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Economics and Factors Affecting Rainbow Trout (*Oncorhynchus mykiss*) Production in Kashmir

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ABSTRACT

The present study was conducted during the period 2014-15 and a sample of 60 trout farmers, 30 each from two districts, namely, Ganderbal and Anantnag was interviewed using a pre-tested questionnaire. The investigation showed that fixed capital investment on sample farm was Rs.6.25 crore per hectare and Rs.1.25 lakh per raceway. The major share of investment was for the construction of raceway, which accounted for 67.60 per cent of total investment on sample farms. The share of total variable and fixed cost was 75.32 per cent and 24.68 per cent, respectively to the total cost. Feed was the major cost component accounting for about 45.35 per cent of the total cost and key factor in deciding profitability of trout farming. Resource use efficiency showed that feed was over-utilised while labour was under-utilised. The returns to scale in trout production of 1.25 indicates increasing returns to scale in trout production. High price of feed and seed are found to be the major constraints in trout culture. The B-C ratio worked out to be 1.80, indicating the economic feasibility of trout farming in the Kashmir valley.

Keywords: Rainbow trout, Cost and return, B-C ratio, Resource use efficiency, Returns to scale and Kashmir

JEL: Q20, Q22, D61

I

INTRODUCTION

Commercial trout culture is well established in Europe and United States of America, where trout farming dates back to over 400 years in Europe and about 150 years in the USA (Hinshaw, 1990). Rainbow trout (*Oncorhynchus mykiss*), is the most commonly raised species, but brown trout (*Salmo trutta*) and brook trout (*Salvelinus fontinalis*), are also farmed (Hinshaw *et al.*, 1990). Chile is the world leading Rainbow trout producer followed by Norway, Iran, Italy and France (FAO, 2013). The first attempt to introduce trout in India was made by Sir Frances Day in 1863 where he introduced eyed eggs and fry of brown trout in the Nilgiri hills, but was unsuccessful. Later Mr F.J. Mitchell succeeded in the introduction of eyed eggs of brown trout in Harwan hatchery, Jammu and Kashmir in 1990. With the assistance of European Economic Community (EEC) Rainbow trout (*Onchorinchus mykiss*) culture was successful in the state of Jammu and Kashmir and Himachal Pradesh (Ayyappan *et al*., 2011).

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Presently, trout farming in India is restricted to the upper Himalayan region and Western Ghats due to climatic constraints. The state of Jammu and Kashmir, especially Kashmir region is the major contributor in trout production, with 447 km of stream, 486 km of rivers and about 157 sq. km of lakes (Sodhi *et al.,* 2013). Trout culture is an ideal option for sustainable use of water resources in mountainous regions of Kashmir because both surface and underground water of the region are suitable for the purpose. In the region, where income-generating and employment opportunities are scarce, trout farming could help to ensure employment and steady incomes (Woynarovich *et al*., 2011). Realising the potential of trout farming in the state, Government of Jammu and Kashmir and Government of India have started a number of schemes to promote trout farming in the state. At present, the state of Jammu and Kashmir has 7 trout hatcheries and 57 trout rearing centres in public sector and 485 rearing units in private sector. The total trout production in the state during the year 2016-17 was 302 tonnes worth Rs.221.56 lakh (Government of Jammu and Kashmir, 2017). Also, the state has a huge human resource in the form of unemployed youth who can be trained in trout farming for earning their livelihood. In spite of huge market demand, vast natural and human resources, trout culture in Kashmir is far away from realising its potential. In this background, the present study was conducted to understand the economics and factors affecting trout production to suggest suitable measures for promoting trout culture in the state.

II

METHODOLOGY

(i) *Data*

The data for the present study was collected from both the primary and secondary sources. The secondary data for the study was collected from the Department of Fisheries, Government of Jammu and Kashmir and other agencies related with Rainbow trout culture. The primary data were collected from the sample farm households by personal interview with the help of a pre-tested questionnaire specially designed for the study. Using simple random sampling a total of 60 trout farmers, 30 each from the two districts Anantnag and Ganderbal, were selected for the study. Prices of inputs purchased from markets were taken as they are and home grown inputs were priced on the prevailing market price. Trout harvested were evaluated at prevailing market price at the time of harvest. Simple statistical tools such as average, percentage and farm business analysis were used to meet the objectives of the study. Interest on fixed capital was calculated at the rate of 12 per cent per annum on fixed capital and interest on working capital was calculated at the rate of 8.75 per cent for a period of 6 months. B:C ratio was used to ascertain the economic viability of trout culture.

