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# Composite carp culture in Andhra Pradesh and Odisha: A comparative study

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## ABSTRACT

The study compares the economics of composite carp culture practices of two randomly chosen districts in eastern India *viz.* West Godavari in the state of Andhra Pradesh and Jagatsinghpur in Odisha State. Andhra Pradesh and Odisha are endowed with vast resources for carp farming. However, in the present study the districts were found to vary widely in terms of technology and level of input use. Data were collected by personally interviewing the respondents (102 from West Godavari and 90 from Jagatsinghpur) chosen through multistage random sampling and by using a structured schedule. Level of adoption of composite carp culture technology in West Godavari District was worked out as 70.21±17.94 which is higher than Jagatsinghpur District (59.46±23.16). The average fish yield recorded for the two districts were 8.2 and 2.6 t $ha^{-1}$ $yr^{-1}$ respectively. Higher yield in the former may be ascribed to input intensive culture, entrepreneurial interest and adoption of recommended practices of carp culture. Taking into consideration, total cost incurred and return of carp culture, the Benefit-Cost Ratio (BCR) was worked out as 1.66 and 1.52 for West Godavari and Jagatsinghpur respectively. The study indicates that composite carp culture has the potential to be a profitable venture by adopting the recommended package of practices.

Keywords*:* Adoption, Benefit-Cost Ratio, Composite carp culture, Economics

## Introduction

Aquaculture sector in India is gaining momentum with impressive growth rate of 7% per annum. Total fish production of the country is recorded as 13.75 million t (2018-19), of which more than 70% is contributed by the inland fisheries sector (GoI, 2020a). India currently ranks third in the world in fisheries and second in aquaculture production, accounting for 6.3% of total global fish production (GoI, 2020b). With a share of 80%, freshwater aquaculture has emerged as a significant contributor to inland fish production (GoI, 2019). Not only is fish an important source of a variety of intrinsic micronutrients, minerals and fatty acids, but it also accounts for approximately 17% of the most affordable, easily digestible, high-quality animal protein. In many Asian and African countries where large proportion of population are still in hunger and under-nourished, fish contributes to a great extent to food and nutritional security (Kent, 1987; Edward, 2000). Fisheries and aquaculture remain important sources of food, nutrition, income and livelihoods for hundreds of millions of people around the world (FAO, 2016).

One of the most widely used practice in fish farming in India is composite carp culture, which involves stocking different carp species incorporating Indian major carps (IMCs) such as catla (*Catla catla*), rohu (*Labeo rohita*), and mrigal (*Cirrhinus mrigala*) as well as three other exotic carps *viz,* silver carp (*Hypophthalmichthys molitrix*), grass carp (*Ctenopharyngodon idella*) and common carp (*Cyprinus carpio*) having different feeding habits. The three IMCs *viz.* catla, rohu and mrigal contribute the major chunk of the freshwater aquaculture production followed by the exotic carps (silver carp, grass carp and common carp) forming the second important group (Rutayisire *et al*., 2017). Scientific fish culture involves stocking and growing two or more compatible and complementary species of IMCs and exotic carps in a water body like pond to maximise the fish production by fullest utilisation of all available niches in the pond ecosystem. Polyculture of compatible fish species is the most ecologically sound fish culture practice which facilitates efficient utilisation of all ecological zones within the pond environment enhancing maximum standing crop and empowerment for rural youth, which in turn will enhance food and nutritional security (Prakash *et al*., 2018). Scientific fish culture enables production of maximum quantity of fish per unit area from a scientifically managed water body by stocking fast growing, economically important, compatible species having shortest food chain utilising all the ecological niches of the water body (Talukdar and Sontakki, 2005; Goswami *et al.,* 2012).

