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*Research Note*

# Economics and Resource-use Efficiency in Exotic Carp Production in Jammu & Kashmir

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**Abstract**

The exotic carps (grass, common and silver carps) constitute a major share in the culture fishes in the state of Jammu & Kashmir. In spite of huge availability of suitable water resources for aquaculture, fish production in the state is very low. The study has identified the factors that affect production of exotic carps in the state and has analyzed the resource-use efficiency. The constraints faced by farmers in fish production have been identified and policy measures have been suggested for improvement of fish farming in the state. The culture of carp has been found a profitable enterprise with net income of Rs.0.88 lakh per hectare per annum. The study on resource-use efficiency has revealed that profitability can be improved by increasing use of carp fish seed and lime and reducing the use of human labour.

**Key words:** Resource use efficiency, exotic carp culture, production function, constraints, Jammu & Kashmir

**JEL Classification:** Q12, Q22

## Introduction

Aquaculture with its significant contribution to blue revolution holds the potential to improve income and nutrition of the poor. Fisheries and aquaculture are the fastest growing production sectors of agriculture in the country (GoI, 2014). India is the second-largest fish producer in the world and in 2013-14 it produced a total of 9.58 million tonnes of fish of which close to two-thirds came from inland sector and the rest from the marine sector (GoI, 2014).

In Asia, aquaculture is dominated by carps that account for 80 per cent of the total aquaculture production (Penman *et al.*, 2005). The cultured carp largely consists of two groups, *viz.* the Indian major carps such as rohu, catla and mrigal and exotic carps such as silver, common and grass carps.

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The fish culture in the Kashmir valley started with the culture of *Schizothorax* species. Since the fish grow very slowly in the captivity (Sunder and Subla, 1984) and also the survivability of fish seed is poor, the focus gradually shifted to culture of exotic carps. Initially, the farmers adopted exotic carp culture as a supplementary enterprise to agriculture to augment their incomes. Although the exotic carp culture accounts for around 70 per cent of total area under fish production in the state, its productivity is far below the national average (GoJ&K, 2012-13) There have been no systematic efforts to study the economics of exotic carp production in the state, and therefore the policy makers feel handicapped to take strategic steps to improve fish production in the state.

With this background, the present study was conducted with following specific objectives: (a) to estimate the economics and identify the factors

affecting exotic carp fish production, (b) to assess the resource-use efficiency in the exotic carp fish farming, and (c) to identify and analyse the constraints faced by the fish farmers so as to suggest some suitable policy measures for the development of fisheries/ aquaculture sector in the state.

## Data and Methodology

Exotic carp is the major form of aquaculture in Jammu & Kashmir accounting for 81.6 per cent of total fish production in the state (GoJ&K, 2012-13). For this study, Jammu district from the Jammu region and two districts *viz.* Ganderbal and Budgam districts from the Kashmir region were selected because of a higher prevalence of exotic carp culture in these districts. The primary data were collected from the exotic carp farmers, which were selected using multistage stratified random sampling and snowball technique. From Kashmir and Jammu regions a total of 80 (40 each) exotic carp farm households were selected for investigation. The sample farms were post-stratified into marginal (land area <1 ha) and small (1-2 ha) farm categories.

The cost of cultivation of exotic carp was estimated using the method mentioned in Acharya and Agarwal (2002) after modifying it for aquaculture production.

The production function analysis was used as a quantitative tool to determine the factors affecting exotic carp production. The production function used in study was developed by taking exotic carp production as dependent variable and other inputs like rice bran, mustard oil cake, cow dung, lime, urea, labour and seed as independent variables and can be expressed as Equation (1):

$$CP = f(RB, MOC, C, Li, U, La, S, Ui) \quad \ldots(1)$$

where,

CP = Total carp production on fish farm (kg/farm),

RB = Total rice bran used on fish farm (kg/farm),

MOC = Total mustard oil cake used on fish farm (kg/farm),

C = Total cow dung used on fish farm (kg/farm),

Li = Total lime used on fish farm (kg/farm),

U = Total urea used on fish farm (kg/farm),

La = Total labour used on fish farm (No. of man-days/farm),

S = Total seeds used on fish farm (No./farm), and

Ui = A stochastic error-term.

Based on a priori and statistical criteria to explain the production of carp, the Cobb-Douglas form of production function was found best fit and is given as Equation (2):

$$\ln CP = \beta + \beta_1 \ln RB + \beta_2 \ln MOC + \beta_3 \ln C + \beta_4 \ln Li + \beta_5 \ln U + \beta_6 \ln La + \beta_7 \ln S + u_i \quad \ldots(2)$$

where, $\beta_i$'s are the unknown parameters to be estimated.