(ii) *Production Function*

Production function analysis was used as a quantitative tool to determine the factors affecting trout production. Trout production was used as the dependent variable and five inputs, i.e., feed, seed, human labour, and medicine and chemical used in trout production, were used as independent variables in estimating the production function.

$$TP = f(F, S, M, L, Ui)$$

where:
TP = Trout production (kg/raceway)
F = Feed use (kg/raceway)
S = Seed use (no. /raceway)
M = Medicine and chemical (kg/raceway)
L = Labour hours (total hour/raceway)
Ui = Stochastic error term.

The Cobb-Douglas production function was found best fit on the basis of a priori and statistical criteria to explain the production of trout. The Cobb-Douglas production function for trout was used as follows:

$$LnTP = \ln\beta 1 + \beta 2\ln F + \beta 3\ln S + \beta 4\ln M + \beta 5\ln L + ui$$

where, all notations are same as used before except β's which are unknown parameters to be estimated.

(iii) *Marginal Value Product (MVP)*

The MVP was estimated as

$$MVP_{Xi} = \beta_i \frac{\bar{Y}}{\overline{Xi}} P_y$$

where,
β_i = regression-coefficient of i-th input (i = 1, 2, 3)
$\bar{Y}$ = geometric mean of output
$\overline{Xi}$ = geometric mean of i-th input (i= 1, 2, 3)
P_y = price of output Y per kg.

(iv) *Resource Use Efficiency*

The resource use efficiency was estimated based on Ugwumba (2010) by calculating the efficiency ratio of MVP/MFC that indicate resource use efficiency.

For the purpose, MVP was estimated at their respective geometric mean level and MFC was taken as unit price of the factor. The MVP-FC ratio of different inputs were estimated as

$$\beta_i \frac{\bar{y}\ (P_y)}{\overline{Xi}\ (P_{Xi})}$$

where,
P_{Xi} = market price of i-th input
Py= market price of output
Decisions:
IF MVP/MFC = 1, then resource is optimally used.
IF MVP/MFC = <1, then resource is over-utilised.
IF MVP/MFC = >1, then resource is under-utilised.

(v) *Constraints Analysis*

Rank Based Quotient (RBQ) was estimated to quantify the severity of the constraints in trout production and marketing as given by Sabarathnam and Vennilla (1996).

$$R.B.Q. = \frac{\sum fi(n+1-i)}{N \times n} \times 100$$

where,
f_i = Number of respondents reporting a particular problem under i-th rank
N = Sample size
n = Number of rank or number of problems identified.

III

RESULTS AND DISCUSSION

(i) *Fixed Capital Investment Pattern on Sample Trout Farm*

The fixed capital investment pattern was estimated per hectare and per raceway since raceway dimension was same at all the sample trout farms, i.e., 20 m^2 and presented in Table 1.

Perusal of the Table revealed that total investment made on the sample farm was Rs.6.25 crore per hectare and Rs.1.25 lakh per raceway. It was also found that major investment was for the construction of raceway which accounted for about 67.60 per cent of the total investment on sample farms. The share of cost incurred on construction of inlet-outlet was 10.69 per cent and about 10.27 per cent of the investment was for construction of fencing on the farm. The other investments on the

TABLE 1. FIXED CAPITAL INVESTMENT PATTERN ON SAMPLE TROUT FARM

Particulars	Rs./ha	Rs./raceway ($20m^2$)	Share (per cent)
(1)	(2)	(3)	(4)
Raceway construction	4,22,74,680	84,549.36	67.6
Inlets-outlet	66,86,330	13,372.66	10.69
Farm shed	53,11,160	10,622.32	8.49
Fencing	64,23,460	12,846.92	10.27
Lighting and cabling	4,82,850	965.7	0.77
Weighing balance	3,27,255	654.51	0.52
Handle net	6,72,390	1,344.78	1.08
Covering net	1,83,475	366.95	0.29
Tub and buckets	1,77,215	354.43	0.28
Total	6,25,38,815	1,25,077.63	100

farms were farm shed, handle net, lighting and cabling, balance, covering net and tubs and bucket with share of 8.49, 1.08, 0.77, 0.52, 0.29, and 0.28 per cent, respectively in the total fixed investment. It was also found that construction of raceway absorbed the maximum investment which may be due to high cost of construction material, topography of the site and high labour cost in the valley.

(ii) *Input Use Pattern on Sample Trout Farms*

The input use pattern was estimated for the sample trout farms and presented in Table 2.

