



Beyond Production: Inland Fisheries as a Nutrition-Sensitive Food System in Jharkhand, India

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Abstract— *Inland fisheries and aquaculture represent a vital, yet underutilized, nutrition-sensitive food system with significant potential to address dual challenges of malnutrition and rural poverty. This review synthesizes scientific and socio-economic evidence to evaluate this dual role in the resource-rich but malnutrition-affected state of Jharkhand, India. An analysis of published nutritional data reveals that commonly consumed freshwater fish species are rich sources of high-quality protein (10–22%), essential long-chain omega-3 fatty acids (EPA and DHA), and critical micronutrients including bioavailable iron, calcium, zinc, and vitamins A and D. These attributes position freshwater fish as a potent dietary tool against anemia, stunting, and hidden hunger prevalent in the region. Economically, the sector supports thousands of rural households, yet state-level productivity (~2,570 kg ha⁻¹ yr⁻¹) lags behind national benchmarks. Persistent constraints in seed quality, feed availability, and extension services limit sectoral performance. Our integrated analysis underscores that inland fisheries are not merely a production sector but a foundational component of sustainable food systems. We conclude by proposing a nutrition-sensitive fisheries framework for Jharkhand, advocating for policy interventions that concurrently enhance scientific aquaculture management, integrate fish into nutrition programs, and strengthen value chains to improve both health outcomes and economic security for vulnerable communities.*



Keywords— *Inland fisheries; Nutrition-sensitive aquaculture; Food security; Micronutrients; Rural livelihoods; Jharkhand; Freshwater fish; Omega-3 fatty acids; Policy interventions; Sustainable food systems.*

I. INTRODUCTION

Global food systems are under increasing pressure to deliver nutritious diets sustainably while supporting economic livelihoods. Within this context, fish and fisheries are recognized as a critical component, contributing substantially to food and nutrition security, particularly in low- and middle-income countries (FAO, 2020). Fish provide a unique package of nutrients—high-quality protein, essential fatty acids, and bioavailable vitamins and minerals—that are often deficient in plant-based diets (Tacon & Metian, 2013). Over the past five decades, global per capita fish consumption has more than doubled, driven by recognition of its health benefits and its role in diverse food cultures (FAO, 2020).

Inland fisheries and aquaculture, often embedded within rural agrarian landscapes, play a disproportionately crucial role in developing regions. Unlike marine fisheries, these systems are directly accessible to rural populations, offering immediate opportunities for household food access and income generation (Béné et al., 2007). The consumption of small, indigenous freshwater fish species, often eaten whole, is especially valuable as it provides highly bioavailable calcium, iron, and vitamin A, directly targeting micronutrient deficiencies termed "hidden hunger" (Mohanty et al., 2016).

India, as the world's second-largest fish producer, relies heavily on its inland waters, which contribute the dominant share of total production (FAO, 2020). The fisheries sector is a significant economic driver, supporting over 14 million

livelihoods (Murugan & Sivagnanam, 2018). However, this aggregate national success masks stark regional disparities. Jharkhand, an eastern Indian state endowed with abundant rivers, reservoirs, and ponds, presents a compelling paradox. Despite rich fisheries resources and a tradition of fish consumption, the state contends with alarmingly high rates of poverty, child stunting, and anemia (Raykar et al., 2015; FAO et al., 2021). This disconnect between resource potential and developmental outcomes signals a critical gap. Harnessing inland fisheries through an explicit nutrition-sensitive lens could therefore offer a sustainable pathway to simultaneously improve dietary quality and rural economic resilience.

This review aims to: (1) synthesize evidence on the nutritional composition and health relevance of freshwater fish in Jharkhand; (2) evaluate the economic contribution of inland fisheries to livelihoods and state development; and (3) identify constraints and propose evidence-based pathways for strengthening a nutrition-sensitive fisheries sector in the state.

II. MATERIALS AND METHODS

This study employs a structured narrative review methodology. A systematic search was conducted for peer-reviewed literature indexed in Scopus, Web of Science, and Google Scholar, using keywords including "freshwater fish

nutrition," "inland fisheries," "aquaculture livelihoods," "Jharkhand," and "micronutrients." Official publications from the Food and Agriculture Organization (FAO) and fisheries statistics from the Government of Jharkhand (2010–2021) were incorporated to provide socio-economic context. Nutritional data extraction focused on the proximate composition, fatty acid profiles, and micronutrient content of predominant freshwater fish species. Economic analysis centered on production trends, productivity metrics, and employment data. The evidence was synthesized thematically to build an integrated assessment of the sector's dual role in nutrition and economics.

