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Research Paper

Economics of Oyster Mushroom (*Pleurotus spp*) Production in Bhagalpur District of Bihar

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ABSTRACT

The mass population of India was vegetarian and attracted to mushroom consumption because they have contained more nutrients like vitamins, minerals, fibers, and medicinal value. The mushroom species (oyster, button, milky and paddy straw) was identified for cultivation in upper and hilly regions of the Indian states suitable for white button mushrooms and plain areas of lower altitude regions in favor of oyster 'Dhingri' (Plutorus sages Kaju) mushroom. Moreover, growers have doesn't fully organize form of mushroom per unit sale in Bhagalpur & territories market of Bihar as well as other states of India. The strategic economic problem of the net sown area was limiting shrink factors day by day due to increase the infrastructure alternate option is open but human population is pressurized for fulfilling the demand become inevitable to best alternative option to supplementary mushroom growing opportunity. Mushroom production in locale area under Bhagalpur district of Bihar was purposively studies of the fourteen each block and village panchayat with the help of snowball referral to subsequent respondents collected 71 complete lists enumerated then obtained sample size (Taro Yamane) 60 oyster growers and cumulative cube root frequency distribution techniques were used. The major variable costs of oyster mushroom that spawn cost was higher expenses followed by the human labour, chopped dry straw, plant protection and polythene bags. The overall farms of fresh oyster mushroom production were accounted to be on an average 16.90 Kg (m^2) per square meter, which were varied to be on an average 18.48 Kg (m^2) per square meter higher for large farms followed by 16.99 Kg (m^2) per square meter of medium farm and 15.16 Kg (m^2) per square meter for the small farm. The overall farm benefit-cost ratio (BCR) was estimated to be on average 1.31 which varied to 1.40 higher for large farms followed by 1.31 for medium farms and 1.19 for small farms. Further, the cost of oyster mushroom production per unit was decreased when the increase in the size of farms and vice-versa.

HIGHLIGHTS

- The cost of production per unit of oyster mushroom was declined trends when the increase in the size of oyster mushroom growers at the same time scale of economics was increased otherwise decrease and vice-versa of the outputs respond with the size of growers. The oyster mushroom cultivation of their day-to-day operational work control point was situated on individual growers or by default of individual hands in the Bhagalpur district of Bihar.

Keywords: Oyster mushroom, production, sample size, costs, and returns, maximization & minimization, markets

Mushrooms are the fruiting body known as macro-fungi that comes under the lower plant kingdom. They have the nature of growing on a heterotrophic (saprophytic) approach to nutrition as the absence of chlorophyll (Subhas Neupane

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et al. 2018) and habitat in complete darkness but darkness is not an essential requirement. The most of crops are taken in the open environment of the field but mushrooms are produced in a controlled environment. The oyster mushroom production has artificially commensurate three (Hs) factors as homogeneity, hygiene, and humidity beyond parameter successfully line up of indoor-room. The edible mushrooms have unique aroma & flavors and are very delicious as 'white vegetables' 'boneless vegetarian meat' contains abundant amounts of proteins, vitamins, fiber, and medicinal value, prefers to more by vegetarian people in a different ceremony as a special dish. Whereas non-edible mushroom species precaution to consumption creates the toxic has been identified as toadstools and *Amanita* genus especially, *Amanita phalloides*, which death cap principle toxic mixture of α and β-amanitin and phalloidin and edible mushroom may also cause illness if they are taken with alcohol (Patel, 2014).

The oyster mushroom production process was started from the flow of resources (rent, wage, interest, and profit) transaction point under time and space in market plan and budget procedures to ends (fresh oyster mushroom product) point control by the individual grower. The oyster mushroom production problem was concerned with micro and macro-level strategies. Where input variables have changed in a quantity of macro-level are don't affect all individual oyster growers but some growers have affected some extent and compare to decide the direction of a positive outcome in aggregate level. There certain rules and conclusions are applied to the factor of production on a particular farm but are not effective at the aggregate farm society level. Growers have so many decision problems for oyster mushroom consumption self and others. When oyster mushroom income has generated by other person consume of oyster mushroom and their usefulness in the aggregate level of study but price determination has a micro-study under forwarded to marketed and marketable surplus-value in use. The oyster mushroom production process was cost minimization taken by growers, whereas the returns, as well as income, were concerned with profit maximization in the marketing process. The oyster mushroom cost minimization & profit maximization strategies in economics were carried out by price spread of input and output appeared in marketing channel of Bhagalpur & territories area. Mushroom grower was faced with price behavior ignorance of perfect to imperfect competition market structure and conduct strategies. On the view on other side mushroom growers were faced with inputs price behavior analysis perceive oligopoly to monopoly market strategies determine the input price particularly material costs like spawn, chemical & pesticides, manure & fertilizers, application of mist water, machine, electricity, and etcetera.

