

Quietly transforming catfish aquaculture: ICAR-CIFA's seed production journey in India

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Pangasius pangasius.

Looking back at freshwater aquaculture in India, the story seems straightforward. Carp dominated everything. Farmers designed ponds for carp, hatcheries produced carp seed, training programmes focused on carp polyculture, and most farmers built their livelihoods around these dependable species. Carp culture provided stability and food security, and rightly so.

Yet anyone who has walked through a local fish market knows another truth. Catfishes often disappear from the stalls first. Consumers willingly pay more for them. Their flesh is soft, tasty and lacks interstitial spines. Many regional cuisines prefer catfish. Some species are even regarded as restorative or medicinal foods. In terms of demand and price, catfishes have always had an edge.

So why did catfish farming remain marginal for so many years?

The answer was not demand, not growth potential, and not farmer interest.

It was seed.

For decades, most indigenous catfishes depended almost entirely on wild fry collected from rivers, wetlands and floodplains. Seed availability was seasonal and unpredictable. Some years, farmers obtained enough fry; other years, they got almost none. A pond might be prepared and fertilised, only to remain empty because seed never arrived. Planning became guesswork. Investment felt risky. Naturally, most farmers retreated to carp, where hatchery seed was assured.

In aquaculture, the rule is simple. Without seed, there is no farming.

Many of the indigenous catfishes described in this article are categorised as threatened or vulnerable in parts of their range due to habitat degradation, overfishing and river regulation. Developing reliable captive breeding and hatchery technologies therefore helps both aquaculture diversification and conservation. It reduces pressure on wild stocks and enables stock enhancement programmes.

Over the last three decades, ICAR-Central Institute of Freshwater Aquaculture (ICAR-CIFA) has steadily and quietly addressed this constraint through systematic research and fieldwork. Instead of treating breeding as a single technical

step, scientists approached catfish culture as a complete biological and production system. They developed broodstock nutrition, induced spawning, hatchery engineering, larval feeding, nursery management and farmer adoption together.

The results did not come overnight. They emerged slowly, species by species. But once dependable hatchery seed became available, everything changed. Hatcheries appeared. Farmers diversified. Local markets stabilised. What had once been an uncertain, capture-dependent activity began to look like a viable aquaculture enterprise.

This transformation is best understood not as a single breakthrough, but as a series of species-specific stories.

Understanding the problem at its roots

Early attempts at catfish breeding showed that the challenge was deeper than simply injecting hormones and waiting for spawning. Many indigenous catfishes evolved to breed under specific environmental cues such as flowing water, temperature shifts, or monsoon flooding. When confined to ponds or tanks, they often refused to spawn or produced poor-quality eggs. Even after hatching, larval survival was inconsistent.

It became clear that induced breeding alone would not solve the problem. Scientists had to manage the entire life cycle carefully.

Researchers began with fundamentals. They conditioned broodstock with balanced, protein-rich diets to improve gonadal maturation. They optimised water quality and space, refined spawning protocols, and standardised egg incubation systems. Researchers provided larvae with appropriate live feeds before gradually transitioning them to formulated diets. They improved nursery practices to reduce stress and mortality.

Gradually, hatchery operations that once depended on luck became predictable. Spawning success improved. Hatching stabilised. Fry survival increased. This shift from uncertainty to reliability laid the foundation for everything that followed.

Induced breeding protocols across species predominantly used synthetic inducing agents such as Ovaprim, Ovatide and Wova-FH, with dosage adjustments based on species and broodstock condition.

Mystus species (small bagrids)

Small bagrid catfishes of the genus *Mystus* were always familiar to rural consumers but largely absent from culture systems. Farmers caught them seasonally from rivers and floodplains and sold them fresh at reasonable prices. Yet farmers hesitated to stock them because seed was unreliable and transport survival poor.

Through careful broodstock conditioning and induced breeding trials, researchers successfully spawned these species in captivity. Refining egg incubation and larval feeding methods significantly improved survival. Once researchers standardised nursery rearing techniques, they could produce robust fingerlings consistently.

These small catfish proved ideally suited for small ponds and low-input farming. Farmers began stocking them alongside carps, often obtaining better returns from the same water area. In several districts of eastern India, small hatcheries now routinely produce *Mystus* seed. What was once a seasonal catch has become a planned aquaculture crop.

