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# Socio-economic aspects of carp polyculture in ponds: A survey research in the fish super zone area of the bara district

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**Abstract**
A survey was conducted in the fish super zone area of Bara district with the view to assessing socio-economic aspects of carp polyculture in the pond from May to June 2017. 60 respondents overall, 30 from each research area, were randomly selected from the Simraungadh and Pachrauta Benauli municipalities. A standardized questionnaire that had been tested in advance was used to collect data through interviews. The DADO, fish super zone and other relevant agencies provided the secondary data required for the study. To reach the study's goals, descriptive and inferential statistics were employed. According to the number of ponds they owned, farmers were divided into three groups: small, medium, and large. 38 % of responders belonged to large scale (pond area greater than 2 hectares). 38% of respondents engaged in fish farming had primary education and 8% obtained graduation. Most of the respondents (47%) had ponds on lease. 75% of the respondents belonged to all categories having fish farming experience for 1-9 years which indicates the popularity of fish farming is increasing in recent years. Despite quality seed supply from government hatcheries (23%), private hatcheries (42%) dominated the seed fulfilment of the super zone. Most of the farmers practiced chhadi fish production (< 20 g) of mrigal species besides bigger fish (>1kg) of other carp. A total of NRs. 1296710 in variable and fixed costs were involved in the production cost per hectare of the pond area. Average net profit and gross return per hectare were found to be NRs. 401600 and 1698000, respectively. The study revealed that the B/C ratio was 1.73. Low farm gate pricing as a result of middlemen's influence was the main issue seen.

**Keywords:** Carp polyculture, fish super zone bara, benefit-cost ratio

## 1. Introduction

Aquaculture emerges as a potentially important sector in agriculture. The production from pond aquaculture is 55842 mt out of the total fish production of 62897 mt from inland aquaculture activities. At the moment, aquaculture contributes roughly 4.29% of AGDP, 1.34% of GDP, and employs 3% of the population (DoFD, 2017) [6]. The total fish production was 83,897 mt and per capita, fish production was 3.01 kg, respectively (DoFD, 2017) [6]. In pond aquaculture, six to seven species of Chinese carps and Indian major carps are the dominant species with average national productivity of 4.92 t/ha/yr (Shrestha and Pandit, 2007) [14].

Bara district is turning into a fishery hub due to more engagement of farmers in fish farming activities. The polyculture with six to seven species with the semi-intensive managed condition is mostly practised (Prabhaharan and Murugan, 2012; Bauer, 2014) [11, 4]. The district has been implementing the Prime Minister Agricultural Modernization Programme (PM-AMP) since 2016–17. When the super zone was implemented, 3185 mt of fish were produced, compared to 10,000 mt overall in the Bara district with an average productivity of 6.2 mt/ha (PMAMP, Fish super zone, Bara 2016/17) [10]. Fish farming was practised by around 452 farmers from 10 farmer groups and 6 cooperatives at project implementation sites. At the project sites, there was a total of 490 ha of water surface.

The primary objectives of the study were an examination of the socioeconomic condition in the fish super zone area of the Bara districts, cost and return estimates for fish production in the study area, and profitability analysis.

## 2. Materials and Methodology

From May to June 2017, for a period of two months, the study was carried out at two project-implemented sites of Bara, namely Simrangadh and Pachrauta Benauli municipalities of Bara district. The list of all the fish growers in the study area was obtained from DADO, Bara. A pretested semi-structured questionnaire was used to conduct interviews with a total of 60 fish farmers, 30 from each site. Fish growers were categorized as small-scale (pond area up to 0.5 ha), medium-scale (0.51-2 ha) and large-scale (more than 2 ha). The DADO, MoAD, NARC, and other relevant organizations operating in the fisheries and aquaculture sectors provided the secondary data required for the study. The two independent samples were compared using a non-parametric test. Mann-Whitney U test is selected since the data is not normally distributed. Using SPSS-16 and MS Excel (2007), the survey data was coded, tabulated, and analysed

**Fig 1:** The research area's map

Divide a gross return by a gross cost to get the benefit-cost ratio (B/C ratio).
i.e. Benefit cost ratio (B/C) = Gross return/Total variable cost.
Gross return (Rs.) = Total quantity of fish produced (kg) × per kg price (Rs.)
Total Variable Cost (Rs.) = total cost for all inputs that are changeable.
Similarly, total cost of production (TC) was subtracted from gross return to determine net profit.
i.e., Net profit (Rs.) = Gross return (Rs.) - Total cost (Rs.)
Where Total Cost (Rs.) = Total Variable Cost (Rs.) + Total Fixed Cost (Rs.)
According to the Cobb-Douglas production function, the return to scale was computed as follows:

$$\text{In } y = \text{In } A + \beta 1 \ln x\,1 + \beta 2 \ln x\,2 + \beta 3 \ln x\,3 + \beta 4 \ln x\,4 + \beta 5 \ln x\,5$$

