



Yield Gap Analysis of Indian Major Carps (IMC) and *Pangassius* Composite Culture in Eastern Uttar Pradesh, India

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Abstract

The present study was conducted during 2021-22 to assess the adoption of aquaculture practices and status of fish productivity in the eastern Uttar Pradesh, India. A total of 73 fish farmers in eight districts were surveyed and their fish culture and management practices were recorded. About 81 % of fish farmers were found to culture Indian Major Carps (*Catla catla*, *Labeo rohita* and *Cirrhinus mrigala*) as composite fish culture, while 6.85 % farmers grew *Pangassius hypophthalmus* along with 10-15% of IMC, and the rest 12.33% did monoculture of *P. hypophthalmus*. Farmers practices extensive (IMC), semi-intensive (IMC) and intensive culture (*Pangassius/Pangasium*+IMC) systems with the annual average fish production of 2.0 tons/ha, 4.14 tons/ha, and 23.59 tons/acre. It was found that the level of production varied with the level of input and type of management practices. Customised training programs on pond preparation, stocking ratio maintenance, feeding management, and water quality management can be helpful in increasing the yield and production of IMC in eastern Uttar Pradesh, considering the underexploited potential, thereby enhancing the income and profit for fish farmers.

Keywords:

Aquaculture, Eastern Uttar Pradesh, IMC, *Pangassius*, Fish production

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Introduction

Aquaculture is the fastest growing food sector worldwide. Globally, India stands second in aquaculture production with a total production of 12.12 million tons (Handbook on Fisheries Statistics, 2022). India is bestowed with 3.15 million ha of reservoirs, 2.36 million ha of ponds and tanks as well as 0.19 million ha of rivers and canals. The national mean fish yield from ponds has gone up from about 0.6 t/ha/year in 1974 to 3.0 t/ha/year at present (Annual Report, 2022-23). Besides meeting the nutritional requirement of fish eating population, the fisheries sector is also providing employment to over 14.5 million people in the country. Uttar Pradesh contributes nearly 14.68% of Indian fish biodiversity and offers considerable scope for inland fisheries development and aquaculture (Lakra, 2010). The state is having vast aquatic resources in the form of rivers and canals (28,500 km), reservoirs (1.38 lakh ha), flood plain lakes/derelict waters (1.33 lakh ha), tanks and ponds (1.61 lakh ha), and flood plain wet lands (1.33 lakhs ha) (DoF, Uttar Pradesh, 2020).

The fish culture systems adopted in the country varies largely, depending on the availability of inputs especially adequate quality and quantity of seed and investment capabilities of the farmers. Adoption of scientific fish culture practices is a gradual process and it is affected by many factors including awareness, knowledge, and skill sets of

farmers, ease of technology adoption, training and development support, among others (Pooja et al, 2017). For improving the fish production it is essential to assess the ongoing farming practices so that scientific interventions to address the gaps can be suggested to the fish farmers. Consequently, the current work was undertaken to study the status of fish production systems, and various fish culture practices including species composition, stocking, feeding, and other management practices in the eastern Uttar Pradesh known as *Purvanchal*, that is predominantly rural, economically backward but with abundant water resources having potential for aquaculture.

Materials and Methods

Study covered eight districts having relatively higher number of fish farmers, nearly 50%, in eastern Uttar Pradesh. A total of 73 farmers, who were willing to participate in survey, were randomly chosen across these districts: Ayodhya (11) Azamgarh (14), Gonda (09), Sultanpur (10), Balrampur(11), Chandoli (07), and Ambedkar Nagar (11). A semi structured interview schedule covering questions on fish production systems, and management practices like pre-stocking, stocking and post-stocking pond management, inputs used, yield, farming constraints, etc., was prepared and data was collected through field visits. Data was entered and coded into a database using Microsoft Excel, and simple descriptive statistics was used to understand and interpret the results. Type of production system defined based on level of input usage, management practices, and production levels were the key criteria used to understand the present status and identify the gaps.

Results and discussion

Our study examined cultured fish species combinations, pond management practices (seed stocking, feeding, fertilizers, medicine, probiotics), cost incurred and revenue earned. Findings revealed that 52.05% of farmers practiced extensive aquaculture system: fish were stocked without fertilization and feeding, no water exchange, and no usage of lime, $KMnO_4$ or any medicines/probiotics. However, farmers reported occasional unmeasured applications of cattle dung. These systems relied

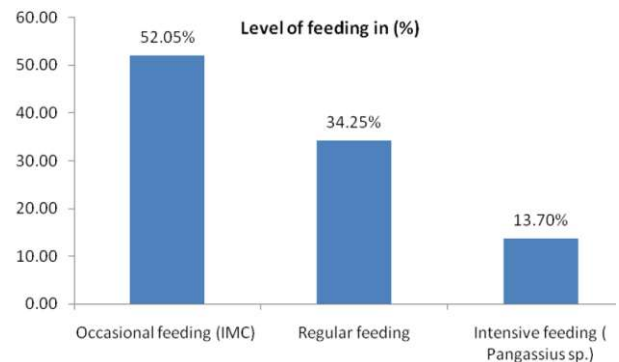


Fig.1. Feeding practice by fish farmers (in %)