Allocative efficiency (AE) was determined by calculating the ratio of marginal value product (MVP) and the marginal factor cost (MFC), i.e.

$$AE = MVP / MFC \quad \ldots(3)$$

and

$$MVP = \beta i \frac{\bar{Y}}{\bar{X}_i} Py \quad \ldots(4)$$

where,

MFC = Price per unit of input

$\beta_i$ = Regression coefficient of the $i^{th}$ input (i=1,2,3)

$\bar{Y}$ = Geometric mean of output

$\bar{X}i$ = Geometric mean of the $i^{th}$ input (i= 1, 2, 3), and

$P_y$ = Price of output.

The MVP was estimated at the respective geometric mean level and MFC was taken as unit price of the factor. If MVP/MFC equal unity then resource is optimally used. A value of less than unity implies over-use of the resource, and of greater than unity under-use of the resource.

Garrett's ranking technique was used to rank the constraints reported by the sample farmers on different factors. The fish farmers were asked to assign rank to all the constraints faced by them and the outcomes of such rankings were converted into score value with the help of formula (5):

$$\text{Percent position} = 100 (R_{ij} - 0.5) / N_j \quad \ldots(5)$$

where, $R_{ij}$ is the rank given for the $i^{th}$ variable by the $j^{th}$ respondents, and $N_j$ is the number of variable ranked by the $j^{th}$ respondents.

**Table 1. Inputs used in production of exotic carp on sample farms in Jammu & Kashmir**

| Inputs | Recommended levels | Farm size category | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Jammu | | Kashmir | | Jammu & Kashmir | | |
| | | Marginal | Small | Marginal | Small | Marginal | Small | Overall |
| Seedling (000' no./ha) | 12.0 | 11.1 | 11.2 | 11.2 | 11.1 | 11.1 | 11.1 | 11.1 |
| Cattle dung (q/ha) | 60.0 | 44.6 | 42.2 | 33.1 | 32.3 | 39.6 | 36.9 | 38.1 |
| Lime (q/ha) | 5.0 | 3.5 | 3.1 | 3.0 | 3.3 | 3.3 | 3.2 | 3.2 |
| Urea (kg/ha) | 200.0 | 47. | 55.0 | 66.0 | 86.0 | 55.0 | 72.0 | 63.0 |
| Rice bran (q/ha) | 15.0 | 34.9 | 38.6 | 37.9 | 49.0 | 36.2 | 44.2 | 40.1 |
| Mustard oil cake (q/ha) | 15.0 | 34.7 | 36.6 | 38.4 | 48.8 | 36.3 | 43.2 | 39.6 |

## Results and Discussion

### Economics of Carp Production in Jammu & Kashmir

#### Inputs Used in Carp Production

The input-used on sample farms is presented in Table 1 along with the recommended levels to depict the differences in adoption. A perusal of Table 1 reveals that the use of major input, viz. fingerlings was around 11000/ha. The seed was provided to the registered farmers by the state department of fisheries through the national fish seed farm in the Kashmir valley and regional fish seed farm in Jammu. There is no significant difference in seed use across fish farms. The use of cattle dung is higher on marginal (3961 kg/h) than on small (3688 kg/ha) farms. There is not much difference in the use of lime on marginal and small farms. The application of urea is only 63.43 kg/ha which is less than the recommended level. The use of rice bran and mustard oil cake (MOC) is estimated at 4008 kg/ha and 3962 kg/ha, respectively— much higher than their recommended level of 1500 kg/ha.

### Costs and Return in Carp Production

Culture of carp is practised in ponds for a period of 10-12 months. For expanding the culture of carps in the state, the Government provided support to farmers through Rashtriya Krishi Vikas Yojana (RKVY). As per the scheme, each pond constructed under the scheme has an area of 0.15 ha with water spread area of 0.10 ha. The costs and returns in carp farming are presented in Table 2. On average, cost of carp culture (Cost $C_3$) is estimated ₹ 9.74 lakh/ha with little difference between the marginal and small farms. Among different cost components, the cost associated with the use of family labour is the major cost contributing about one-third to the total cost, followed by depreciation on fixed capital (16.3%). Among cash expenses, feed shares the major cost with mustard oil cake and rice bran together accounting for 12 per cent of the total cost. These findings are in line with those of Jayaraman (1999).