III. FISHERIES RESOURCES AND PRODUCTION CONTEXT OF JHARKHAND

Jharkhand's tropical monsoon climate and extensive network of rivers—including the Damodar, Subarnarekha, and Brahmani systems—support a significant inland water resource base exceeding 140,000 hectares, comprising reservoirs, check dams, and village ponds (Government of Jharkhand, 2019) (Figure 1). These water bodies form the foundation for capture fisheries and diverse aquaculture practices, including pond-based culture and cage aquaculture.

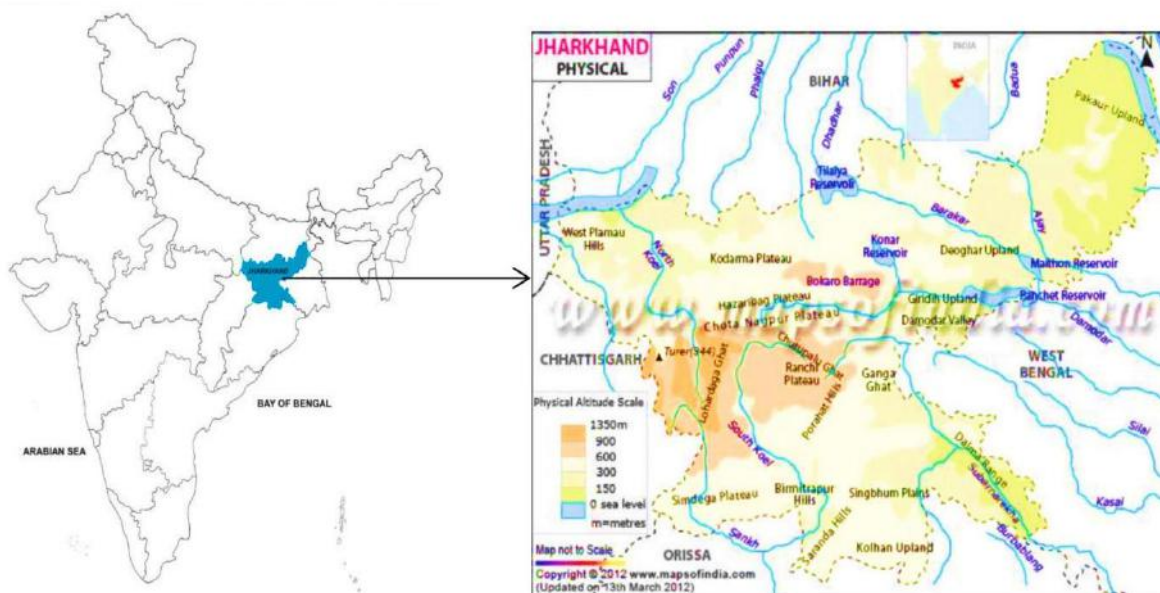


Fig.1 illustrates the spatial distribution of major inland water resources in Jharkhand, highlighting their potential for fisheries development.

Freshwater aquaculture in the state is dominated by Indian major carps (*Catla catla*, *Labeo rohita*, *Cirrhinus mrigala*) and exotic carps like silver carp and grass carp. Importantly,

small indigenous species (SIS) and air-breathing fish (*Clarias batrachus*, *Channa* spp.) also contribute

significantly to local diets, prized for their taste and nutritional value (Sankar et al., 2010).

Despite this potential, the sector operates below capacity. Current fish production (~223,000 metric tons in 2019-20) fails to meet domestic demand, necessitating substantial imports from other states (Prakash & Singh, 2016). The average productivity of 2,570 kg ha⁻¹ yr⁻¹ remains below the national average, highlighting a substantial yield gap and an opportunity for development.