Andhra Pradesh and Odisha, two important states in eastern India, have vast resources and potential for

freshwater as well as marine fish production. Andhra Pradesh is the major producer of fish in India with the highest production of 34.49 lakh t of which inland fish production has a share of 28.45 lakh t (*i.e*. 82.5%). Being endowed with varied resources and potential, the state is able to provide vast opportunities in fisheries sector in general and freshwater sector in particular (GoI, 2018). Although production in Odisha has increased significantly over the last decade, there appears to be an acute shortage of freshwater fish and the state continues to import freshwater fish from neighbouring states. Understanding the various issues that farmers face and developing strategies to address them will help to increase production and productivity (Ngasotter *et al.,* 2020). This study was conducted with the goal of investigating the socio-economic background and adoption behaviour of fish farmers, as well as comparing the cost and returns of carp culture in Andhra Pradesh and Odisha.

## Materials and methods

*Study area*

The current study was conducted in the districts of Jagatsinghpur in Odisha and West Godavari in Andhra Pradesh (Fig. 1) in 2019-20 using an ex-post facto research design. The village and respondents were chosen using multistage random sampling. From West Godavari District, four blocks namely Bhimadole, Bheemavaram, Narsapuram and Veeravasam were selected after discussion with the fishery officials of the district and data were collected from a total of 102 respondents. Similarly, after discussion with the Head, Krishi Vigyan Kendra and fishery officials from Jagatsinghpur District, three blocks namely Tirtol, Kujanga and Balikuda were selected purposively because of the presence of more fish farmers. To obtain a representative sample, 30 respondents were chosen from each block, for a total of 90 interviews.

*West Godavari*

West Godavari District is one of the nine districts in the coastal region of Andhra Pradesh with administrative headquarters situated at Eluru. As of 2011 census of India, the district has an area of 7,742 km$^2$ and a population of around 39.3 lakhs. The district is well developed in fisheries with resources of fishery wealth in marine, brackish water, reservoir and inland fisheries. It is in fact the aqua hub of Andhra Pradesh. Kolleru Lake located in this district is one of the largest freshwater ecosystem in India providing a greater opportunity for expansion in fisheries sector. Blue revolution is well planned in this district through a multi-pronged approach which includes the introduction of fast-growing, high-yielding species. For the year 2017-18, this District achieved 10.51 lakh t of fish production with Gross Value Added (GVA) of ₹10,088 crores. For the year 2018-19, a target was set for 11.50 lakh t with GVA of ₹15,000 crores.

*Jagatsinghpur*

According to the 2011 census, Jagatsinghpur District is a coastal district in Odisha, with an area of 1759 km$^2$ and a population of 11.37 lakh people. Jagatsinghpur plays an important role in the agrarian and industrial economies, as well as in sea trade and fishing commerce. Around seventy percent of its population depends on agriculture and agro-based occupations. In culture fisheries, the state has a production potential of 3.9 lakh t (GoI, 2018). In 2017-18, the district of Jagatsinghpur produced 0.13 lakh t of freshwater fish, accounting for 2.8% of Odisha's total freshwater fish production (GoO, 2019).

*Scoring pattern*

The soci-oeconomic aspects *viz,* age, education level, pond location, extension contact, media exposure, level of understanding and adoption of suggested technology that might affect adoption of composite carp culture method