TABLE 2. INPUT USE PATTERN ON SAMPLE TROUT FARMS

Particulars	(Per raceway)	(Per hectare)
(1)	(2)	(3)
Seed (No.)	2965.98	10771700
Feed (kg)	627.83	23214700
Medicine and chemicals (Rs.)	475	237700
Labours (Rs.)	159.06	79500
Electricity (Rs.)	202.9	101500
Total	--	34405100

Since the trout culture is practised in raceways with average area of 20 m^2 each, the input used were estimated per raceway as well as per hectare. Seed the key input in trout farming, was being used at the rate of 2966 seed per raceway and 10.77 million per hectare. Feed was being used at the rate of 627.83 kg per raceway and 2.32 tonnes per hectare. Other inputs used were medicine and chemicals, labour and electricity since these inputs could not be measured in quantity, value has been estimated which was found to be Rs.475, Rs.159.06 and Rs.202.9 per raceway, respectively. The total value of these inputs was Rs.3.44 crore per ha. There was no charge for water since it is naturally available and so it is advisable for those farmers who have access to continuous water supply either from streams or springs to take up trout culture.

(iii) *Costs and Return in Trout Farming on Sample Farms*

The costs and return in trout farming in terms of per raceway and per hectare was estimated for the sample trout farms and presented in Table 3.

TABLE 3. COSTS AND RETURN IN TROUT CULTURE ON SAMPLE FARMS

Particulars	Cost (Rs./ha)	Cost (Rs./raceway)	Per cent share
(1)	(2)	(3)	(4)
Seed	10771740.00	21543.48	21.04
Feed	23214675.00	46429.35	45.35
Medicine and chemicals	237700.00	475.4	0.46
Transportation	2064495.00	4128.99	4.03
Hired human labour	79530.00	159.06	0.16
Miscellaneous	575650.00	1151.30	1.12
Total working capital	36943785.00	73887.57	72.16
Interest on working capital	1616290.00	3232.58	3.16
Total variable cost	38560075.00	77120.15	75.32
Depreciation	3201105.00	6402.21	6.25
Interest on fixed capital	7602545.00	15205.09	14.85
Annual repair and maintenance	1613550.00	3227.10	3.15
Land rent	217390.00	434.78	0.42
Total fixed cost	12634595.00	25269.19	24.68
Total cost A+B	51194670.00	102389.34	100
Total production (kg)	237270.00	474.54	
Cost of production (Rs./kg)	215.77	215.77	
Selling price (Rs.)	389.17	389.17	
Farmer's margin (Rs./kg)	173.40	173.40	
Gross revenue	92338365.90	184676.73	
Net revenue	41143695.90	82287.39	
B:C Ratio	1.80	1.80	

It is evident from the table that total cost incurred in trout farming was Rs.5.12 lakh per hectare and Rs.1.02 lakh per raceway. The total variable cost worked out to 75.32 per cent, whereas total fixed cost was 24.68 per cent of the total cost. The findings of present study is in line with Bonzoglu *et al.*, (2009) who estimated variable cost in trout and sea bass farming as 74.02 per cent and 67.49 per cent of total cost, respectively, while the fixed cost accounted for 25.98 per cent and 32.51 per cent of the same.

Among the total variable cost, feed and seed holds the highest share to the total cost with 45.35 per cent for feed and 21.04 per cent for seed. Bonzoglu *et al.*, (2009) also found that feed cost accounted for about 45.53 and 47.73 per cent in total cost of trout and sea bass, respectively. From the above finding it is clear that feed and seed were the key factors in deciding the profitability. Due to the scattered nature of trout farms in the valley and absence of feed and seed retailing unit at local level the farmers were forced to purchase these vital inputs directly from the production centres resulting into substantial cost in transportation which accounted about 4.03 per cent to the total cost. Under the fixed cost, interest on fixed capital accounted for

the highest share of 14.85 per cent in the total cost followed by depreciation which accounted 6.25 per cent of the total cost. The other components of costs were interest on working capital, annual repair and maintenance, medicine and chemicals, land rent, hired human labour cost and miscellaneous charges having share of 3.16, 3.15, 0.46, 0.42, 0.16 and 1.12 per cent, respectively in the total cost of trout farming. During the study the prevailing price of feed was Rs.73/kg and seed price ranged from Rs.5 to Rs.10 per fingerling based on the sizes. Since both these vital inputs were produced by departments of fisheries price ceiling has been maintained to make them available to the trout farmers at reasonable price.

