return by 10% slightly reduces the B/C ratio to 1.11 and R/C ratio to 0.11. Therefore, changes in cost and gross return influence the outcomes of an investment.

Table 5: Sensitivity analysis when gross returns increase and decrease by 10%

Variable	New gross return	Net return	R/C ratio	B/C ratio	IRR
Prices (+10%)	4632.65	1212.275	0.36	1.36	36%
Prices (-10%)	3789.675	369.3	0.11	1.11	11%

The economic analysis of production of mushroom using individual substrates is presented below in table 6. Total cost includes (Spawn, poly bags, individual substrate cost, equipment cost, wood cost, formaldehyde, rope, tunnel, labor cost). Whereas the benefit-cost ratio is calculated based on the individual substrate across three harvests.

Table 6: Economic Analysis of individual substrates

Substrate	Total Cost	Benefit	BC ratio	Rank
Rice Straw	1088.75	1397.5	1.28	A
Maize Stalk	1113.75	1187	1.07	B
Banana leaves	1088.75	908	0.83	C
Tree leaves	963.75	719	0.75	D

The findings revealed considerable differences in the economic viability of certain substrates. Rice straw had the highest benefit-cost (BC) ratio, indicating that for every unit of currency invested, a benefit of 1.28 units is gained. This makes rice straw the most economically viable substrate among the tested. The relatively low cost and high benefits associated with rice straw make it an attractive option for sustainable use. (Dubey et al., 2019) also reported that mushroom production is more suitable in terms of economic return from the rice straw than other agricultural residues with a high B-C ratio. (Khadka & Parajuli, 2013) has explained that rice straw is a suitable substrate for *Pleurotus ostreatus*, which is also proved by our experiment.

Maize stalk with a BC ratio of 1.07 ranks second (B). It has a somewhat higher cost than rice straw. Its benefit also makes it a viable alternative substrate. However, its lower BC ratio compared to rice straw suggests it is less efficient in terms of return on investment.

Banana leaves despite having the same cost as rice straw, exhibit significantly lower benefits resulting BC ratio of 0.83. This lower efficiency in generating benefits ranks it at C. This implies that banana leaves are less viable compared to rice straw and maize stalk.

Tree leaves have the lowest BC ratio (0.75) which places them bottom rank (D). The lower benefit and comparatively lower cost result the least favorable economic outcome among substrates analyzed. This indicates tree leaves are the least economically efficient substrate option.

Overall, the results indicate that rice straw is the most economically favourable substrate due to its high BC ratio, followed by maize stalk, banana leaves and tree leaves. This analysis helps in decision-making in selecting substrates.

4. Conclusion

The financial viability of mushroom cultivation is affected by fluctuation in both cost and gross return. Implementing strategies to maximize gross return improves profitability. So, farmers should focus on optimizing yields and market prices to ensure the economic viability of mushroom cultivation. Among substrates evaluated, rice straw emerges as the most feasible option followed by maize stalk. On the other hand, banana leaves and tree leaves are less efficient in terms of economic return. Although Pleurotus species are among the easiest mushrooms to cultivate, growers can encounter various challenges that might reduce profits. Like any food production system, Pleurotus growers need to stay updated on new technologies to overcome future obstacles that can determine the success or failure of their operations.

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