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# Enhancing benefits through incorporation of *Puntius gonionotus* in polyculture system: Outputs from an adaptive trial in rural Odisha

**Ananth PN, Sahoo PR, Das PC, Das SS and P Jayasankar**

**Abstract**
Species diversification in aquaculture is becoming a thrust area for research and extension in India with the concern of exploiting additional opportunity of managing available extensive indigenous fish resources. The present study is based on an adaptive Trial at farmer's field conducted by Krishi Vigyan Kendra-Khordha, the farm science centre on the incorporation of *Puntius gonionotus* in polyculture system. The results indicated that average gross production after final harvesting of the ponds was found to be 3235.7 and 3584.83 kg in T1 (farmers practice) and T2 (incorporation of minor carps) respectively. The benefit cost ratio was found to be increased from 2.37 to 2.53 indicating a good return and better prospect of incorporation of *P. gonionotus* in polyculture with Indian Major Carps (IMC). An additional average net income of Rs 26,030/ha with a meagre additional investment of Rs 4,330/ha from the same water body encourages the farmers towards the new technology. This adaptive Trial results reconfirmed the research station Trial that *P. gonionotus* is a candidate species for polyculture system for the farmer's adoption in large scale. However, the study also concluded that promotion of incorporation of minor carps in polyculture system needs to be linked with markets as the demand is scattered than the local consumption.

**Keywords:** Minor carps, Krishi Vigyan Kendra, polyculture, adaptive Trial

## 1. Introduction
The research and development efforts during the last five decades have greatly enhanced average fish yields in the country making carp culture an important economic enterprise (Pillai and Katiha, 2004) [1, 2]. The technology developed for fish culture in two or more species of compatible fishes are cultured simultaneously is the most advanced and popular form of aquaculture in India and is known as composite fish culture (Mondal *et al.*, 2011) [3]. The availability of quality seed is prerequisite for rapid expansion and growth of aquaculture. However, uncertainty in timely seed supply is one of the major constraints (Radheyshyam, 2010) [4]. Though being a popular form of livelihood over the years scarcity of water is creeping into the constraint basket faced by fish farmers in India in adopting composite fish culture. Demonstration of fish culture practices in community ponds are challenged by its nature as water bodies are common property resources which requires substantial support from communities (Ananth *et al*., 2014) [5].

India is predominantly a carp based aquaculture system and species diversification is found to be an option towards providing a variety of fishes to consumers. Species diversification is another important area that Research and Development institutions are thriving hard to standardize breeding programmes and promote other species with a marginal replacement of Indian Major Carps (IMC). Most farmers in India culture catla and rohu for their higher market prices and rapid growth. However, one needs to understand that there are some new species that can be incorporated in the polyculture system (Nair and Salin, 2007) [6]. Developmental strategies need attention towards diversification of aquaculture through locally available fish species (Sinha *et al.*, 2012) [7]. With the increase in demand for aquacultured foods, there is need for more efficient production systems. Though the country is rich in aquatic resources, the index of biodiversity utilized for aquaculture is of the order of 0.13 (~85% from Indian major carps; ~ 5% air-breathing fishes; ~10% restall species together (Ayyappan *et al*., 2009) [8]. Hence, for the sustainability of aquaculture,

more species need to be brought into the culture (Nair and Salin, 2007) [6] and they again indicate that many indigenous freshwater fish, including several minor carps and barbs, enjoy better markets and prices in India than major carp. The incorporation of these fishes with major carp in polyculture should make them more economical than major carp polyculture alone, although the yield characteristics and concepts of competition among these species need to be more fully understood. In India, necessity of inclusion of more promising species into the freshwater aquaculture systems has been emphasised long ago. They also inform that there are many minor carp species available in the natural waters of India which have culture potential and regional importance which command high consumer preference (Das and Mishra, 2016) [9].

The concept of carrying capacity and standing biomass in pond ecology plays a major role in increasing the production per unit area. Judicious use of these factors provides the opportunity to incorporate minor carps and barbs in major carp culture system. Scientific study claims that initial higher growth rate of minor carps and barbs increases the production potential and additional income from culture ponds. These fishes have also a good market demand and consumer preference and play an important role in species diversification and conservation.

Krishi Vigyan Kendra (KVK)-Khordha, a fully funded farm science centre of Indian Council of Agricultural Research (ICAR), New Delhi works in Khordha district under the administrative control of ICAR-Central Institute of Freshwater Aquaculture, Bhubaneswar with the mandates of technology assessment, refinement and demonstration. This paper is based on the adaptive Trial undertaken with incorporation of minor carps *Puntius gonionotus* in polyculture system in farmers field. The aim of the adaptive Trial is to assess the feasibility of the technology at farmers field though confirmed potential has been reported from research station by Das (2015) [17]. The output of this adaptive Trial is meant towards extension of these results to state for further popularisation as aquaculture is a state subject. With this background the present study was conducted with the following objectives to assess the feasibility of the technology at farmers field, to elicit the response of farmers towards the process of technology and benefits and to recommend at the district level for promotion of this viable technology. The present study was conducted in 2014-16 with the support of ICAR, New Delhi.