The cost of fingerlings is estimated at ₹ 15725/ha for the state as a whole, equivalent to 1.61 per cent of the total cost. A similar pattern is observed in both the regions of state. The state government recommendation on stocking density of about 1200 fingerlings of 60-75 mm size or 2000 number of spawns of 30-40 mm size in 0.1 ha water spread area was followed by most of the farmers in the state. In Kashmir region, the ponds stocked with fingerlings is a common practice, while stocking with spawn is common in the Jammu region. Because of large size of seed, the mortality rate is low and survival is higher despite significant differences in the climate of Jammu and Kashmir regions.

The average gross income per hectare per year from fish farming for the farmers in the state is estimated ₹ 10.64 lakh, being about 10 per cent higher on small farms. The gross income per hectare per year from fish farming is less in Jammu region that in the Kashmir valley. The net income from fish farming is ₹ 0.88 lakh on overall basis. The carp farming was more profitable in Kashmir valley than in Jammu region mainly due to better price realization in Kashmir region (₹ 187/kg) than in Jammu region (₹ 142/kg).

The different measures of costs of carp culture, viz. costs $A_1/A_2$, $B_1$ $B_2$, $C_1$, $C_2$ and $C_3$ are higher for small than marginal farmers in both Kashmir and Jammu regions. It is also observed that net returns are also higher on small farms than on marginal farms

**Table 2. Farm size-wise costs and return in carp culture on sample farms in Jammu & Kashmir**

Value in (000' ₹/ha)

| Cost component | Farm size category | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Kashmir region | | Jammu region | | Jammu & Kashmir | | | |
| | Marginal | Small | Marginal | Small | Marginal | Small | Overall | Share (%) |
| Sample size | 17 | 23 | 13 | 27 | 30 | 50 | 80 | |
| Fingerlings | 14.6 | 18.4 | 13.5 | 15.2 | 14.1 | 16.7 | 15.7 | 1.6 |
| Cow dung | 11.9 | 17.4 | 11.0 | 10.6 | 11.5 | 13.7 | 12.9 | 1.3 |
| Urea | 1.0 | 1.7 | 0.7 | 0.8 | 0.9 | 1.2 | 1.1 | 0.1 |
| Lime | 4.4 | 4.8 | 4.1 | 5.1 | 4.3 | 5.0 | 4.7 | 0.5 |
| Rice bran | 44.9 | 66.9 | 50.6 | 54.4 | 47.4 | 60.2 | 55.4 | 5.7 |
| Mustard oil cake | 56.7 | 73.9 | 52.7 | 54.8 | 55.0 | 63.6 | 60.4 | 6.2 |
| Labour | 30.9 | 37.7 | 29.4 | 36.0 | 30.3 | 36.8 | 34.3 | 3.5 |
| Interest on working capital | 7.5 | 9.3 | 7.8 | 9.1 | 7.6 | 9.2 | 8.6 | 0.9 |
| Communication charges | 1.0 | 1.1 | 1.3 | 1.2 | 1.1 | 1.2 | 1.1 | 0.1 |
| Depreciation on fixed capital | 179 | 204 | 134 | 119 | 160 | 158 | 159 | 16.3 |
| Repair and maintenance | 18.9 | 19.6 | 20.5 | 21.5 | 19.6 | 20.6 | 20.2 | 2.1 |
| A. Cost $A_1/A_2$ | 371 | 455 | 325 | 328 | 351 | 386 | 373 | 38 |
| Interest on fixed capital | 181.0 | 197.7 | 113.5 | 119.7 | 151.7 | 155.6 | 154.1 | 15.8 |
| B. Cost $B_1$ | 552 | 653 | 439 | 448 | 503 | 542 | 527 | 54 |
| Rental Value of land | 32.6 | 38.5 | 28.6 | 32.7 | 30.8 | 35.4 | 33.7 | 3.5 |
| C. Cost $B_2$ | 585 | 691 | 467 | 480 | 534 | 577 | 561 | 58 |
| Imputed value of family lab. | 324.5 | 295.4 | 351.5 | 336.6 | 336.2 | 317.6 | 324.6 | 33.3 |
| D. Cost $C_3$ | 1000 | 1085 | 901 | 899 | 957 | 985 | 974 | 100 |
| Yield (q/ha) | 58.4 | 65.4 | 64.1 | 67.7 | 60.8 | 66.6 | 64.5 | |
| Price (₹/kg) | 185 | 190 | 142 | 143 | 166 | 164 | 165 | |
| Gross income (GI) | 1078 | 1240 | 908 | 964 | 1010 | 1094 | 1064 | |
| Cost of production (₹/kg) | 171 | 166 | 141 | 133 | 157 | 148 | 151 | |
| Net income (GI-Cost$C_3$) | 78 | 155 | 7 | 65 | 53 | 109 | 88 | |
| Farm business income =GI- Cost $A_2$ | 707 | 785 | 583 | 636 | 659 | 707 | 689 | |
| Family labour income =GI-Cost $B_2$ | 526 | 587 | 469 | 516 | 477 | 516 | 502 | |
| B:C ratio at Cost $A_1/A_2$ | 2.9 | 2.7 | 2.8 | 2.9 | 2.9 | 2.8 | 2.9 | |