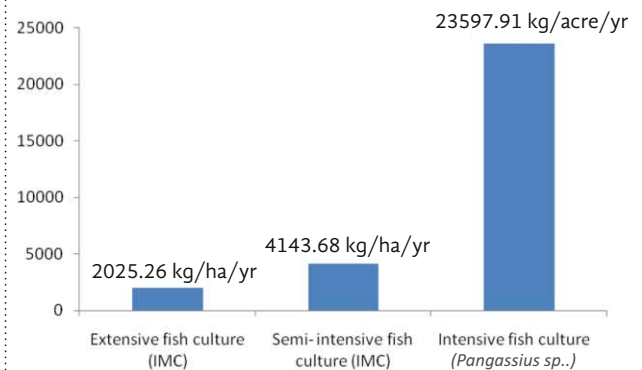


Fig.2. Fish production in different culture systems

solely on natural productivity ("biogenic capacity"), yielding an average of 2025 kg/ha/yr. Farmers stocked carp fry/fingerlings (IMC) without maintaining species ratios or optimal densities, preventing realization of full production potential.

About 14% of fish farmers utilized floating pellet feed for *Pangasius hypophthalmus* culture (Fig. 1). This intensive practice yielded 23.59 tons/acre/year (Table 1, Fig. 2), contrasting sharply with extensive Indian Major Carp systems. Fingerlings were transported from West Bengal via rail or hired vehicles and stocked in ponds with size averaging 4,000 m². Adjacent nurseries existed in 90% of these farms, enabling multiple and year-round stocking of 200–350 g juveniles after harvesting market-sized fish (800–1,100 g).

Approximately 34.25% farmers were following improved semi-intensive culture practices (Fig.3). In this practice the farmers apply farm made traditional

Table 1: Fish production, cost and income under different culture systems in eastern Uttar Pradesh

Culture Practice	Production (tons/ha/yr)	Gross Income (Rs./ha/yr)	Production Cost* (Rs./ha/yr)	Net Income (Rs./ha/yr)
Extensive fish culture (IMC)	2.02	2,53,157	50,635	2,02,526
Semi- intensive fish culture (IMC)	4.14	5,17,960	1,81,286	3,36,674
Intensive fish culture (Pangassius sp.)	58.50	49,15,918	34,38,661	21,06,822

* Only operational cost was considered

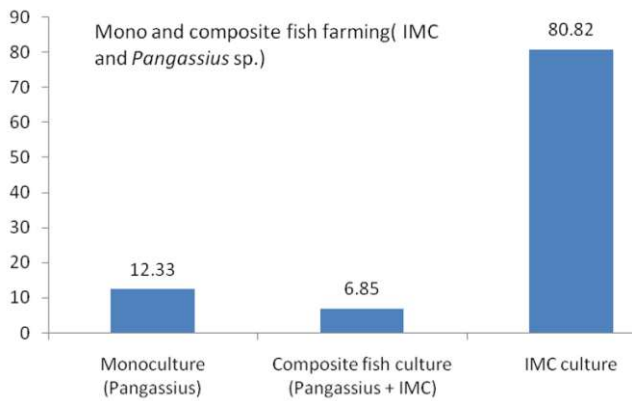


Fig.3. Farmer-wise Fish Culture Systems (%)

fish feed regularly. The cattle dung was the most common manure used to fertilize the pond, while mustard oil cake and rice polish in 1:1 mixture was the most common feed applied. This system yielded an average annual production of 4,143.68 kg/ha (Table 1).

The Pangassius culture practice is an intensive system and is being practised widely. In Azamgarh district alone, around 2000 ha was under culture. Farmers are found to stock 12-15000 fish seed per acre, while all the fish farmers maintained nursery pond along with culture pond to ensure year round supply of large size *Pangassius* stunted fish seed to the culture farm. The ponds embankments have been constructed above the ground level. The inlet pipe exists below 20-30 cm level of embankment, whereas the outlet pipes have been installed at the bottom of pond to facilitate the easy draining of pond while pond preparation. The fish seed is treated with $KMnO_4$ while stocking in pond to get rid of any microbe and parasite.