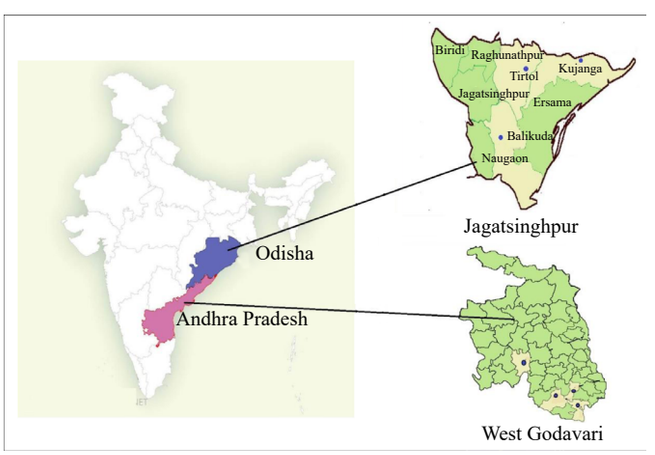


Fig. 1. Map showing the study locations

were discussed in the interview process. The total score of an individual was calculated to measure characteristics like media exposure and knowledge level. The responses for the variable exposure to mass media were scored on a 1-3 scale for exposure to newspaper, radio, television, Facebook, You Tube, Whatsapp, text messages, internet, e-mail, magazines and leaflets/bulletins. A knowledge scale with step-by-step instructions was created for knowledge level in accordance with Jethi *et al.* (2019) which included a preliminary Likert's approach screening of the items through t-statistics, mean scores, reliability and validity tests and mean score calculation. The responders were then given a knowledge exam to see how much they knew about various components of composite carp culture. The respondents were then divided into three groups based on the mean and standard deviation of the combined score of both variables (SD). The three categories were: low (Mean-SD), middle (Between Mean-SD) and high (>Mean+SD).

To measure the level of adoption, a collection of 22 items was created in three major phases *viz,* Pre-stocking, Stocking and Post-stocking of composite carp culture technique. The items were then forwarded to subject-matter experts. They were questioned to rank the items' relevance to the topic matter on a Likert type 3-point continuum as most relevant (3), relevant (2) and not relevant (1). The items were initially screened using the Likert technique by computing the t-score along with reliability and validity tests. Finally, 13 items from the original set were kept to be given to the respondents. The 13 practices included: (i) Removing predatory and weedy fish; (ii) Preparing ponds for each crop cycle; (iii) Adjusting water pH with lime or alum; (iv) Installing filters at the water inlet and outlet; (v) Stocking seeds after proper acclimatisation; (vi) Disinfecting seeds before stocking; (vii) Fertilising and manuring according to recommendations; (viii) Plankton crash noted during crop cycle; (ix) Supplemental feeding provided based on biomass calculations; (x) Water exchange and aeration adopted to maintain water quality; (xi) Fortnightly sampling done to assess health of the fish; (xii) Dead animals disposed of with care and (xiii) Supplemental feeding with pellet feed. Farmers were questioned whether they used the practices or not. The technology's adoption and non-adoption received scores of 1 and 0, respectively. As a result, the maximum possible score for each respondent was 13. The adoption quotient was calculated for each respondent using the formula proposed by Pareek and Chattopadhyay (1966):

Adoption quotient = No. of practices adopted/No. of practices advocated x 100

After working out the adoption quotient, the mean and standard deviation of both the districts were compared. Descriptive statistics of variables *i.e.* frequency and percentage was also carried out to draw further inferences.

*Economic model*

The Gross Margin Analysis (GMA) tool was used in this study to determine the profitability of composite carp culture. GMA is an important tool for determining farm profitability. A gross margin (GM) is the difference between the fish farm's gross income (total revenue) and the total variable costs required to produce the output (Firth, 2002). Total revenue was calculated by multiplying total output by the price per unit of fish. Variable costs are those that vary in direct proportion to production level. The total variable cost includes input costs such as fertiliser, transportation, labour, feeding and the cost of other inputs such as fingerlings.

Gross Margin = Total Revenue - Total Variable Cost

To determine the profitability of the proposed scheme, the rate of return on total investment was calculated as follows:

ROI = (Net Margin/Total Cost) * 100

where Net Margin = Gross Margin - Non-operating Expenses

In the above formula, net margin was calculated after deducting non-operating expenses such as loan interest.