Where, Y = Gross Return/Total return (Rs. /ha)
*A* = Constant or Intercept of the function
X1 = Cost of labor (Rs. /ha)
X2 = Cost of feed (Rs. /ha)
X3 = Cost of fingerling (Rs. /ha)
X4 =Cost of fertilizer and Organic Manure (Rs./ha)
X5 = Cosy of fuel and electricity (Rs. /ha)
*β1 β2 .......β5* = Coefficient of respective variables
ln = Natural logarithm

All production coefficients added together show a return to scale and it show how much an output change resulted from a 1% change in all inputs.

## 3. Results and Discussion

### 3.1 Social and demographic information about the respondents

The respondents' population and gender distribution, education levels, landholding sizes, and fish farming expertise are among their socio-demographic features.

#### 3.1.1 Farmer's category

Out of 60 surveyed fish growers, a majority of respondents (38.3%) were large-scale farmers followed by medium (36.7%) and small (25%), respectively.

**Table 1:** Farmers' farm category based on water surface

| Farmers Category | Frequency | Percentage |
|---|---|---|
| Up to 0.5 ha (Small) | 15 | 25.0 |
| 0.51 - 2 ha (Medium) | 22 | 36.7 |
| Above 2 ha (large) | 23 | 38.3 |
| Total | 60 | 100.0 |

Data indicates the % response of the selected respondents (n).

#### 3.1.2 Education status

From (Table 2) it is evident that the majority of respondents' family members were literate. The illiterate respondent farmer's % was only 5%. 60 farmers were surveyed, and 38.3% had completed their primary education, 30% their secondary education, 18.3% their intermediate education, and 8.3% their graduation. Most of the large-scale farmers were literate and had done graduation.

**Table 2:** Level of education of respondent fish farmers

| Education | Small scale | Medium scale | Large scale | Total |
|---|---|---|---|---|
| Illiterate | 6.7 | 4.5 | 4.3 | 5 |
| Primary | 46.6 | 40.9 | 30.4 | 38.3 |
| SLC | 20 | 40.9 | 26.1 | 30 |
| Intermediate | 20 | 13.6 | 21.7 | 18.3 |
| Graduation | 6.7 | 0 | 17.4 | 8.3 |

Data indicates the % response of the selected respondents (n).

**3.1.3 Pond Ownership:** In the fish producers surveyed, 25% of the ponds belonged to the respondents themselves. Leased ponds made up 46.7% of the cultivation ponds. While the majority of small-scale farmers (60%) had their own private ponds, the majority of large-scale farmers (50%) had leased land. (Table 3).

**Table 3:** Pond ownership of respondent farmers

| Pond ownership | Small scale | Medium scale | Large scale | Total |
|---|---|---|---|---|
| Private | 60 | 26.7 | 13.3 | 25 |
| Lease | 17.9 | 32.1 | 50.0 | 46.7 |
| Both | 5.9 | 52.9 | 41.2 | 28.3 |

Data indicates the % response of the selected respondents (n)

**3.1.4 Experience in fish culture:** Out of 60 fish growers, 75% of farmers had 1-9 years of experience in aquaculture, while 15% had 10-19 years of experience (Table 6). About 10% of farmers had 20-29 years of fish farming experience. The majority of farmers are having 1-9 years of experience which indicates that farmers are moving towards fish farming in recent years.

**Table 4:** Fish farming experience

| Farming Experience | Small scale | Medium scale | Large scale | Total |
|---|---|---|---|---|
| 1-9 yrs. | 92.8 | 90.9 | 52.2 | 75 |
| 10-19 yrs. | 7.2 | 0 | 34.8 | 15 |
| 20-29 yrs. | 0 | 9.1 | 13.0 | 10 |

Data indicates the % response of the selected respondents (n)

**3.1.5 Source of seed:** 41.7% of the fulfilment of seeds was from private hatcheries followed by 23.3% from government hatcheries. Private hatcheries were the main source of seed where as farmers were still using Indian hatchery seeds. Although the seeds of government hatchery are of good quality, they are not enough to fulfil fish seed requirements.

