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AQUACULTURE ASIA

Diversified aquaculture in Nagaland

Fish cooperative development and performance

Women carp farmers

Pabda *Ompok bimaculatus*

Aquaculture Asia

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NACA

An intergovernmental organisation that promotes rural development through sustainable aquaculture. NACA seeks to improve rural income, increase food production and foreign exchange earnings and to diversify farm production. The ultimate beneficiaries of NACA activities are farmers and rural communities.

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AQUACULTURE ASIA

FAO Guidelines for Sustainable Aquaculture: A Blueprint for Future Food Security

The newly adopted FAO Guidelines for Sustainable Aquaculture mark a significant step towards ensuring the long-term viability of one of the world's fastest-growing food sectors. Endorsed at the 36th FAO Committee on Fisheries (COFI), these guidelines are not just a technical document but a roadmap for transforming aquaculture into a sustainable pillar of global food security and economic development.

Aquaculture plays a crucial role in addressing the global challenge of hunger and malnutrition, providing nutrient-rich food to a growing population. However, its rapid expansion has also raised concerns about environmental impact and sustainability. The FAO guidelines aim to address these challenges by promoting practices that are economically viable, socially equitable, and environmentally responsible.

Key principles underpinning the guidelines include sustainability, environmental stewardship, and the use of the Ecosystem Approach to Aquaculture. These principles ensure that aquaculture development respects biodiversity, supports ecosystem functions, and contributes to climate resilience. By integrating these principles into national policies and regulations, countries can foster an aquaculture sector that benefits both present and future generations.

The guidelines are voluntary, and designed to complement existing laws and regulations, offering a flexible framework adaptable to diverse geographical, environmental, and socio-economic contexts. They advocate for sustainability, environmental stewardship, participation, transparency, accountability, and the rule of law in governing aquaculture activities, essential for fostering trust and confidence among stakeholders.

Moreover, the guidelines prioritise animal health and welfare, promoting responsible aquaculture practices that minimise disease outbreaks and ensure humane treatment of aquatic organisms. This holistic approach not only enhances productivity but also reduces environmental risks associated with intensive aquaculture operations.

As nations strive to meet the Sustainable Development Goals, the guidelines provide a roadmap towards achieving these objectives. They encourage collaboration among governments, industry stakeholders, and civil society to build a resilient and sustainable aquaculture sector that supports global food security while safeguarding natural resources.

For those interested in exploring the guidelines further, or obtaining a copy, please refer to the announcement on the FAO website at:

https://www.fao.org/fishery/en/news/41457

Simon Wilkinson

AQUACULTURE ASIA

Progressive women carp farmers of Haldia, Purba Medinipur, West Bengal, India

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The internationally recognised chemist from West Bengal, the late Professor Asima Chatterjee (1917-2006), once said, "I wish to work as long as I live." On 17th June 2024, Mrs Arati Barman, a 68-year-old fish farmer, echoed these words. She is from Dwariberia Village in Deulpota Gram Panchayat, under Sutahata Police Station and Haldia Development Block, in the Purba Medinipur District of West Bengal. The author spoke with Mrs Barman at her farm. Recently, P.K. Mukhopadhyay and U. Banerjee highlighted the significant and noticeable roles of women in diverse domains of aquaculture[1]. They described women-led Self Help Group (SHG) members involved in aquarium fish farming in the Nandakumar Block. They also mentioned two women collecting fertilised carp eggs from a circular hatchery chamber. These eggs are then further nursed. In India, West Bengal ranks second in annual table fish production through aquaculture. Purba Medinipur leads among the 23 districts in the state, especially in the production of major carps.

Instances of women in aquaculture and the need

In India, women from Manipur, Assam, and West Bengal participate in sustainable aquaculture. They are involved in pond fertilisation, nursery fish seed rearing, fish feeding, and harvesting. In the north-eastern states and West Bengal, women's participation in aquaculture is around 55%. Experts from ICAR-Central Institute for Women in Agriculture, Odisha, believe that improving rural women's access to credit and developing women-friendly aquaculture technologies can help. Involving women trainers and extension workers, and organising women aquaculture clubs, can also enhance technology transfer[2]. The late Dr Radheyshyam, an eminent fishery scientist, saw the need for expanding women-friendly freshwater aquaculture technologies. He noted the benefits of these technologies in terms of economic profit, labour efficiency, and self-employment for rural women in India[3]. The late eminent fishery scientist Dr M.C. Nandeesha studied women's participation in carp culture activities across different states. He made viable recommendations to address related issues.