*Break-even analysis*

$$\text{Break-even point} = \frac{\text{Fixed costs}}{\text{Sales price per unit - Variable cost per unit}}$$

*Capital productivity*

Capital productivity shows how efficiently capital is used to generate output. It reflects the joint influence of labour input per unit of capital used and multifactor productivity (MFP); the latter reflecting the overall efficiency of production.

$$\text{Capital productivity} = \frac{\text{Total output}}{\text{Capital input}}$$

## Results and discussion

*Socio-economic profile and adoption behaviour of fish farmers*

The socio-economic variables (independent variables) of both the districts were analysed and are presented in Table 1. Majority of the fish farmers of both the districts were in the age group of 35-50 years followed by old age group (>50 yrs) and young age group (20-35 yrs). Around one-fourth (24.5%) of the farmers of West Godavari District have an education level of matriculation whereas, it was 28.9% for the farmers of Jagatsinghpur District. None of the fish farmers of West Godavari were found having a pond area of less than 1 acre. Majority

(85.3%) of them have pond area >2 acres followed by 1-2 acres (14.7%). Whereas, majority (64.44%) of the fish farmers have a pond area of 1-2 acres followed by >2 acres (25.56%) in Jagatsinghpur District. Only 10% of the respondents have a pond area of <1 acre. It suggests that farmers in West Godavari are engaged in large-scale carp culture for commercial purposes. The majority (46.1%) of West Godavari fish farmers have low extension contact, whereas the majority (45.56%) of Jagatsinghpur respondents have a medium level of extension contact. It can be depicted that the fish farmers of West Godavari are practicing carp culture with their own experience having less contact with the extension personnel or activities. Majority of fish farmers of both the districts were found having medium level of exposure towards mass media and knowledge level. The yield from composite carp culture was found to be in the range of 0.77-6.2 t $ha^{-1}$ $yr^{-1}$ for Jagatsinghpur District and for West Godavari District it was found in the range of 3.25-10.16 t $ha^{-1}$ $yr^{-1}$. Fish farmers of Jagatsinghpur District are able to get a mean fish yield of 2.57 t $ha^{-1}$ $yr^{-1}$ which is less than the average production in the demonstration pond *i.e.* 3 t $ha^{-1}$ $yr^{-1}$ (GoI, 2019). Fish farmers of West Godavari District are getting a mean yield of 8.23 t $ha^{-1}$ $yr^{-1}$ nearly equal to that of experimental/research station *i.e.* 8 t $ha^{-1}$ $yr^{-1}$ (ICAR, 2009). The mean adoption quotient of West Godavari District was found to be 70.21 with a standard deviation 17.94. The corresponding figure was less for Jagatsinghpur District *i.e.* 59.46 with a standard deviation of 23.16. The higher adoption quotient indicates that the farmers in West Godavari are adopting more number of recommended practices than that of the farmers of Jagatsinghpur District. Adoption of modern technologies is one of the most promising strategies to increase farm income (Varshney *et al.,* 2020).

The cost and return structure of the fish farmers of both the districts were analysed and is presented in Table 2. The average pond area possessed by the farmers of West Godavari was found to be 5.82 acres while it was 0.91 acre for the fish farmers of Jagatsinghpur District. It indicates that the farmers of the former district are practicing it in a commercial and intensive way. The commercial freshwater aquaculture in Andhra Pradesh is of intensive and semi-intensive type. Only a few farmers adopted modified extensive and extensive farming (Abraham *et al.,* 2010). The lease value incurred by the fish farmers of West Godavari is ₹1,18,094 which is about four times