Rita chrysea

Rita chrysea is an indigenous catfish found only in the Mahanadi river system of eastern India. The population is declining due to over-exploitation. Research focused on understanding its reproductive biology and developing captive breeding methods.

Work on brood nutrition, simplified spawning methods, husbandry, and seed rearing management stabilised hatchery production. This research opens the way for both farming and stock enhancement to conserve this native species.



Rita chrysea.

Ompok species (pabda group)

Among the indigenous catfishes, pabda enjoys almost universal consumer preference. Its delicate flesh commands premium prices in markets. Yet for years, pabda culture remained limited because hatchery seed was unavailable.

Initial larval survival was low, and researchers considered the species delicate. However, systematic refinement of spawning, incubation and feeding practices proved otherwise. With improved larval nutrition and careful water management, survival rates increased steadily.

Once dependable seed became available, farmers quickly adopted the species. Hatcheries supplying pabda fry began operating locally, creating entrepreneurship opportunities while reducing pressure on wild populations. The success of pabda demonstrates how targeted hatchery science can unlock the commercial value of a traditionally important fish.

***Horabagrus brachysoma* (yellow catfish)**

This striking yellow catfish from the Western Ghats has both ornamental and food value. However, declining natural populations and limited knowledge of captive breeding restricted its use.

Research showed that the species adapts well to pond conditions when farmers manage broodstock appropriately. Successful hatchery production supported both farming and conservation. Reduced dependence on wild capture helped protect natural stocks, while farmers gained access to a new species.

It stands as a clear example of how aquaculture development and biodiversity conservation can go hand in hand.

***Clarias batrachus* (magur)**

Magur perhaps best illustrates the direct livelihood impact of catfish seed technology. Hardy, air-breathing, and tolerant of low oxygen, it thrives in small ponds, tanks, and backyard systems. For land-poor households, few fish are more suitable.

Yet unreliable seed and poor larval survival long held back expansion.



Horabagrus brachysoma.



Clarias batrachus.



Heteropneustes fossilis.

Improved brood nutrition, simplified breeding methods, and portable FRP hatchery systems made dependable seed production feasible. Equally important, scientists developed formulated feeds to support early life stages.

CIFA developed a larval feed, Starter-M, and a fry feed, CIFAMA, both now commercialised and widely used. These feeds significantly improved survival, uniform growth, and nursery performance, allowing farmers and hatchery operators to raise healthy fingerlings with greater consistency.

To support decentralised seed production, CIFA designed and fabricated low-cost FRP-based modular hatchery units for *Clarias batrachus* (FRP-Magur hatchery) and *Ompok* spp. (FRP-Pabda hatchery). These units have been installed and adopted in multiple states across India, enabling small-scale hatchery operators to produce seed under controlled and hygienic conditions.

Today, in many villages, farmers stock small ponds beside their homes with magur fingerlings. They harvest and sell fish fresh in local markets, often earning

a steady weekly income. For many families, magur culture is no longer experimental. It is dependable.

Heteropneustes fossilis (singhi)

Singhi shares many of magur's strengths: hardiness, high consumer demand, and suitability for small water bodies. Earlier, an inconsistent seed supply limited its culture.

Refinements in brood management, spawning, and larval rearing stabilised hatchery production. Farmers now use singhi as a diversification species, spreading risk across multiple crops and improving overall farm resilience.

Clarias dussumieri

This lesser-known indigenous catfish has a restricted distribution and declining populations. Research focused on understanding its reproductive biology and establishing captive breeding methods.

Although still emerging as a culture species, hatchery production opens possibilities for both farming and stock enhancement. The work highlights the importance of conserving native genetic resources while exploring new aquaculture opportunities.

Pangasius pangasius

Among larger indigenous catfishes, *Pangasius pangasius* offers strong commercial potential because of its fast growth and good feed conversion. However, dependence on riverine seed once restricted expansion.

Standardising breeding, nursery techniques and feeding management enabled dependable hatchery production. To support different growth stages, CIFA also developed stage-specific feeds: Starter Pangas for larvae, Pangas Grow-I for fry and Pangas Grow-II for fingerlings. These feeds improved growth rates, feed efficiency, and survival, enabling more intensive and predictable production. With reliable seed and suitable feeds, farmers could confidently adopt larger-scale culture. The species has now moved from capture-based supply to organised aquaculture.