IV. THE NUTRITIONAL PROFILE OF FRESHWATER FISH: A DIETARY POWERHOUSE

4.1. High-Quality Protein and Lipids

Freshwater fish are a rich source of digestible protein (10–22% of edible portion) with an excellent essential amino acid profile (Figure 2). This is particularly beneficial in Jharkhand, where diets are often cereal-based and lack adequate lysine and methionine—amino acids abundantly present in fish (Mohanty et al., 2019). The lipid content (1–20%) is characterized by a favorable profile of polyunsaturated fatty acids (PUFAs). While total lipid is generally lower than in marine fish, freshwater species provide physiologically significant amounts of long-chain omega-3 fatty acids, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), known for their cardioprotective and neurodevelopmental benefits (Calder, 2004).

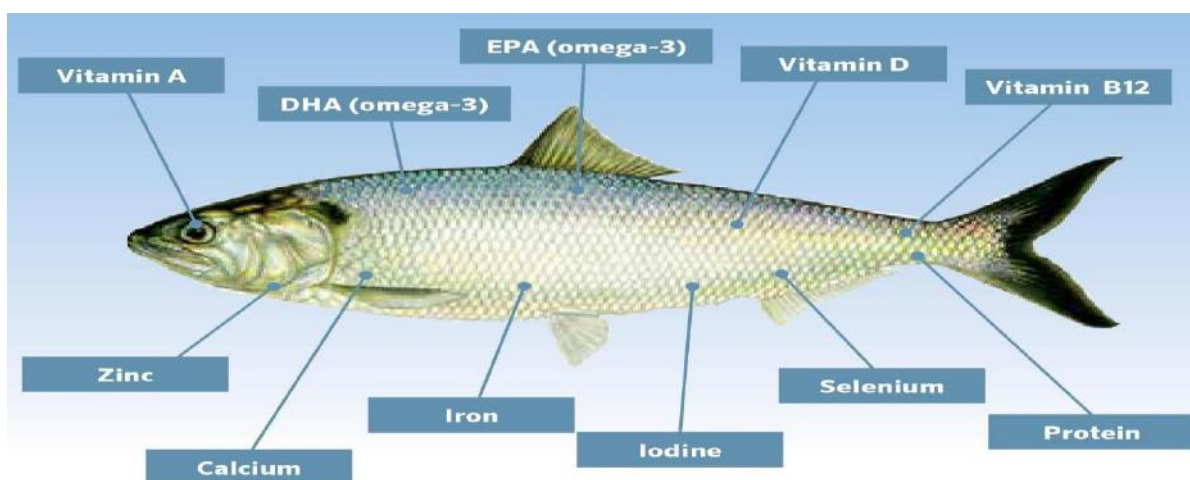


Fig.2 presents a comparative overview of the proximate composition of major freshwater fish species consumed in Jharkhand.