mainly due to higher yield. The benefit-cost ratio in carp farming is lower (2.79) in Kashmir valley than in Jammu region (2.89), indicating the economic viability of carp culture in both the regions of state. Similar results were obtained by Goswami and Patil (2013) and Uddin and Takeya (2005).

## Factors Affecting Carp Production

To determine the factors affecting carp production, the three forms of production function, namely linear, Cobb- Douglas, and Semi log linear were tried. The Cobb-Douglas form of production function was found to be the best fit on both the economic and statistical criteria. The parameters of production function were estimated by step-wise method using SPSS16 and the results so obtained are presented in Equation (6) along with F value, $R^2$ and summation of coefficients (β).

$$CP = 84.69\ S^{0.160\,*}\ La^{0.259*}\ Li^{0.069**} \quad \ldots(6)$$
$$(0.038)\quad (0.057)\quad (0.028)$$

$N = 80$, $R^2 = 0.584$, $F = 31.825$, $\Sigma bi = 0.48$

where,

CP is the total carp production on fish farm (kg/farm),

S is the total seed used on fish farm (No./farm),

La is the total labour used on fish farm (No. of man-days/farm), and

Li is the total lime used on fish farm (kg/farm)

*Note:* 1. Figures in parenthesis represent standard error

2. (*indicate significance at 1% level) (**indicate significance at 5% level)

The estimated production function indicates that the carp seed, human labour and amount of lime used are the three major factors affecting carp production in Jammu & Kashmir. These factors are jointly responsible for 58.40 per cent variation in carp production. The coefficient of seed used (0.160) indicates that with increase in seed stocking by one percent, the carp production will increase by 0.16 per cent. Similarly, the coefficient for human- labour-use (0.259) and lime-use (0.069) indicates that with increase in these inputs by one per cent, carp production will increase by 0.26 per cent and 0.07 per cent, respectively. Uddin and Farjana (2013) have also found that 1 per cent increase in human labour will lead to 0.297 per cent increase in the gross output for pond fish farming holding other variables constant.

The sum of the coefficients in the Cobb-Douglas production function (estimated elasticity function) for the state of Jammu & Kashmir was 0.48, which indicates the existence of decreasing returns to scale in carp production. This implies that an increase in all inputs leads to a less than proportionate increase in output. Similar results have been reported by Singh *et al.* (2009).

**Resource-use Efficiency**

Resource-use efficiency was estimated for those variables which had significant effect on carp production. The efficiency ratio [Marginal Value Product (MVP) to Marginal Factor Cost (MFC)] for the state as a whole is more than unity for seed and lime and less than unity for labour, which indicate underutilization of seed and lime and over-use of labour (Table 3). Thus, profitability of fish farming can be increased by increasing the use of lime and carp seed and reducing the use of labour. In the previous section, the production elasticity of labour has suggested that increase in use of labour will increase fish production, however, this increase will not add to the profit of fish farmers. More than unity value for efficiency ratio for MOC in the Jammu region and for seed in the Kashmir region indicates that profitability in carp culture can be improved by increasing the use of MOC in Jammu region and fish seed in the Kashmir region. The unexploited economic margins, indicated by the existence of more than unity efficiency ratio, at first sight suggest that farmers are not fully efficient in exploiting the economic opportunity available to them. However, we need to keep in mind that while farmers make *ex-ante* decision about farming, our evaluation of their efficiency is based on *ex-post* examination of their decisions. Actually realised results need not reflect fully the results expected at the time of decision-making.