The upper and hilly regions of the Indian states have been identified the cultivation of *white button* mushrooms and plain areas in lower regions favour oyster '*Dhingri*' (Plutorus sages Kaju) mushroom. The hilly & high-altitude areas of Bihar, UP, and other states of India were possible for the natural cultivation of mushrooms. Other places have artificially created a conducive situation for growing mushrooms. The crops cultivation in general and mushroom growing, in particular, has been a good step of decision under a corrective measure of complimentary as well as supplementary linkage product raising *vis-a-vis* healthy farming, income & employment and nutritive both rural and urban population. However, the Bihar state has part of the country (India) pioneer in developing the year of technologies for mushrooms cultivation mainly three species such as *Pleurotus species* (Oyster mushroom), *Agaricus species* (Button mushroom), and *Calocybe Indica* (milky/white mushroom).

The costs and return process was taken of the production aspect through the mushroom grower's links together inputs (particularly material costs) buying and another side of outputs (returns from oyster mushroom) sells in the market. The lack of appropriate price policy was ambiguities (not clear) justification of the central agency (Governmental organization) on behalf of the producers to determine the mushroom per unit sale in markets by this entrepreneur. The domestic input and outputs market of India has been expanding on account of changes in food habits & taste, rising income status, and rapid urbanization. However, India has few inputs for mushroom production especially machines, fuel & electricity, chemicals & pesticides, and fertilizer buying in Bhagalpur and territories market appeared in form of oligopoly

to monopolistic market scale. There are several growth centres in Bihar for mushroom production but their level of production and marketing technology has been not fully exploited to a desired commercial line due to some serious economic and technical constraints and also due to lack of credit requirement of producers and efficient marketing system. Which studies were concentrated on the cost of production to help financial and marketing decision-making account for the profitability of the mushroom business? However, the study on mushroom production has been not covered in totality in Bihar state because it distinguished three agro-climatic zones already defined. So that the cost of the production decision-making process was forwarded to returns to cost ratio of mushroom growers in Bhagalpur district comes under agro-climatic zone III (A). Thus, the present study has been formulated with the specific objective as to estimate the costs and return of fresh oyster mushrooms in the study area.

MATERIALS AND METHODS

The cross-sectional data have been offered the opportunity to assess the first stage random sampling techniques to be used for the Bhagalpur district of Bihar purposively selected to the adequate mushroom growers available in the locale area. The crops grower in general whereas mushroom growers in particular registered/unregistered population was prepared a list through the snowball rolling technique used as the referral to subsequent respondents in a small town and rural area of Bhagalpur district. Furthermore, every one of the populations has an equal chance of being chosen representative sample. The sample size was estimated to be 60 samples from 71 mushroom grower populations based on the *Taro Yamane* method. In all stages, the sample selection process has been adopted simple random sampling without replacement (SRSWOR) a unit chance of being selected more than once.

RESULTS AND DISCUSSION

The results have been a part of the numerical observation of the objectives' to explain the extent of results analysis value in using that condition to be sustained and the discussion has subjectively investigated the counterpart movement of the biased and unbiased situation described by the

Table 1: Cumulative cube root frequency distribution of mushroom growers' samples in Bhagalpur district of Bihar

Sl. No.	Mushroom growing bed in square meter	Dry straw in quintal	Number of sample	$\sqrt[3]{f}$	Cumulative $\sqrt[3]{f}$
	(1)	(2)	(3)	(4)	(5)
1	25 to100	11.49 to 63.55	5	1.71	1.71
2	100 to 175	63.55to 121.86	7	1.91	3.62
3	175 to250	121.86 to 180.17	12	2.29	5.91
4	250 to 325	180.17 to 238.48	13	2.35	8.26
5	325 to 400	238.48 to 296.79	10	2.15	10.42
6	400 to 475	296.79 to 355.1	7	1.91	12.33
7	475 to 550	355.1 to 413.41	4	1.59	13.92
8	550 to 625	413.41 to 471.72	2	1.26	15.18
	Total		**60**		