## 2. Materials and Methods

### 2.1 Study Area

The present study was conducted in Khordha which is one of the 33 districts of Odisha State endowed with natural resources for providing livelihood in both rural and urban sectors. Agriculture is the mainstay which plays a vital role in the economic development of the district with animal resources as side line of almost all the farming community in the district. Fisheries also serve as a major livelihood option of the rural community in three blocks where freshwater resources are prominent livelihood activities. Area under freshwater aquaculture is 1929.24 ha comprised of tanks and ponds and tuning to a production of 15,760 MT (DFO, 2015) [10].

### 2.2 Management of the Adaptive Trial

The present adaptive trial was conducted in two blocks of Khordha district of Odisha State, India. Six farmers from each block and two ponds from each farmer were selected for the study. Selected farmers were trained on the technology, package of practices and potentials of the technology.

### 2.3 Technology package under Trial and process

#### 2.3.1 Stocking

One pond from each farmer is stocked with seeds of Indian Major Carp (Catla, *Catla catla; Rohu, Labeo rohita;* and Mrigal, *Cirrhinus mrigala*) with stocking density of @8000/ha (T1, Farmer practice) and the other pond was stocked with seeds of Indian Major Carps (IMC) with stocking density of @8000/ha and *P. gonionotus* with stocking density of @1600/ha (T2, Recommended practice). In Recommended practice *P. gonionotus* was incorporated @20% of total stocking density (i.e 1600 numbers) into the polyculture system. In both the treatments, catla, rohu and mrigal were stocked in the ratio 40:30:30.

#### 2.3.2 Feeding and fertilization

Feeding was provided with Groundnut oil cake and Rice bran @ 6% of the biomass in the first month and 4% of the biomass in the second month. In subsequent months feeding was restricted to 2-1%. Pond fertilization was done with raw cow dung (as organic fertilizer), urea and single super phosphate (as inorganic fertilizer) for plankton production (Handbook on Fisheries Statistics, 2014) [11].

#### 2.3.3 Harvesting

Harvesting of *P. gonionotus* was done after 5-6 months of stocking, allowing the major carps to grow further for another 4-5 months.

### 2.4 Observations and Analysis

Water quality was analysed monthly and liming of pond was carried out on the basis of water quality (APHA, 2014) [12]. Before the Trial the farmers were trained on the technology under Trial with the provision of fingerlings of IMC and minor carps. Observations were periodically undertaken involving the farmers in a participatory mode. Simple percentage analysis was done to calculate the survival, average weight gain and average gross production. Economic parameters like average cost of culture, average gross return, average net return and Benefit-Cost ratio were calculated to assess the profitability of the recommended practice. As the trial was conducted in farmer's field in participatory mode, the cost towards input was calculated as per the price in the prevailing locality.

## 3. Results and Discussion

Important water quality parameters like pH, total hardness and total alkalinity were measured in monthly basis and necessary lime and fertilization application were carried out as per standardised protocol of carps pond management. Water quality parameters were found to be within the tolerable limits as reported for carps (Tripathi *et al.,* 2000 and Jena *et al.,* 2002) [13, 14]. Combined survival rate of IMC were found to be 74.9% and 72.8 % in T1 and T2 respectively. The survival rate of *Puntius gonionotus* in T2 was found to be 83.6% (Table1). The result follows the trend found by (Das and Mishra, 2016) [9] in earthen ponds at research stations and (Jena *et al.,* 2007) [19] that the relatively higher survival of silver barb indicates its better adaptability to the culture condition. The average weight gain of IMC was 540 and 534.8 g in T1 and T2 respectively. The average weight gain of

*Puntius gonionotus* was 351g in T2 in 5-6 months of culture. The results also falls in line with the study of (Haque *et al.,* 1998) [15] that a significantly higher (P<0.05) fish yield (1793.65 Kg/ha/yr) was observed in the four species polyculture system containing *Puntius gonionotus* when the combined yield of all species was compared. Average gross production was calculated after final harvesting of the ponds and found to be 3235.7 and 3584.83 kg in T1 and T2 respectively. A perusal of Table 1 reflects that an average increase in production to the tune of 10.77% in T2 over T1 (Table1).