Table 1. Socio-economic variables and adoption level of the respondents

| Variables | Category | West Godavari (n=102) | Jagatsinghpur (n=90) |
|---|---|---|---|
| Age | Young (20-35 years) | 18 (17.6%) | 11 (12.22%) |
| | Middle (35-50 years) | 55 (54.0%) | 53 (58.90%) |
| | Old (>50 years) | 29 (28.4%) | 26 (28.8%) |
| Education level | Illiterate | 16 (15.7%) | 0 |
| | No formal schooling | 6 (5.9%) | 12 (13.33%) |
| | Primary | 15 (14.7%) | 9 (10%) |
| | Middle | 18 (17.7%) | 13 (14.44%) |
| | Matriculation | 25 (24.5%) | 26 (28.90%) |
| | Higher secondary | 11 (10.8%) | 11 (12.22%) |
| | Graduation | 8 (7.8%) | 16 (17.78%) |
| | Post-graduation | 3 (2.9%) | 3 (3.33%) |
| Pond area | <1 acre | 0 | 9 (10.00%) |
| | 1-2 acre | 15 (14.7%) | 58 (64.44%) |
| | >2 acre | 87 (85.3%) | 23 (25.56%) |
| Extension contact | Low | 47 (46.1%) | 32 (35.56%) |
| | Medium | 30 (29.4%) | 41 (45.56%) |
| | High | 25 (24.5%) | 17 (18.88%) |
| Exposure to mass media | Low | 15 (14.7%) | 25 (27.77%) |
| | Medium | 75 (73.5%) | 54 (60.00%) |
| | High | 12 (11.8%) | 11 (12.23%) |
| | Mean±SD | 45.01±6.77 | 60.13±14.73 |
| Knowledge level | Low | 18 (17.6%) | 19 (21.12%) |
| | Medium | 67 (65.7%) | 58 (64.44%) |
| | High | 17 (16.7%) | 13 (14.44%) |
| | Mean±SD | 44.04±8.34 | 60.65±19.40 |
| Yield (t $ha^{-1}$ $yr^{-1}$) | Range | 3.25-10.16 | 0.77-6.2 |
| | Mean | 8.23 | 2.57 |
| Adoption level | Mean±SD | 70.21±17.94 | 59.46±23.16 |

Table 2. Comparative economics of composite carp culture in West Godavari and Jagatsinghpur

| Particulars | | Amount (₹) | |
|---|---|---|---|
| | | Jagatsinghpur (n=90) | West Godavari (n=102) |
| No. of respondents | | 102 | 90 |
| Total area (ha) | | 593.70 | 81.58 |
| Avg. area (ha) | | 5.82 | 0.91 |
| Lease (₹) | | 1,18,094.20 | 29,617.17 |
| Pond preparation (₹) | | 53,297.96 | 24,065.94 |
| Seed cost (₹) | | 50,138.12 | 50,766.67 |
| Lime (₹) | | 3,065.52 | 2,231.70 |
| Inorganic fertilisers | DAP (₹) | 2,814.03 | 1,711.07 |
| | SSP (₹) | 2,087.67 | 821.92 |
| | Urea (₹) | 1,868.25 | 2,672.27 |
| Organic manure (₹) | | 7,899.99 | 3,588.80 |
| Additives (₹) | | 11,723.09 | 3,424.29 |
| Feed | Pelleted feed (₹) | 86,916.62 | 40,359.46 |
| | Rice bran + oil cake (₹) | 1,41,905.80 | 12,398.15 |
| Disease (₹) | | 12,839.99 | 1,038.65 |
| Cost of harvesting (₹) | | 11,672.56 | 7,530.815 |
| Cost of labour, maintenance and miscellaneous (₹) | | 46,163.89 | 31,933.91 |
| Total variable cost (₹) | | 4,32,393.49 | 2,24,543.61 |
| Cost of production (₹) | | 5,50,487.69 | 2,54,160.83 |
| Total production (kg $ha^{-1}$) | | 8323.73 | 2,769.52 |
| Total revenue (₹) | | 9,15,610.58 | 3,87,732.81 |
| Gross margin (₹) | | 4,83,217.09 | 1,63,189.24 |
| Net margin (₹) | | 3,65,122.89 | 1,33,572.00 |
| Rate of return on investment (ROI) | | 66.33 | 52.04 |
| B:C ratio | | 1.66 | 1.52 |
| Break-even production (kg) | | 2034.35 | 501.98 |
| Capital productivity | | 2.12 | 1.72 |

that of Jagatsinghpur District (₹29,617). Average pond preparation cost was found more (₹53,297) for West Godavari than the other district (₹24,065). It is because, after every 2-3 years the fish farmers are cleaning the excess swamp and residues from the pond area in order to make it suitable for the next crop cycle. Average seed cost for both the districts were found nearly equal with a difference of ₹600 which indicates less variation in stocking of the fish seeds. But the stocking size was different for both the districts.