Table 2: Classification of mushroom growers' sample to spawn bed area, use of dry straw, and area under crops in Bhagalpur district of Bihar, the year 2020-21

	Categories of mushroom grower size			Number of samples	The average size of mushroom growers		
Sl. No.	Mushroom growers' classes	The mushroom area under spawn/ substrate bed in m^2	Use of dry straw in quintal	Mushroom growers	Mushroom area (Spawn bed in m^2)	Use of dry straw (In quintal)	Net area sown (In hectare)
1	Small (1-2 ha)	025 to 222.16	11.49 to 154.60	36 (60.00)	103.55	49.72	1.35
2	Medium (2-4 ha)	222.16 to 389.88	154.60 to 238.52	18 (30.00)	224.22	167.90	2.45
3	Large (> 4 ha)	>389.88	>238.52	6 (10.00)	428.93	273.45	4.76
4	Overall farm			60 (100.00)	172.29	107.55	2.02

logical view interpreted to be present in the table as cropping pattern, household building & yard area, cost and returns as recurring and non-recurring costs, oyster mushroom grade specification, and fresh mushroom producer to consumer through the different marketing channel and disposal pattern.

Cropping pattern

The cropping pattern of mushroom growers revealed in Table 3 that the gross cropped area under mushroom of the overall farm has been estimated to be on an average 3.55 hectares, which were varied to be 6.61 hectares higher gross cropped area of the large farms followed by 4.07 hectare of medium and 2.78 hectares of the small farm.

After that, the annual crop area of the overall farm was estimated to be on an average 81.25 percent of the gross cropped area, whereas the perennial crops area only 13.07 percent of the gross cropped area. In the case of the area under mushroom where indoor environment cultivates was only 4.52 percent of the gross cropped area, which varies to be 6.66 percent higher of the gross cropped area of the large farm followed by 5.65 percent of medium and 3.59 percent of small farm.

Building and yard area under the mushroom

The household building area has been observed in Table 4 that the household building & yard area of overall farms was accounted to be on an average

Table 3: Cropping pattern adopted by mushroom growers (In hectare)

Sl. No.	Type of Crops	Categories of mushroom growers' size			Overall farms
		Small (n1=36)	Medium (n2=18)	Large (n3=6)	(n=60)
1	Annual crop	2.36 (84.65)	3.14 (77.10)	4.84 (73.30)	2.84 (81.25)
2	Perennial crops	0.33 (11.76)	0.54 (13.35)	1.32 (20.04)	0.49 (13.07)
3	Mushroom	0.10 (3.59)	0.23 (5.65)	0.44 (6.66)	0.17 (4.52)
4	**Gross cropped area**	2.78 (100.00)	4.07 (100.00)	6.61 (100.00)	3.55 (100.00)
5	Net sown area	1.35	2.45	4.76	2.02
6	Cropping intensity in (%)	206.25	166.11	138.81	187.46

Figures in parentheses indicate the percentage of the gross cropped area.

Table 4: Household building & yard area under mushroom growing household (In square meters of area)

Sl. No.	Particular household building & yard area	Unit	Categories of mushroom growers' size			Overall (n=60)
			Small (n1=36)	Medium (n2=18)	Large (n3=6)	
1	Indoor-room length (L)	In ft	13	16	20	14.6
2	Indoor-room width (W)	In ft	10	12	14	11
3	Indoor-room height (H)	In ft	11	12	12	11.4
4	Indoor-room of volume	In ft^3	1500.19	2544.45	3653.01	2028.75
5	Indoor-room of volume	In m^3	42.48	72.05	103.44	57.45
6	Indoor-room length (L)	In m	3.96	4.95	6.17	4.48
7	Indoor-room of width(W)	In m	3.05	3.73	4.34	3.38
8	Indoor room of the base area ($L \times W$)	In m^2	12.31	18.75	27.06	15.72
9	Number of indoor-room	Number	2	3	4	2.50
	Indoor room of the total base area ($L \times W$)	In m^2	24.62	56.25	108.24	39.3
10	The basal area covers to shelve arrange of the indoor room (2/3 area under mushroom cultivation)	In m^2	17.26	37.37	71.49	28.71
11	The passage area covers physical handling and movement for the production process	In m^2	6.9	16.15	32.55	14.37
12	The area under the oyster mushroom	In m^2	74.74 (72.18)	151.23 (67.41)	252.00 (58.75)	115.41 (66.97)
13	The area under button mushroom	In m^2	24.38 (23.54)	61.36 (27.35)	146.39 (34.13)	47.67 (27.66)
14	The area under the milky mushroom	In m^2	4.43 (4.28)	11.76 (5.24)	30.54 (7.12)	9.24 (5.36)
15	Net area of mushroom	In m^2	103.55 (100.00)	224.34 (100.00)	428.93 (100.00)	172.32 (100.00)
16	Household area under building & yard	In m^2	221.80	250.73	286.48	236.95
17	Area under yard	In m^2	110.79	101.47	94.48	106.36
18	The area under the household building	In m^2	111.02	149.26	192.00	130.59