**Table 1:** Stocking and harvesting details of the Trial

| Treatment | Species | Stocking density (numbers/ha) | Survival (%) | Average weight gain (g) | Average gross production (kg) |
|---|---|---|---|---|---|
| T1 (Farmer practice) | Catla, Rohu and Mrigal | 8000 | 74. 9 % | 540 | 3235.7 |
| T2 (Recommended practice) | Catla, Rohu and Mrigal | 8000 | 72. 8 % | 534.8 | 3114. 8 |
| | *Puntius gonionotus* | 1600 | 83.6 % | 351.4 | 470.03 |

During the sixth month of the Trial farmers were informed to harvest the minor carps and on the other hand to allow the major carps to grow which is the decisive in this technological option. Farmers in this study perceived that incorporation of minor carps and harvesting after 5-6 months is profitable which supplements intermediary income during the crop cycle. Research station studies by (Das, 2012) [16] indicates that in turn reconfirms this study that an interim production of the minor carps/barbs after six months of culture gives an additional fish production and income to the farmer and increases the total fish productivity of the unit culture area, besides ensuring effective utilisation of pond productivity.

Inclusion of minor carps and barbs in culture system has been proven to be advantageous in terms of increasing biomass harvest from the pond. Besides, such intercropping system also provides a scope of interim roll back of the investment from the harvest of the minor carp groups after 5-6 months of culture. This not only reduces the capital investment in the system, but also part of the sale price can further be utilized towards feed cost during the subsequent culture of major carps (Das, 2015) [17]. The overall assessment of any technology under an adaptive Trial ends with the economic analysis which is key in the micro farming situation as farmer benefits and economics is predominant. In the present study the economic analysis was performed to find out the benefit cost ratio and the gross/net return (Table2). The benefit cost ratio was found to be increased from 2.37 to 2.53 indicating a good return and better prospect of incorporation of *P. gonionotus* in polyculture with IMC. An additional average net income of Rs 26,030/ha with a meagre additional investment of Rs 4,330/ha from the same water body encourages the farmers towards the new technology. Monoculture of *P. gonionotus* gave an average gross production of 815 kg.ha [1] after five months, whereas from polyculture, gross production amounted to 1,373 kg-ha$^{-1}$ during the same rearing period [18].

**Table 2:** Economic Analysis of the Trial

| Treatment | Average cost of culture (Rs/ha) | Average gross return (Rs/ha) | Average net return (Rs/ha) | Benefit-Cost ratio (Gross Return/ Gross Cost) |
|---|---|---|---|---|
| T1, (Farmer practice) | 123790 | 294448.7 | 170658.7 | 2.37 |
| T2 (Recommended practice) | 128120 | 324809.4 | 196689.4 | 2.53 |

There are a number of studies related to incorporation of medium carps and barbs into the polyculture system, which indicate their production potential and profitability (Jena *et al.,* 2007, Das and Mishra, 2016, Milstein *et al.,* 2008, Hossan *et al.,* 1997, Haque *et al.,* 1998) [19, 9, 20, 21, 15]. The present study in participatory mode and utilizing the available resources with farmers provide encouraging result for its wide scale adoption which reconfirms that it is viable in the micro farming situation.

### 3.1 Market for Minor carps

The growth and development of the fisheries sector is highly dependent on an efficient fish marketing system (Ayyappan *et al.,* 2009) [8] and the same is true with minor carps though the production technology has been proven to be feasible with this study. Adoption of this viable technology will be surely in a large extent if the there is a market preference.

The assessment trials indicated that the production increased from 2.4 t/ha to 3.6 t/ha and 28.8% increase in net income. Incorporation of medium carps is a feasible technology for larger scale adoption. As a medium sized carp Puntius Sarana, the species has high market demand and fetches price even higher than the Indian major carps in several regions (Jena *et al.,* 2007) [19] Common carp, owing to its early maturing and pond breeding habit, may upset the population balance, thereby resulting in poor growth of other component species (Sinha *et al.,* 1985) [22]. Incorporation of *L. calbasu* in place of common carp may be a better strategy to avoid this problem and the authors argues that being categorised as local fish by the consumers, these minor carps also command 20-30% higher market price than the Indian major carps depending on the regional demand (Das and Mishra, 2016) [9]. Attempts are made to diversify the major carp based composite culture systems by changing the composition incorporating minor carps. This is also in line with the inferences by (Borah *et al*.,2014) [23] that *L. calbasu* fetches a market price of Rs. 150-250 per kg depending on the season in Assam. The market potential identified by the study on minor carps also stands close to the observation made by from the social standpoint, the adaptation of the cultivated species to the environment and market facilitates the production and marketing process, requires less investment and effort in selling the products and reduces risks for farmers

### 4. Recommendations and Conclusion

The overall results of the Trial concludes that the incorporation of minor carps in polyculture system is prospective in terms of additional income for farmers and also

on providing variety of fish through species diversification. The confirmation of this adaptive Trial is that minor carps are a candidate species in the polyculture system by following the technological package recommended by the research system.

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