The average cost of producing 1 kg of trout was found out to be Rs.215.77 while average selling price was Rs.389.17/kg. Since farmers sold trout directly from farm at farm gate price, they were able to achieve a margin Rs.173.40/kg. In a similar study by Hassan *et al.* (2007) in Northern Pakistan reported that trout farmer incur cost Rs.234/kg and revenue of Rs.310/kg resulting in a profit of Rs.76 hence concluded that trout farming is profitable in the region. The gross revenue was estimated to be Rs.9.23 crore per hectare and Rs.1.84 lakh per raceway while the total cost was Rs.5.12 crore per hectare and Rs.1.02 lakh per raceway respectively. Benefit-cost ratio was estimated to be 1.80 that indicates economic viability of the business which is in line with the findings of Olaoye (2013) who estimated that variable cost accounts for 86.68 per cent and fixed cost about 13.32 per cent in Nigeria with BCR of 1.69 indicating economic viability of trout farming in Nigeria. They found substantial difference between fixed cost in earthen and concrete pond which was lower for earthen pond. In Kashmir, trout farming was practiced in concrete raceway and hence cost of construction of raceway was very high.

(iv) *Estimated Trout Production Function*

Three forms of production function, namely, Linear, Cobb-Douglas and Semi-log linear were tested to look into the explanatory behaviour of various inputs that go into the production of trout. The magnitude of the correlation coefficients indicated that multi-collinearity was not a serious problem in estimating the parameter of trout production function. The Cobb-Douglas form of the production function was found to be the best fit on the basis of both economic and statistical criteria. The basic Cobb - Douglas model was linearised by transforming into log linear form as used by Bozoglu *et al.*, (2007). The parameters of the production function were estimated by stepwise method using SPSS 22.0 and results obtained in last run are presented below in the production function form along with the value of F, R^2 and summation of coefficients (β).

$$TP = 0.194 * F^{-0.223^{**}} L^{1.473^{*}}$$

(-0.155) *(0.921)*

N=60 $R^2 = 0.772^{*}$ F=89.62 $\Sigma bi = 1.250$

Note: Figures in the parentheses represent standard error.
* and ** Significant at 5 and 1 per cent level of significance.

The estimated production function indicates that labour hour and trout feed used were the two factors mostly affecting the trout production. These factors are jointly responsible for 77.2 per cent variation in trout production as indicated by the estimated R^2 = 0.772. Co-efficient of feed used (-0.223) indicates that with increase in feed use by 1 per cent, trout production will decline by 0.22 per cent. Similarly coefficient of labour hours (1.473) indicates that one per cent increase in labour hour will increase trout production by 1.47 per cent. Thus, trout production can be increased by reduction in feed use and increase in labour hour to optimum level.

(v) *Return to Scale*

The return to scale in trout production was estimated to be 1.25 which indicates existence of increasing return to scale in trout production. Thus there is scope to increase size of trout farms by adding more raceways to existing one. Ugwanba (2010) also found increasing return to scale for cat fish production in Nigeria.

(vi) *Resource Use Efficiency*

Resource use efficiency was examined for those variables which had significant effect on trout production. The efficiency ratio (r) of marginal value of product (MVP) and marginal factor cost (MFC) determine the efficiency of the employed resources. If r =1, it indicate that particular resource is efficiently allocated or optimally utilised. The marginal value products of feed and labour hours were worked out at their respective geometric mean level. The acquisition costs of both the inputs were taken as MFC for the estimation of efficiency ratio. The results obtained are presented in Table 4.

TABLE 4. ESTIMATED RESOURCE USE EFFICIENCY IN TROUT FARMING

Particulars (1)	Geometric mean (2)	Co-efficient (3)	MVP (4)	MFC (5)	MVP/MFC (6)	Decision (7)
Feed (F)	22.75	- 0.233	- 59.48	73	- 0.8148	Over-utilised
Labour (L)	43.22	1.473	301.7	43.75	6.896	Under-utilised

Perusal of the table revealed that feed and labour hours were used at inefficient level since resource allocative efficiency for trout production (r) is not equal to 1. The estimate of 'r' for feed in trout production is -0.8148 which is less than one and indicate the over-utilisation of feed in trout farming. Similarly more than 1 estimates of 'r' for labour hours (6.896) indicate the under-utilisation of labour in trout production. Thus there is need to optimise the use of both the feed and labour resources for increasing the profitability in trout farming. Ugwanba (2010) found over use of labour in cat fish production but other inputs like feed, seed and fertiliser were under-utilised in Nigeria.