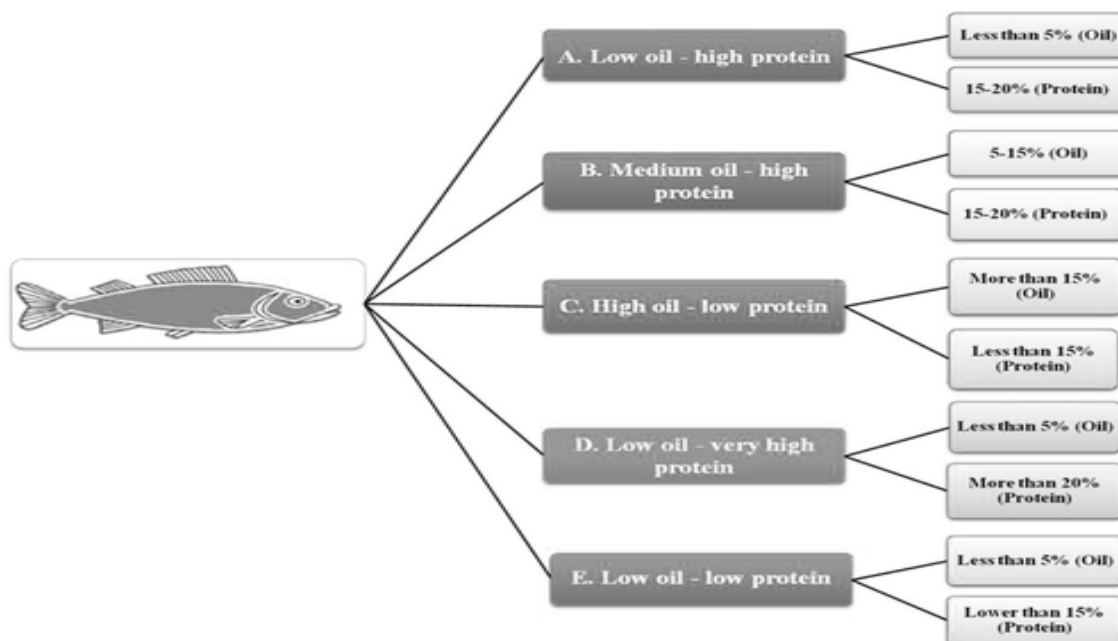


Fig.3 Summarizes the relative micronutrient density of selected freshwater fish species.

4.2. Critical Micronutrients for Combating Hidden Hunger

The most compelling nutritional argument for freshwater fish, especially SIS consumed whole, lies in their micronutrient density (Figure 3). They are excellent sources of bioavailable iron (1–3 mg/100g) and zinc (0.6–1.8 mg/100g). Crucially, consuming small fish with bones provides exceptionally high levels of calcium (200–1,500 mg/100g), offering a highly accessible solution to calcium deficiency (Malde et al., 2010). Furthermore, fish, particularly their livers and viscera, are important sources of fat-soluble vitamins A and D, essential for immune function, vision, and bone health.

V. RESULTS AND SYNTHESIS

5.1. Nutritional Significance in Local Context

The synthesized data confirm that freshwater fish available in Jharkhand can substantially contribute to filling nutrient gaps. Regular consumption can enhance protein quality and provide meaningful cumulative intakes of EPA and DHA. More directly, integrating SIS into daily diets represents a highly localized and sustainable strategy to combat the region's high prevalence of iron-deficiency anemia and calcium insufficiency.

5.2. Economic Contributions and Livelihoods

The fisheries sector is a vital source of livelihood for thousands, particularly among tribal and marginalized communities (Figure 4). Employment spans the value chain: from primary production in ponds and reservoirs to seed rearing, processing, and marketing. This makes the sector a critical buffer for rural economic security. However, the below-average productivity indicates systemic inefficiencies that curb greater income generation and sectoral growth.