**Table 5:** Procurement of seed by respondent farmers

| Source of Seed | Small scale | Medium scale | Large scale | Total |
|---|---|---|---|---|
| Government hatchery | 13.3 | 22.7 | 30.4 | 23.3 |
| Private Hatchery | 46.7 | 31.8 | 47.8 | 41.7 |
| India | 0 | 0 | 2 (8.7) | 3.3 |
| Govt. and Pvt. hatchery | 6.7 | 13.6 | 13.0 | 11.7 |
| Govt. and India | 13.3 | 13.6 | 0 (0) | 8.3 |
| Pvt. and India | 13.3 | 9.1 | 0 | 6.7 |
| All three | 6.7 | 9.1 | 0 | 5 |

Data indicates the % response of the selected respondents (n)

### 3.1.6 Mode of selling

Farmers produced both categories of fish i.e., bigger size (>1 kg) and chhadi fish (40-60 g mrigal). A maximum of the fish 76.7 % was supplied directly to wholesalers, followed by 16.7% to retailers. The majority of fish 91.3 % produced by large-scale farmers were supplied to the wholesaler.

**Table 6:** Mode of selling by respondent farmers

| Mode of selling | Small scale | Medium scale | Large scale | Total |
|---|---|---|---|---|
| Retailer | 26.7 | 22.7 | 4.3 | 16.7 |
| Whole seller | 66.6 | 68.2 | 91.3 | 76.7 |
| Retailer & Wholesaler | 6.7 | 9.1 | 4.3 | 6.7 |

Data indicates the % response of the selected respondents (n).

### 3.1.7 Problems Identified

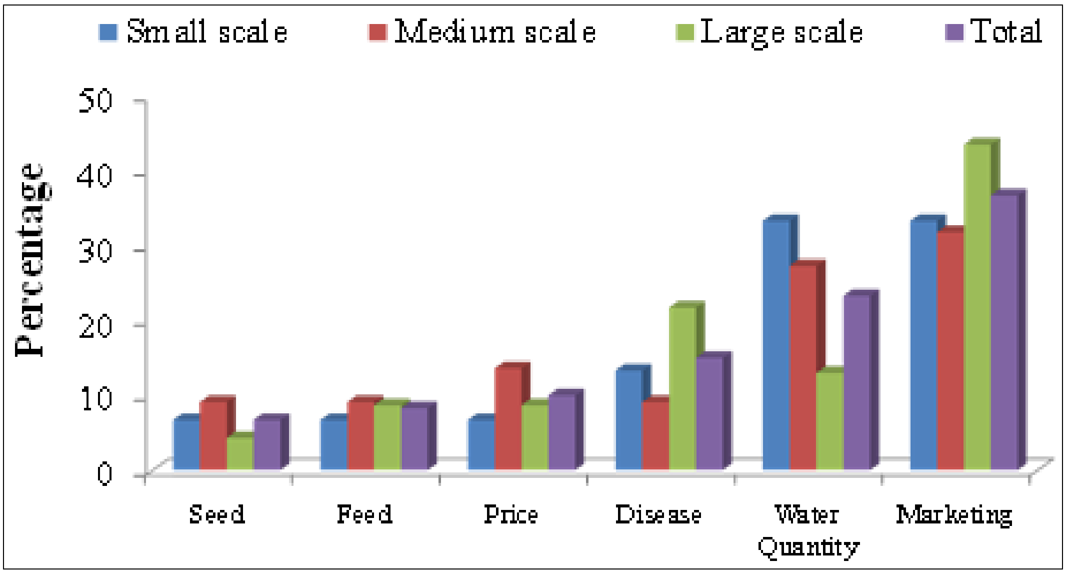


**Fig 2:** Problems faced by farmers in study sites

The results of the interviews revealed a number of issues.. Long marketing channel was a major constraint for collecting small-size fish (chhadi) which resulted in lower market prices. In the study area, diseases were found to be the most prevalent issue, followed by fish ponds with similarly high ammonia levels.