In western districts of Odisha, many women find aquaculture suitable for group enterprises. Women Self Help Groups (SHGs) have successfully bid for pond leases and achieved high fish yields. Women have reported that fish care fits well into their daily schedules. They are gaining increased agency through group formation, leasing water bodies, and starting aquaculture. This process helps them gain technical skills and expertise[4,5]. Mission Shakti, the flagship SHG movement of the Government of Odisha, has brought significant changes.

Mrs. Arati Barman holding a large catla.

It has improved the knowledge, attitudes, and practices of women SHGs towards fish farming in derelict or under-utilised Gram Panchayat tanks and ponds.

Experiences with leasing ponds to women groups show positive results. After training, these groups have excelled in fish culture[6]. In rural Bangladesh, a 'special' empowered group of women under the Community-Based Fisheries Management project manages inland fisheries and fish farming ponds. They also care for poultry and livestock, earning a sustainable livelihood and have taken control of same[7]. Increased economic activities from small-scale aquaculture have created income opportunities for rural women in Bangladesh[8]. To empower women, the Department of Fisheries, Government of West Bengal, has encouraged forming women cooperatives in the ornamental fishery sector. This includes both indigenous and exotic freshwater ornamental fishes. Dr M. Mukherjee, former Director of Fisheries, West Bengal, stressed the need for development schemes related to women as the fishery sector has significant potential for women's employment[9]. Jaljeevika, a fishery-based non-profit in Jharkhand, has trained many women SHG members in fish farming in cages in large inland water bodies. About 1,200 women have been trained and guided in major carp seed rearing, from spawn to fingerling, under the West Bengal ADMI Project of the Department of Water Resources Development.

Women carp farmers of Haldia, Purba Medinipur, West Bengal

Women involved in aquaculture are critical to achieving Sustainable Development Goals. They contribute to food security and nutrition in rural areas. In Purba Medinipur, women practice family-based freshwater aquaculture in backyard ponds. This helps improve the health of rural households and supports their lives and livelihoods. In 2019, in a 1,320 m² pond owned by national-award-winning fish farmer Sarat Chandra Bhowmick in Basanchak Village, Haldia Block, natural breeding of pengba (*Osteobrama belangiri*) brooders occurred. These brooders had been raised from previously stocked fry stages. In the next three months, 7.5-10 cm fry were produced in nylon net hapa enclosures. His wife, Mrs Bandita Bhowmick, took proper care of rearing pengba larvae and oxygenating the pond water. She also supplied Pengba fry to local women interested in fish farming for their homestead ponds. This encouraged them to use their ponds for pengba farming instead of leaving the ponds unused[10]. The fry were sold at a nominal rate of INR 2-5 per piece.

Fish culture in large freshwater bodies has taken up in Purba Medinipur.

The author met S.C. Bhowmick at his home on 17th June 2024. Mrs Bhowmick often gets up early in the morning. She harvests paddy from the field using a sickle, cooks food at home, and feeds the fish. She practices mixed farming of *O. belangiri*, *Labeo rohita*, and *Catla catla* in their homestead pond. Harvested large fish are sold in the local auction market. She has taken training in fish farming organised by the West Bengal Fisheries Department at Haldia Block. She also received input support for fish farming as a beneficiary of a departmental scheme.

Author with Mrs. Barman at her fish farm.

The largest aquaculture water body of Mrs. A. Barman.

Much of the daily life of women in Purba Medinipur revolves around small ponds found in almost every rural household's backyard. These ponds support multi-species fish culture, including Indian major carps and indigenous nutritious fishes that enhance rural diets. This practice, documented in the film 'Unseen Faces Unheard Voices - Women and Aquaculture in Purba Medinipur, West Bengal' by the International Collective in Support of Fishworkers, contributes to family nutrition and local food security. It also provides some income for women through fish rearing and marketing. Mrs Nanda Rani Sahoo is one of the women fish farmers in Haldia Block. Mrs Arati Khatua from Contai Block noted that initially, she did not provide supplementary feed to growing fish in her homestead pond, resulting in unsatisfactory growth. However, after proper pond preparation and management practices, she stocked major carp fingerlings, which showed significant growth. She nets the fish herself, consuming most at home and selling a small amount.

Mrs Shefali Manna from Haldia Block is a member of the women-led Fish Production Group in Chaulkhola Village, Debhog Gram Panchayat. She received block-level training on fish farming organised by the West Bengal Fisheries Department. Supported by the ATMA Project under the Department of Agriculture, West Bengal, she has educated herself on maintaining clean homestead ponds, adopting improved technologies for better pond management, and stocking appropriate numbers of fish fingerlings according to pond size and carrying capacity. These FPG members are collectively engaged in fish farming to supplement their family income. In Chaulkhola Village, they also organise the four-day Durga Puja festival annually. In October 2021, they used this platform to educate about the importance of scientific fish culture in small- to medium-scale village freshwater resources. They highlighted its impact on rural socio-economic development, including women's self-employment, empowerment, income generation, and the nutritional benefits of fish. This initiative is uncommon and commendable.