Clarias dussumieri.



Mystus cavasius.



Wallago attu.

Wallago attu

Wallago attu, a large predatory catfish, posed unique challenges, particularly cannibalism during early larval stages. Hatchery survival was often low.

Research focused on understanding behaviour, feeding strategies and density management. While commercial production remains technically demanding, the knowledge generated provides a scientific base for future advances and demonstrates continued commitment to indigenous species development. Rearing under controlled red-light conditions significantly reduced

larval cannibalism and improved survival rates, particularly during the early post-yolk absorption stage.

Timeline of progress

ICAR-Central Institute of Freshwater Aquaculture has developed catfish seed technologies over nearly five decades. Foundational work during 1971–1985 was carried out under the All India Coordinated Project on Air-breathing Fishes and the CIFRI/IDRC Rural Aquaculture Project. This generated essential biological information on the breeding and larval ecology of indigenous and air-breathing catfishes. Building on this

base, the 1990s focused on captive breeding and hatchery standardisation of *C. batrachus* and *H. fossilis*. The 2000s expanded efforts to larger species, such as *W. attu* and *H. brachysoma*, with improvements in brood nutrition, hatchery systems, and nursery management. During the 2010s, researchers consolidated technologies and extended them to *Rita chrysea*, *Mystus* spp., and *P. pangasius*, with support from feed development, demonstrations, and farmer adoption. More recently, the 2020s have emphasised species diversification through hatchery production of *Ompok* spp. and *C. dussumieri*. Together, these decade-by-decade advances mark a steady progression from exploratory research to dependable, farmer-ready seed production systems.

Programme contributions and integrated expertise

The progress described above emerged not from isolated trials but from sustained, coordinated efforts that integrated reproductive biology, hatchery technology and fish nutrition within a single programme framework. Breeding and hatchery standardisation focused on developing reliable protocols for induced spawning, egg incubation and larval rearing, while parallel advances in feed formulation and nutritional management ensured stage-specific support for larvae, fry, fingerlings and broodstock. CIFA developed formulated feeds for all catfish species discussed in this paper, covering

Table 1. Standardised breeding and hatchery parameters of indigenous catfishes developed at ICAR-CIFA.

| Species | Ideal weight | Ideal age (years) | Hormone (ml/kg) | Latency | Yolk absorption | Fecundity | Larvae produced |
|--------------------------------|--------------|-------------------|-----------------|---------|-----------------|---------------------------|--------------------------|
| <i>Clarias batrachus</i> | 100-150 g | 2 | 1.0-1.5 | 16-17 h | 72 h | 4-5K/ 100g ♀ | 2.5-3K/ 100g ♀ |
| <i>Clarias dussumieri</i> | 90-150 g | 2 | 1.0-1.2 | 11-12 h | 72 h | 6-7K/ 100g ♀ | 3-3.5K/ 100g ♀ |
| <i>Heteropneustes fossilis</i> | 100-150 g | 2 | 0.8-1.0 | 9-10 h | 72 h | 10-15K/ 100-120g ♀ | 6-7K/ 100g ♀ |
| <i>Mystus cavasius</i> | 80-100 g | 2 | 1.0 | 12-13 h | 60 h | 10-20K/ 50-80g ♀ | 7-9K/ 100g ♀ |
| <i>Rita chrysea</i> | 80-100 g | 2 | 1.0-1.5 | 13-15 h | 72 h | 12-13K/ 90-130 g | 8-9K/ 90-130 g |
| <i>Horabagrus brachysoma</i> | 150-180 g | 2-3 | 1.0 | 12-14 h | 72 h | 18-19K/ 100g ♀ | 8-9K/ 100g ♀ |
| <i>Ompok bimaculatus</i> | 130-180 g | 2 | 1.0-1.5 | 10-11 h | 65-70 h | 14-15K/ 100g ♀ | 6-7K/ 100g ♀ |
| <i>Pangasius pangasius</i> | 1.0-1.5 kg | 3-4 | 1.0 | 13-14 h | 55-60 h | 150-160K/ 1.2-1.5 kg ♀ | 80-110K/ 1.2-1.5 kg ♀ |
| <i>Wallago attu</i> | 1-2 kg | 3 | 0.5-1.0 | 10-11 h | 50-55 h | 30-40K/ 1.1-1.4kg ♀ | 13-17K/ 1.0-1.5 kg ♀ |