### 3.2 Economic Analysis
#### 3.2.1 Production Yield

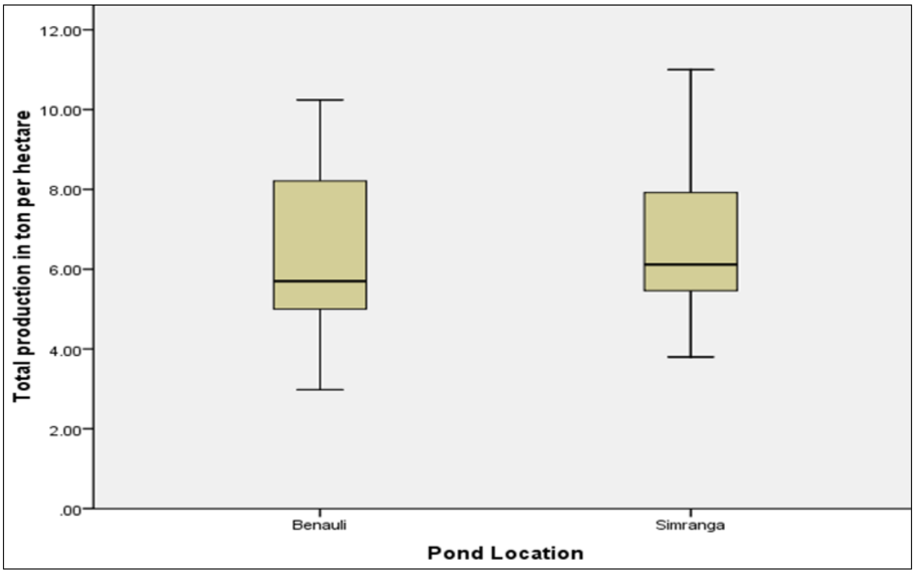


**Fig 3:** Box plots showing total production in tons per hectare at both sites

The total yield was compared between the two study sites it was found that the median total yield for Pachrauta Benauli was 5.8 mt/ha compared to 6.1 for Simrangadh. The Mann-Whitney Test found this difference to be statistically non-significant:

$U = 417$, $p = .631$.

#### 3.2.2 Annual cost of fish production per hectare of pond.
The annual total cost (TC) of producing fish per hectare of pond area was Rs. 1296710. About 75.3% of the entire cost, or Rs. 976900, was made up of variable costs Table 7. Variable costs include the price of fingerlings, feed, labour, fertilisers and manure, limestone, fuel and electricity, pond management, and other expenses.

**Table 7:** Fish production costs per hectare pond per cycle

| S.N. | Cost Particular | Cost (Rs) | Frequency |
|---|---|---|---|
| **A. Variable cost items** | | | |
| 1 | Feed | 664000 | 51.21 |
| 2 | Seed | 36800 | 2.83 |
| 3 | Organic Manure and Fertilizer | 40808 | 3.14 |
| 4 | Fuel and Electricity | 56600 | 4.36 |
| 5 | Labour | 117000 | 9.02 |
| 6 | Limestone | 5340 | 0.41 |
| 7 | Pond Maintenance | 30400 | 2.34 |
| 8. | Miscellaneous | 26183 | 2.01 |
| | TVC | 976900 | 75.35 |
| **B. Fixed Cost Items** | | | |
| 1. | Land Rent | 221000 | 17.04 |
| 2. | Depreciation | 65600 | 5.06 |
| 3 | Interest | 33283 | 2.56 |
| | TFC | 319510 | 24.64 |
| | Total Cost | 1296410 | |

#### 3.2.3 Cost, revenue and benefit-cost ratio per hectare of pond
The overall cost of producing fish per hectare of the pond in the study area was estimated to be Rs. 1296400 (Table 7). Total returns (TR) and net profit were found to be, Rs. 1698000 and Rs. 401600, respectively. The highest TR and net profit were attained at Rs. 26, 80,000 and Rs. 13, 32,000, respectively. It was determined that the minimal TR per hectare was Rs. 11, 50,000. The B/C ratio for fish farming was found to be 1.73 (Table 8).

**Table 8:** The study region's lowest, highest, and average costs, returns, profits, and benefit-cost ratios for each ha of pond area.

| Description | Lowest (Rs.) | Highest (Rs.) | Average (Rs.) |
|---|---|---|---|
| Cost | 8,65,000 | 17,65,450 | 12,96,400 |
| Return | 1150000 | 26,80,000 | 16,98,000 |
| Net Profit | 3,64,000 | 13,32,000 | 4,01,600 |
| Benefit cost ratio (B/C) | 1.17 | 2.64 | 1.73 |

### 3.3 Production function analysis

Fish production requires a lot of inputs. The volume of fish generated either result from the impact of the inputs used or influences the volume of fish produced to some extent. In this work, an extended Cobb-Douglas production function was used to estimate the effect of inputs, and the outcome is expressed in Table 9.

**Table 9:** Calculated values for the Cobb-Douglas production function of fish production's coefficients and related statistics

| Model | Unstandardized Coefficients | | t-value | Sig. |
|---|---|---|---|---|
| | B | Std. Error | | |
| (Constant) | -0.059 | .885 | -.067 | .947 |
| Variable cost for seed per hectare | 0.159* | .008 | 2.942 | .03 |
| Variable cost for feed per hectare | 0.013* | .004 | 5.764 | .02 |
| Variable cost for Labor per hectare | 0.019* | .001 | 2.594 | .04 |
| Variable cost for fuel and electricity per hectare | -0.001 | .001 | -.302 | .764 |
| Variable cost for manure cum fertilizer per hectare | 0.027 | .008 | 1.423 | .160 |

Dependent Variable: Total production in ton per hectare R=0.80, R square =0.64, Adjusted R square=0.60, S.E = 0.79, F-value= 19.18, *represent significant at 5% level, respectively.