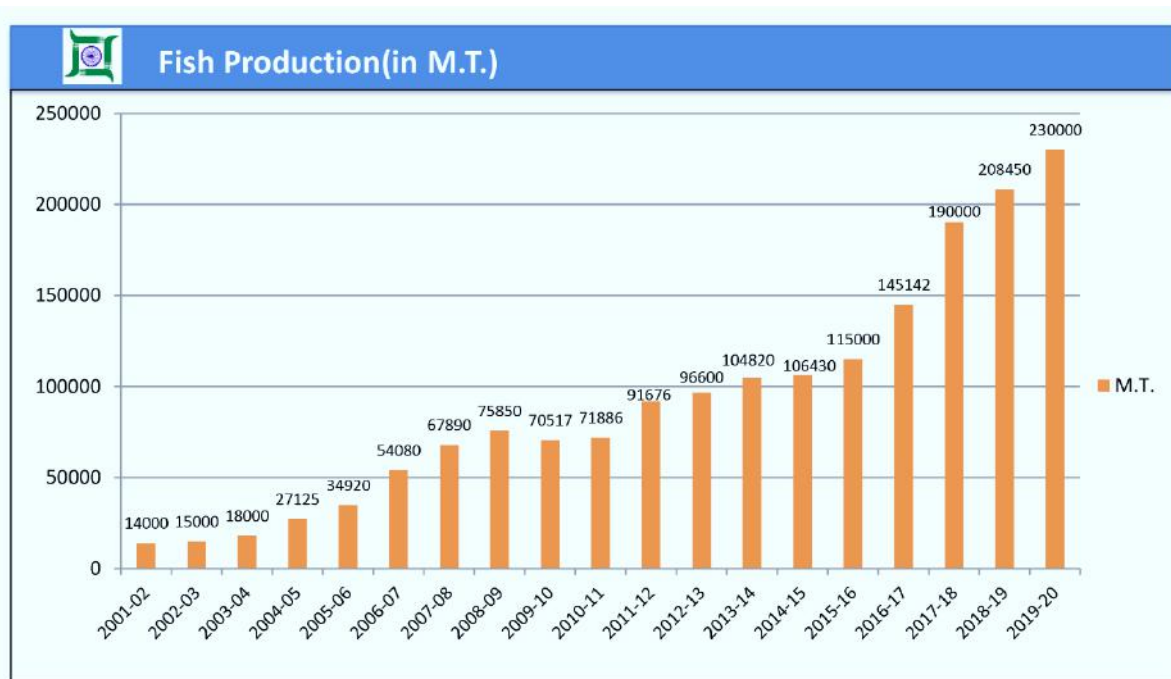


Fig.4 State-level inland fish production and productivity in Jharkhand

5.3. Identified Constraints

Key constraints hindering the sector mirror challenges across eastern India: inconsistent supply of quality fish seed, high cost and low availability of formulated feeds, weak technical extension services, and poor post-harvest infrastructure (Prakash & Singh, 2016; Cai et al., 2019). These factors collectively suppress yields, increase vulnerability, and limit the sector's potential economic and nutritional impact.

VI. DISCUSSION: TOWARDS A NUTRITION-SENSITIVE FISHERIES FRAMEWORK

This review establishes that inland fisheries in Jharkhand are at a nexus of nutrition security and economic development—a dual role that remains under-optimized. The evidence moves beyond viewing fish merely as a commodity for production, reframing it as an essential component of a healthy food system, particularly for vulnerable groups.

Our findings align with and contextualize global literature on nutrition-sensitive fisheries (Béné et al., 2007; FAO, 2020), but they ground the argument in the specific socio-ecological reality of Jharkhand. The high prevalence of malnutrition is not due to a lack of nutritional solutions within the local food system but rather to a lack of strategic focus on harnessing them. Simply increasing aggregate fish production will not automatically translate into better nutrition. Success requires ensuring that nutrient-rich fish (especially SIS) are accessible, affordable, and consumed by women and children in the first 1,000 days of life.

Economically, overcoming the identified constraints requires a shift from a focus on area expansion to one of productivity enhancement and value-chain efficiency. Strengthening hatchery networks, promoting cost-effective feed alternatives, and improving market access are essential to boost incomes and make fish more affordable for the poor.

VII. POLICY IMPLICATIONS AND FUTURE DIRECTIONS

To unlock the dual potential of inland fisheries, we propose the following integrated, nutrition-sensitive pathways for policy in Jharkhand:

1. **Promote Nutrient-Dense Species:** Actively integrate small indigenous fish species (SIS) into aquaculture extension programs and backyard pond models, emphasizing their nutritional superiority.
2. **Strengthen Input Systems:** Establish reliable, decentralized hatcheries for quality seed and support local production of affordable, farm-made feeds.
3. **Integrate with Nutrition Programs:** Link fisheries development with government nutrition safety nets (e.g., Mid-Day Meal Scheme, Integrated Child Development Services) to create guaranteed markets for small-scale fishers and farmers while improving child nutrition.
4. **Empower Women in Value Chains:** Facilitate women's access to resources for small-scale aquaculture and post-harvest processing, recognizing their pivotal role in household food and nutrition security.
5. **Invest in Climate-Resilient Practices:** Develop and disseminate aquaculture practices resilient to climate variability, ensuring the sector's sustainability.

Future research should prioritize longitudinal studies on the health impacts of fish consumption in tribal communities, detailed value-chain analyses to identify equity bottlenecks, and the development of climate-adaptive aquaculture technologies.

VIII. CONCLUSION

Inland fisheries and aquaculture in Jharkhand are not a peripheral activity but a cornerstone for sustainable and equitable development. This review demonstrates that the sector can simultaneously address the pressing challenges of malnutrition and rural poverty. Freshwater fish, as nutrient-dense foods, offer a direct dietary solution to micronutrient deficiencies, while the sector provides crucial livelihood opportunities. Realizing this potential requires a deliberate policy shift from a production-centric approach to a holistic, nutrition-sensitive framework. Strategic investments in technology, institutions, and inclusive governance can transform Jharkhand's abundant blue resources into a powerful engine for health, prosperity, and resilience.

CONFLICT OF INTEREST

The author declares no conflicts of interest, and I confirm that no AI tools were used in the generation or composition of this work.

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