(vii) *Constraints Faced by Sample Trout Farmers*

The constraints faced by farmers were identified and asked to rank them according to their preferences. Based on the responses of the farmers the RBQ score were estimated to know the severity of the constraints and rank was accorded based on RBQ score and the results so obtained are presented in Table 5.

TABLE 5. CONSTRAINTS FACE BY SAMPLE TROUT FARMERS

Sl. No. (1)	Constraints (2)	RBQ score (3)	Rank (4)
1.	High price of inputs (seed and feed)	97.47	I
2.	Transportation	91.87	II
3.	Lack of marketing facility	85.05	III
4.	Non availability of clear and continuous water	84.02	IV
5.	Lack of insurance on crop	79.43	V
6.	Lack of knowledge of modern and scientific trout farming	79.25	VI
7.	Predation	77.95	VII
8.	Difficulty in obtaining credit	76.21	VIII
9.	Scarcity of skilled labour	76.04	IX
10.	Disease occurrence	65.66	X
11.	Non-availability of quality seed	37.72	XI

A total of 11 constraints were identified and ranked with the help of RBQ score to quantify the severity of these constraints. The results revealed that majority of the farmers ranked high price of inputs mainly feed and seed as rank one with 97.47 per cent RBQ score. Since trout culture is an intensive culture system purely dependent on artificial feeding, high price of feed has great impact on its profitability. The cost of feed during study period was Rs.73/kg which trout farmers considered as quite high. Due to low demand for feed at present which constraint the feed mills to operate to its full capacity which resulted its high price. The existing trout seed price of Rs.5-10/piece was very high in comparison to carp seed. The high price may be due to the reason that all the hatcheries were run by the government and under-utilised which leads to high cost of production. Privatisation of seed and feed production may improve the seed and feed availability that will result in reduction in seed and feed price. The extra production can be sold to states like Himachal Pradesh. Sikkim and Arunachal Pradesh where trout culture has been started; this will help to earn some extra revenue. This will not only increase profitability of trout farming but also attract rural youth for trout culture which ultimately generate employment in the valley. The second most important constraint faced by the trout farmer was transportation of the inputs with 91.87 per cent RBQ score. The transportation of seed requires some technical knowledge as fingerling require high oxygen. Sometimes it becomes difficult for the farmers to transport the seed from hatcheries to the farm. As there was only one oxygenated transportation vehicle with the state fisheries department, transporting seed through it was a costly affair due to long distance. As there were only two feed mills and trout farms were scattered in different parts of Kashmir, transportation of feed becomes costly affair for those farms located at

distance from the feed mills. The third most important constraints faced by the farmers was the lack of marketing facility in the valley and presently trout was sold on the farm gate price. Consumers prefer fresh over imported fish from other states and there is great demand for trout in city like Srinagar but due to lack of marketing facility they are unable to. So, there is strong need to promote special marketing system like collective marketing to enable them to sell in market in fresh condition which will yield better price. Other important constraints faced by the farmers which also seems to be severe as reflected from the RBQ score were lack of continuous availability of clean and clear water, lack of crop insurance, lack of knowledge of modern and scientific trout farming, predation, difficulty in obtaining credit, scarcity of skilled labour, disease occurrence and poor quality of seed. All these constraints are seems to be sever except the quality of seed which was reported by very few farmers. The seed produced in the hatcheries were of best qualities which were also exported not only to other state but neighbouring countries like Nepal and Bhutan in the past as reported by the department of fisheries. The feed and seed are found to be the two most important factor in trout production and it adsorbs almost 70 per cent of cost of production as pointed out by Bombeo-Tuburan *et al*., (2001), Oluwemimo and Damilola (2013) and Ele *et al*., (2013). Lazard (2010) also highlights the fact that trout faced a number of constraints like environment, social, and economics. Trout being cultured in intensive system, better management practices need to be followed to reduce the cost of production and avoid any environmental damage.

IV

CONCLUSION

Kashmir valley has vast potential for trout culture and based on the findings of the present study it can be concluded that trout culture is highly profitable and there exists great scope for trout culture in Kashmir. A major investment is required in raceway construction while feed and seed accounts for much of operating cost. The feed and labour are the major factors that affect trout production and they jointly account for 77.2 per cent variation in trout production. The resource use efficiency estimate indicates that the reduction in use of feed and increase in use of labour to optimum level will improve the profitability of trout production. High price of feed and seed were the major constraints in trout production. Looking at vast natural resources and suitable climatic condition for trout culture in Kashmir, there is a need to popularise trout culture as a source of livelihood among rural youth.

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