The Cobb-Douglas production function was used to assess the impact of varied inputs (Table 9). Five variables, including seed, feed costs, labour costs, fuel and electricity costs, and organic manure and cumulative fertilizer costs, were estimated to indicate their effects on fish output. Three of the five variables, seed, feed, and labour cost were significant at 5% ($p<0.05$); the other two variables fuel and electricity costs and the price of organic manure combined with fertilizers were not significant ($p>0.05$). For the production of fish, the total coefficients of the various inputs came to 0.217. This suggests a declining return to scale and that an increase of 1% in all the inputs used in the function will result in an income increase of 0.217%. For fish production, the model's coefficient of multiple determinations $R^2$ was 0.64. It demonstrates that the explanatory factors included in the model explained about 64% of the variation in gross return. The fish farmers constituted about 38.3%large scale farmers followed by 36.7% medium-scale and 25% small-scale farmers, respectively. The majority of respondents' family members were literate. The illiterate respondent farmer's % was only 5%. Out of 60 farmers surveyed, 38.3% had completed their primary education, 30% their secondary education, 18.3% their intermediate education, and 8.3% their graduation. According to Asif *et al*. (2015) [3], 95% of farmers identified fish cultivation as their primary source of income. The majority of the large scale (50%), had taken land in lease while the majority of the small-scale farmers (60%) had their own private pond.75% of farmers had 1-9 years of experience in aquaculture, while 15% had 10-19 years of experience. About 10% of farmers had 20-29 years of fish farming experience. Anyone can become a prosperous fish farmer with training and extensive expertise in fish culture. Similar results were also identified by Chaki (2011) [5], who noted that expertise and training in fish culture have an impact on the final fish production and are reported to be 47% higher than that of untrained farmers. Farmers in the research area brought the majority of the carp seeds from private hatcheries. According to Sharif et al. (2015) [12], common carp, grass carp, bighead carp, common carp, and Chinese major carp were the most common species produced in hatcheries. Even while government hatcheries produce high-quality seeds, there aren't enough of them to meet the demand for fish seeds. A large majority 16.7% of fish farmers sold their catch directly to merchants, while 76.7% did so for wholesalers. The fish producers discovered that the shorter marketing channel, which comprised fish farmers, merchants, and consumers, was more beneficial. (Hossain *et al.*, 2015) [7].

Around 75% of the overall cost of production was made up of variable costs. With a 51.2% contribution to the overall to variable cost category, feed accommodates the highest cost item. Oluwasola and Damilola (2013) [8] assert that variable costs made up 78% of the overall cost of production. Akinyele John (2011) [2] discovered a similar outcome in Nigeria, where variable costs made up 74% in which feed constitutes roughly 24.72% of the total cost of production. This outcome is comparable to that of the study conducted by (Penda *et al*. 2013; Sharma *et al*. 2018; Adhikari *et al*. 2019) [9, 13, 1]

Fish farming in the superzone seems to be a profitable business as indicated by the B/C ratio of 1.73. The B/C ratio estimated by Oluwemimo and Damilola (2013) [8] and Asif *et al* (2015) [3] were found to be 1.5 and 1.65, respectively. When the median total yield for the two study sites was examined, it was discovered that Pachrauta Benauli's was greater at 5.8 mt/ha than Simrangadh's was at 6.1, above the country's average productivity of 4.92 mt/ha/year (DoFD, 2017) [6]. The productivity of the super zone area of Bara districts was higher than neighbouring districts due to chhadi fish production.

At 5% ($p<0.05$), the relationship between labour, feed, and seed on gross revenue was statistically significant. Assuming declining returns in nature, the total elasticity of the model's variables was found to be 0.217. Similar findings were made by Akinyele (2011) [1] in Nigeria, where the coefficient of production was determined to be 0.781, indicating that production takes place in the second stage of the production function. According to the study by Penda *et al.* (2013) [9], the sum of the coefficient of production is 0.591, which supports the finding that there are declining returns to scale.

### 4. Conclusion

The goal of the current study was to assess the socioeconomic status of carp polyculture from May to June of 2017 over a 2-month period in the Bara districts' fish super zone. A profitable industry in the fish superzone is carp polyculture. This practice can change the socio-economic condition of fish farmers and related people in this area.

### 5. Acknowledgement

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