Table 2. Species-wise feeding regimes and nutritional requirements across life stages of indigenous catfishes. Note: All species fed with mixed plankton, *Artemia* nauplii and tubifex as live feed.

| Species | Min. protein brood feed | Min. protein larval feed | Min. protein fingerling feed | First form. feed post-hatch | Larval feed particle size | Fingerling feed pellet size (mm) | Fingerling ration size % body weight | Feeds/day |
|--------------------------------|-------------------------|--------------------------|------------------------------|-----------------------------|---------------------------|----------------------------------|--------------------------------------|-----------|
| <i>Clarias batrachus</i> | 35% | 40-50% | 35% | 9-10 days | 35-50 µ | 0.5-1.5 | 2-5 | 2 |
| <i>Clarias dussumieri</i> | 35% | 40-50% | 35% | 10-11 days | 35-50 µ | 0.5-1.5 | 2-5 | 2 |
| <i>Heteropneustes fossilis</i> | 35% | 40-50% | 35% | 11-12 days | 35-50 µ | 0.5-1 | 2-5 | 2 |
| <i>Mystus cavasius</i> | 35% | 40-50% | 35% | 11-12 days | 35-50 µ | 0.5-1 | 2-5 | 2 |
| <i>Rita chrysea</i> | 35% | 40-50% | 35% | 13-14 days | 35-50 µ | 0.5-1 | 2-5 | 2 |
| <i>Horabagrus brachysoma</i> | 35% | 40-50% | 35% | 10-11 days | 35-50 µ | 0.5-1 | 2-5 | 2 |
| <i>Ompok bimaculatus</i> | 35% | 40% | 35% | 12-14 days | 35-50 µ | 0.5-1 | 2-5 | 2 |
| <i>Pangasius pangasius</i> | 32% | 40% | 35% | 12-13 days | 35-50 µ | 1-3 | 2-5 | 2-3 |
| <i>Wallago attu</i> | 40-50% (offal/live) | 50-60% | 40-50% | Animal protein day 4+ | Crushed liver/form. feed | 1-5 | 1-5 | 3-4 |

broodstock, larval, fry, fingerling and grow-out stages. This ensured nutritional continuity throughout the production cycle and minimised dependence on inconsistent live feeds. This close coupling of reproduction and nutrition research led to complete, field-validated technology packages rather than fragmented solutions. Such an integrated approach proved central to achieving consistent seed production and to the widespread adoption of catfish hatchery technologies by farmers and private hatchery operators across the region.

Conclusion

The transformation of catfish aquaculture in India did not happen through a single dramatic breakthrough. It came through steady, patient, species-wise progress. Broodstock management improved. Hatcheries became simpler and more reliable. Researchers developed larval feeds. Nursery survival increased. Researchers trained farmers and adapted technologies to field realities.

By solving the most fundamental constraint - dependable seed supply - ICAR-Central Institute of Freshwater Aquaculture helped indigenous catfishes move from rivers and wetlands into ponds and hatcheries.

Today, farmers stock magur, pabda, *Mystus*, or *Pangasius* fingerlings with confidence. Hatcheries operate locally. Feed technologies support every life stage. Livelihoods have strengthened. Natural stocks face less pressure.

It may appear quiet from the outside, but across thousands of ponds, this steady, science-driven progress has reshaped freshwater aquaculture in lasting ways.

In every sense, it has been a silent revolution, one that began with seed and continues to grow with every harvest. Together, these advances have firmly positioned indigenous catfishes as a significant and sustainable component of India's freshwater aquaculture sector.

About the Authors

Dr. Sangram Ketan Sahoo is a senior fish reproductive biologist with over three decades of experience in breeding and hatchery standardisation of indigenous catfishes and other freshwater species.

Dr. Shiba Shankar Giri is a fish nutrition scientist with more than 30 years of experience in feed formulation and nutritional programming for freshwater aquaculture.

Together, their integrated work in reproduction and nutrition has contributed significantly to the development and dissemination of catfish seed and feed technologies across India.