As the fish farmers of West Godavari are practicing commercial and intensive aquaculture, they stock yearlings in their pond. An average of 2506 numbers of yearlings were stocked per hectare of water area. Due to bigger size, survival rate was more than 90%. Each yearling was around 150 g size during stocking and 1-1.5 kg at the time of harvesting. The average selling price was ₹110 per kg of fish. In Jagatsinghpur, most of the farmers were stocking fingerlings due to unavailability of bigger size seed material. An average of 10153 numbers of fingerlings were stocked per hectare and their survival rate was around 70%. The harvesting size was same as West Godavari, whereas it took more time to complete one cycle of production. Due to higher demand of live fish in local market, the farmers were able to sell the fish at ₹140 per kg of fish.

Major difference was observed in feed cost of both the districts. Cost incurred for pelleted feed were ₹86,916.62 for West Godavari and ₹40,359.46 for Jagatsinghpur districts, whereas the cost incurred for rice bran including oil cake were ₹1,41,905.80 and ₹12,398.15 for West Godavari and Jagatsinghpur districts respectively. It clearly indicates that carp farming is more input intensive for West Godavari than that of Jagatsinghpur District. The average production was 8.3 t $ha^{-1}$ $yr^{-1}$ in West Godavari, which surpasses the yield of research station (8 t $ha^{-1}$ $yr^{-1}$). However, Jagatsinghpur recorded yield of 2.7 t $ha^{-1}$ $yr^{-1}$ (less than that of the FFDA demonstration pond yield of 3 t $ha^{-1}$ $yr^{-1}$). In a study comparing the production and economics of three types of fish culture methods namely commercial feed based culture system, conventional feed based culture system and extensive method without feed, Shivakumar *et al.* (2014) discovered that the commercial feed based culture system produced the most

when compared to the other two systems. The study also stated that profit is more in commercial feed based system than extensive method of cultivation without feed. Hussain *et al.* (2013) observed in their study that CFC (composite fish culture) production and profitability are more than double that of local practices due to the adoption of good management practices. The B:C ratio for West Godavari was worked out as 1.66, however it was 1.52 for Jagatsinghpur District clearly indicating more benefits over the total production cost. ICAR-CIFA is also conducting various training programs to provide proper technology on scientific fish farming for improving the livelihood of tribal families (CIFA, 2019). With an increase in the state's annual per capita fish consumption, demand for fish and fisheries products has increased. As a result, it is critical to boost fish production by utilising the state's abundant resources. The majority of fish farms still use traditional fish farming techniques and more fish farms need to be converted to scientific farming (Ngasotter *et al.,* 2020). The fish farmers should be made aware of the schemes like Pradhan Mantri Matsya Sampada Yojana (PMMSY) that has been introduced by Govt. of India to reap financial benefit. Making fish farmers aware of these schemes has the potential to transform fish culture into a full-fledged entrepreneurship. Commercial farmers make significant contribution to investments in the sector. Despite the sector's past performance, there are ample opportunities to double production by 2030 and quadruple production by 2050 (CIFA, 2015). There is no doubt that the commitment of fish farmers and carp culture will grow in the coming years. However, a strong commitment from government agencies and research institutions, as well as more intensive and comprehensive collaboration, training and technology expansion are urgently required (Abraham *et al.,* 2010).

The study observed that carp culture practice in Andhra Pradesh and Odisha varied in terms of technology, adoption of recommended practices, level of input use, yield as well as profit. Input intensive carp culture with higher production and returns characterises fish farming in West Godavari District. The farmers have adopted several innovative measures for ensuring a profitable fisheries enterprise. On the contrary, the fish farmers of Jagatsinghpur District practice extensive farming with low doses of inputs. Production and net returns suffered due to poor adoption of recommended practices. Govt. of India has recently come up with PMMSY scheme with a budget of ₹20,050 crores for the overall development of fisheries and aquaculture sector. It is time that farmers take advantage of such incentives and shift from extensive to semi-intensive carp culture, especially in Jagatsinghpur District.

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