The fish farmers exchange 25 % of water in a month. The probiotics, zeolite, lime, salt, mixture of jaggary, yeast/probiotic, oil cake and rice police in fermented slurry form are applied in each pond to enhance the planktonic and beneficial microbial population. About 7% farmers cultured IMC along with *Pangassius* sp. in their ponds. They explained that the *Pangassius* growth is dependent on nutritionally balanced commercial floating pellet feed. A large quantum of unconsumed feed, fecal matter and organic load accumulated at the pond bottom that in a way enhanced the pond water productivity, and enhanced plankton production in ponds. This plankton could be efficiently utilized by the IMC, thereby efficient nutrients recycling in IMC and *Pangassius* mixed composite fish farming system. The IMC fish growth is achieved without any extra feed input, thereby providing an additional income for fish farmers.

The study also revealed the popularity of IMC (*Catla catla*, *Labeo rohita*, *Cirrhinus mrigala*) as nearly 80% of fish farmers adopted this system. Consumer preference and the hardy nature of fishes to grow and survive in local environmental conditions. Another 12.33 % farmers practised *Pangassius* monoculture in

their ponds, which was an intensive culture system. Unlike IMC, it is a short period crop with minimum of 4 months and a maximum of 6 months, depending upon the level of input and management level followed.

On an average, the annual fish production in *Pangassius* monoculture system varied from 12 to 14 tonnes for a six month crop / acre. Since, they stock fishes that have been reared for seed stocking in high density the stunted size stocked in pond attain high growth rate. The rearing of seed in stunted manner along with their adjacent culture pond enables them to stock the new fresh stock in February itself as soon as the temperature become favourable for their growth. This practice enables them to take two crops of *Pangassius* in a year. During winter season the *Pangassius* farmers maintain their seed and culture stock by exchanging pond water with ground bore well water during early morning hours to maintain the water temperature in the pond. The soil with high organic matter load are used in agricultural crop field every 4-5 years. All the *Pangassius* fish farms have bird and snake fencing to prevent any loss and spread of diseases. Lime was used regularly by 21.17 % fish farmers; $KMnO_4$ was used by 17% fish farmers; insecticides were used by 12.41% fish farmers; and Benjal Konium Chloride were used by 6.5% of fish farmers. In extensive IMC-based culture systems, farmers just stocked the seed and applied cattle dung occasionally, while in semi-intensive fish farming, feed ingredients namely mustard oil cake, rice bran, green grasses, raw cow dung, and urea were found to be used, either in combinations or in isolation to get increased fish production. Annual average fish production in extensive fish culture was only 2.02 tons/ha, whereas in semi-intensive fish culture ponds the production was 4.14 tons/ha, and in intensive *Pangassius* culture ponds the production was as high as 58.50 tons / ha (Table 1)

Half the fish farmers (52.05%) fed farm made feed comprising of mustard oil cake and rice polish. As nutrient content of farm - made feeds differ in their nutrient content depending on the ingredients used, especially in terms of crude protein content, crude protein source (NRC, 2011) and crude protein to energy ratio, they affect feed efficiency (Kabir et al. 2019). Indian major carps, exotic carps, silver carp (*Hypophthalmichthys molitrix*), grass carp (*Ctenopharyngodon idella*), and common carp (*Cyprinus carpio*) share major part of India's inland fish production. Polyculture of carp species is a profitable venture because this aquaculture system requires less feed as they depend partly on natural feed, i.e. plankton (Dey et al., 2013; Alam et al., 2019). The available literature showed that *Pangassius*-carp polyculture is adopted by farmers to increase farm income and pond productivity since carps do not require additional feeding, and thereby improve their resilience against downward fluctuations in fish prices (Ahmed and Toufique, 2015). In recent years, among the fish species, Pangas has become the most popular commercial aquaculture species due to well suited

weather condition, ease of culture, low production cost, higher response to external feeding, availability of seeds and high market demand in Bangladesh (Khan, 2012). *Pangassius* fish is being reared on floating pellet fish feed. On average, the FCR of *Pangassius* fish farming varies between 1.4 to 1.65, depending upon the management practices and geographic locations. The production as revealed in the study is a function of investment in terms of feed, seed, fertilizer, probiotics, medicines, and water quality management.

Conclusion

Eastern Uttar Pradesh is endowed with vast inland freshwater resources and sustainable use of these water bodies will help to enhance the yield per unit area. Maximum production of 23.5 tonnes per acre per year have been achieved in *Pangassius* fish culture. The intensive fish culture that requires use of feed, probiotics, water quality management medications as and when required is rare in IMC production systems in Uttar Pradesh. Land and water scarcity further exacerbated by climate change, and competition for land and water resources from other food production systems, along with increasing demand for fish in the near future would necessitate shift to intensive fish culture systems. The systematic intensification and diversification of IMC culture along with improvement in the technical know how of fish farmers are the need of the day to tap the optimum production potential in the state. Diversification of fish species and adoption of new aquaculture technologies like Re-circulatory Aquaculture System (RAS) and Biofloc farming with proper training and knowledge will help to enhance fish production and productivity. The study provides insights to develop customised training programs and development interventions to not only enhance fish production from the state but also improve the income and livelihoods of the farmers.

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