**Table 3. Resource-use efficiency in carp farming in Jammu & Kashmir**

| Input use | Geometric mean | Co-efficient | Marginal value product (MVP) | Marginal factor cost (MFC) | Efficiency ratio (MVP:MFC) | Decision |
|---|---|---|---|---|---|---|
| | | | **Kashmir region** | | | |
| Seed | 7.07 | 0.53 | 87.82 | 0.78 | 69.20 | Under-utilized |
| Labour | 2.09 | 0.11 | 61.15 | 392.65 | 0.15 | Over-utilized |
| | | | **Jammu region** | | | |
| Mustard oil cake | 5.90 | 0.29 | 45.52 | 15.60 | 2.92 | Under-utilized |
| Labour | 2.25 | 0.16 | 64.59 | 396.25 | 0.16 | Over-utilized |
| | | | **Jammu & Kashmir (Overall)** | | | |
| Seed | 7.14 | 0.16 | 23.59 | 0.81 | 29.12 | Under-utilized |
| Labour | 2.15 | 0.26 | 126.74 | 395.45 | 0.32 | Over-utilized |
| Lime | 3.29 | 0.07 | 22.05 | 15.24 | 1.44 | Under-utilized |

**Table 4. Constraints faced by fish farmers in Jammu & Kashmir**

| Constraint | Jammu region | | Kashmir region | | State | |
|---|---|---|---|---|---|---|
| | Garret score | Rank | Garret score | Rank | Garret score | Rank |
| Dependence on middle men | 73.04 | 1 | 75.66 | 1 | 74.35 | 1 |
| Poor marketing facility | 64.04 | 2 | 62.26 | 3 | 63.15 | 2 |
| Low demand in local market | 55.23 | 4 | 64.84 | 2 | 60.04 | 3 |
| Lack of knowledge about modern carp farming | 63.60 | 3 | 54.18 | 6 | 58.89 | 4 |
| Quality seed availability | 54.98 | 5 | 57.18 | 4 | 56.08 | 5 |
| Transportation of seeds | 53.54 | 7 | 55.29 | 5 | 54.42 | 6 |
| Unavailability of skilled labour | 54.94 | 6 | 45.26 | 7 | 50.10 | 7 |

### Constraints to Carp Production

Farmers were asked to rank their constraints according to their severity. Based on the response of farmers, the Garret score has been estimated to find the severity of each constraint and rank for each constraint was accorded based on Garret score and the results so obtained are presented in Table 4. Out of total 11 constraints identified, dependence on middle men for selling their produce has been ranked as most critical, clearly indicating inefficiency in fish markets in the state or lack of fish farmers' access to markets.

The next important constraint faced by the farmers of both Jammu and Kashmir region is poor access to markets. There is no specific market where fish were exclusively sold. The market constraint was ranked second in Jammu region and third in Kashmir region. The second constraint faced by fish farmers of Kashmir valley is low demand for fish in the local market because of preference for poultry meat and mutton than for fish. The fish farmers sell fish directly to consumers at their door steps. In Jammu region, the lack of knowledge about modern and scientific carp farming is the third major constraint and low demand in local market is ranked fourth constraint. Supply of poor quality seed is an important constraint faced by the farmers in both Kashmir region and Jammu region. The farmers are not satisfied with size of supplied fingerlings and survival of seed in ponds after stocking.

## Conclusions

The carp farming is profitable venture in the state of Jammu and Kashmir and must be promoted for gainful employment of the youth. The study has estimated the economics and resource-use efficiency of carp production in Jammu and Kashmir. The estimated production function for carp culture in the state has indicated that carp seeds, human labour and lime-use are the three major factors that affect carp production. The indicators of resource-use efficiency show that seed and lime are under-utilized, while labour is over-utilized. The study has observed that most of the carp farms are assisted by the Department of Fisheries for inputs like feed, seed, etc. but their limited supplies lead to adoption gaps. So, there is a need to encourage the local people to start private hatcheries and feed production so that availability of inputs is increased.

The fish seeds are supplied to farmers through National fish seed farm in Kashmir and Regional fish seed farm in Jammu. The study has observed that sample farms are far away from the seed sources and transportation of seed is one of the major constraints faced by the farmers. So there is a need to provide mobile seed facilities by the government through which fish seeds can be made available to farmers nearer to their farms. This will not only reduce the cost and inconvenience to farmers but also enhance the survival of seed after stocking leading to higher productivity of fish in the state.

The fish farming has been observed as a supplementary business with main focus on agriculture and hence carp culture practice is extensive in nature with high input and yield gaps. So, there is a need to make the educated youth and local farmers aware about the profitability in intensive culture of carps so that new entrepreneurs can invest in the business. It is also noticed that only few farmers were keeping the records of inputs used and produce harvested. The farmers

should be trained in record keeping which will help them in taking proper decisions in farm management.

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