Figures in parentheses indicate the percentage of the net area of mushrooms.

236.95 (m^2) square meters, which were varied to be 286.48 (m^2) square meters higher area of large farms followed by 250.73 (m^2) square meters of medium farms and 221.80 (m^2) square meters of the small farms.

Costs and return of oyster mushroom

The cost and returns of oyster mushrooms were varies with consumption, income, and employment. The cost and returns of oyster mushrooms showed in Table 5 that the gross income of oyster mushroom production of overall farms was estimated to be on an average ₹ 1785.34 (m^2) per square meter, which were varies to be in ₹ 1947.68 higher gross income of medium farms followed by in ₹ 1797.41 of large and in ₹ 1603.07 of small farms. The net income of oyster mushrooms of overall farms was estimated to be on an average ₹ 422.90 per (m^2) per square meter, which were varied to be ₹ 510.42 (m^2) per square meter higher net income of large farms followed by

Table 5: Costs and return of oyster mushroom production on sample farm in Bhagalpur district of Bihar, the year 2020-21 (In ₹ per square meter)

Sl No.	Particular costs and return of oyster mushroom	Categories of mushroom growers			Overall (n=60)
		Small (n1=36)	Medium (n2=18)	Large (n3=6)	
1	Oyster mushroom of total costs	1342.48	1481.60	1286.99	1362.44
2	Return of fresh mushroom in Kg	15.16	18.48	16.99	16.90
3	Return of by-product as substrate in Kg	133.76	153.85	151.64	146.06
4	Income from fresh oyster mushroom	1516.13	1847.68	1698.84	1690.41
5	Income from by-product as compost	86.95	100.00	98.57	94.94
6	Gross income from oyster mushroom	**1603.07**	**1947.68**	**1797.41**	**1785.34**
7	Net income from oyster mushroom	260.59	466.08	510.42	422.9
8	Cost of production per Kg	88.55	80.19	75.76	80.60
9	Benefit-cost ratio (BCR)	1.19	1.31	1.40	1.31

Table 6: Recurring and non-recurring (Fixed & Variable) costs incurred on sample farms of oyster mushroom production in Bhagalpur district of Bihar, the year 2020-21 (In ₹ per square meter)

Sl. No.	Particular oyster mushroom costs	Categories of mushroom growers			Overall farms (n=60)
(A)	**Non-recurring/ fixed cost**	**Small (n1=36)**	**Medium (n2=18)**	**Large (n3=6)**	
1	The rental value of House & Yard	57.94 (4.32)	38.14 (2.57)	21.48 (1.67)	41.13 (3.02)
2	Government revenue, Cess & fee	2.06 (0.15)	2.06 (0.14)	2.06 (0.16)	2.06 (0.15)
3	Depreciation of Building Construction	5.31 (0.40)	9.75 (0.66)	10.52 (0.82)	8.34 (0.61)
4	Depreciation of Inventory and Equipment Assets	8.72 (0.65)	7.62 (0.51)	6.72 (0.52)	7.79 (0.57)
	Sub-total	74.03 (5.51)	57.58 (3.89)	40.77 (3.17)	59.33 (4.35)
5	Interest in fixed capital	6.44 (0.48)	4.80 (0.32)	3.31 (0.26)	5.02 (0.37)
	Sub-total (Fixed costs)	80.47 (5.99)	62.37 (4.21)	44.08 (3.43)	64.34 (4.72)
(B)	**Recurring (Variable) cost**				
1	Human Labour	332.88 (24.80)	383.78 (25.90)	254.41 (19.77)	313.85 (23.04)
2	Chopped dry straw	222.32 (16.56)	255.71 (17.26)	252.04 (19.58)	242.75 (17.82)
3	Fuel and Cooking gas	60.82 (4.53)	69.95 (4.72)	68.95 (5.36)	66.41 (4.87)
4	***Plant Protection***				
i	$CaCO_3$ (Hydrated lime)	3.96 (0.30)	4.56 (0.31)	4.49 (0.35)	4.33 (0.32)
ii	Carbendazim & formalin	75.44 (5.62)	86.79 (5.86)	85.54 (6.65)	82.39 (6.05)
5	Spawn (oyster) In Kg	329.26 (24.53)	378.71 (25.56)	373.28 (29.00)	359.52 (26.39)
6	Polythene bags 150 to 160 gauze	61.74 (6.93)	71.01 (7.07)	69.99 (4.48)	67.41 (6.39)
7	Electricity charge	6.93 (0.52)	7.07 (0.48)	4.48 (0.35)	6.39 (0.47)
8	Miscellaneous charge, pegs of rope, etc	93.90 (6.99)	77.58 (5.24)	56.01 (4.35)	78.09 (5.73)
9	Subtotal	1187.24 (88.44)	1335.13 (90.11)	1169.19 (90.85)	1221.15 (89.63)
10	The interest of variable costs @12.5 % half-year	74.77 (5.57)	84.10 (5.68)	73.72 (5.73)	76.94 (5.65)
11	Sub-total (Variable costs)	1262.01 (94.01)	1419.23 (95.79)	1242.91 (96.57)	1298.09 (95.28)
12	Total costs (A+B)	1342.48 (100.00)	1481.60 (100.00)	1286.99 (100.00)	1362.44 (100.00)

Figures in parentheses indicate the percentage of the total costs (A+B).

₹ 466.08 per (m^2) square meter of medium and in ₹ 260.59 per (m^2) square meter of small farms. But the cost of production of oyster mushrooms was estimated to be on average ₹ 80.60 per Kg of the overall farm, which was varied to be on average ₹ 88.55 per Kg higher cost of production of small farms followed by ₹ 80.19 per Kg of medium and in ₹ 75.76 per Kg of large farms. Therefore, it was observed that the net income and cost of production of oyster mushrooms were diverse values on categories of size farms and *vice-versa.* Furthermore, it shows that the net income was increasing with increasing size of the farm, but the cost of production was decreasing with increasing size of farms, in other words, state that the scale of economics positive association with the increase in the size of farms and negative association decrease in size of growers' day to day operational work control at a point. The fresh oyster mushroom production of overall farms was estimated to be on an average 16.90 Kg (m^2) per square meter, which were varied to be on an average 18.48 Kg (m^2) per square meter higher of large farms followed by 16.99 Kg (m^2) per square meter of medium farm and 15.16 Kg (m^2) per square meter of the small farm. The benefit to cost ratio (BCR) of overall farms was accounted to be on an average 1.31:1 which were varied to be 1.40: 1 higher for large farms followed by 1.31:1 for medium farms and 1.19:1 for small farms. Therefore, the benefit to cost ratio (BCR) increased with an increase in the size of farms and decreased the benefit to cost ratio (BCR) with the decrease in the size of farms.

CONCLUSION

The edible mushrooms have unique aroma & flavors and are very delicious as contain abundant amounts of proteins, vitamins, fiber, and medicinal value for the mass Indian population were vegetarian and prefers mushrooms. The type of mushroom species cultivation was identified in upper and hilly regions of the Indian states suitable for *white button* mushrooms and plain in lower regions favor of oyster '*Dhingri*' (Plutorus sages Kaju) mushroom. The impact of profit maximization by producer behaves to realized price taker through the system of production and marketing. But growers have doesn't organize mushroom per unit sale in Bhagalpur and territories market of Bihar as well as other states of India.

In the case of oysters, the mushroom area was the decreasing size of mushroom growers with increasing size of mushroom farms, whereas the button mushroom area was increasing with increasing size of mushroom farms. The major variable cost of oyster mushrooms that spawn cost was higher expenses followed by the human labor, chopped dry straw, plant protection, and polythene bags. It was observed that net income and cost of production of oyster mushrooms diverse between categories of farms size. Further, it was shown that the net income was increasing with the increasing size of the farm, but the cost of production was decreasing with the increasing size of farms, in other words, states the scale of economics increase or decrease with the size of the grower's day to day operational work control at a point.

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