In an on-site conversation with the author on 7th July 2024, Mrs Jharna Manna, a Governing Body member of Chaulkhola Fish Production Group (FPG), mentioned their focus on

Author speaking at a Fish Farmers Day programme 2024.

Homestead pond of Mrs. Bandita Bhowmick

larger fingerling production (100-300 g size) of *Labeo rohita*, *Cirrhinus mrigala*, and *Labeo bata* in two rainfed freshwater bodies spanning 800 m² and 3,400 m² leased by the group. Thirty women members from Chaulkhola and adjacent Shibramnagar villages are involved in carp culture. Initially registered as a Self-Help Group in 2010-2011, engaging in activities such as poultry and goat farming, it became an FPG in 2017-2018. Advanced fry stages (7.5-12 cm) are sourced from Narghat near the Haldi River, about 25 km away, costing INR 275-300/kg (for *L. rohita* and *C. mrigala*) and INR 400-500/kg (for *L. bata*). Mrs Manna received fish culture training in 2022 organised by the Government of West Bengal. FPG members visited a freshwater fish farm in Digha, Purba Medinipur, and Mrs. Arati Barman's fish farm nearby for practical knowledge on aquaculture management practices. They routinely feed good quality mustard oil cake and other ingredients. Fish weighing 100-300 g at harvest are sold at INR 160-180/kg to grow-out carp farmers. Chaulkhola FPG has benefitted from fish seed and lime provided by the Government of West Bengal. Most members own backyard ponds ranging from 400-800 m² where they practice small-scale carp culture. Mrs Manna expressed gratitude for the guidance received from Sri S.K. Sahu, former Fishery Extension Officer, Haldia Block.

Even in Dadanpatrabar Village, Ramnagar-II Block of Purba Medinipur District, fisherwomen interviewed in a study reported that besides fish harvesting and marketing, they handle all aspects of fish farming within their households. This includes growing vegetables, raising poultry, and managing ponds for commercial fish farming[11]. Mrs Sumitra Mantri from Haldia Block actively assists her husband in managing their ponds dedicated to commercial fish farming. Their farming area has expanded from 364 decimal (1.456 ha) in 2018 to 10.4 ha in 2021. They follow proper fish feeding schedules and water quality management practices. The efforts and

Mrs. Jharna Manna and her homestead pond.

success stories of Sumitra and other women in freshwater fish farming were highlighted in the documentary produced by ICSF.

Distinguished woman fish farmer of Purba Medinipur

Mrs. Arati Barman, a distinguished woman fish farmer from Purba Medinipur, shared her achievements and perspectives with the author. Born and raised in Rajnagar Village, Tamluk Block, she learned the fundamentals of fish farming from her father, who commercially produced major carp fingerlings. The fish seed market in Rajnagar is renowned throughout Purba Medinipur. Despite her age, Mrs. Barman actively participates in drag netting during early dawn fish harvests in waist-high water, weighs the fish, and cleans large nets diligently. She sometimes stays overnight at shelters near water bodies to prevent poaching. Since starting with a modest operation in 1985, she has expanded her freshwater carp farming to cover many acres of water bodies. After marrying into a family involved in Hilsa ilisha fishing in motorised boats near Haldia, she began commercial carp seed rearing and fingerling production in two small ponds near her father-in-law's house in Dwariberia Village during the late 1980s. Since 2003-2004, she has been engaged in major carp farming, producing two crops annually in three water bodies: 1.664 ha (her own), 8.32 ha (of which she owns three-fourths), and 3.744 ha (leased), all with water depths of 1.2-2.4 m. Additionally, she manages two large fish farming water bodies in Garughata Village, Mahishadal Block, measuring 83.2 ha, located 18-20 km from Dwariberia.

In her water bodies, Mrs. Barman stocks *Labeo rohita* weighing 400-500g, which grow to 1400-1,500g within six months. *Catla catla*, stocked at 750-1,000g, reaches 3,000-3,500g at harvest. *Cirrhinus mrigala*, stocked at 300g, grows to 1,200g over the same period. Sub-adults are purchased at INR 40-150/kg and sold after six months at INR 180/kg. Some adult *Lates calcarifer* are also introduced to control *Tilapia* sp and weed fish populations. Pelleted feed (INR 35-50/kg) and a mix of broken rice and rice bran (INR 22/kg locally) serve as supplementary feeds. Previously, Mrs. Barman stocked Indian major carps (25-40 g fingerlings) at 3,000/2,080 m². Currently, she stocks 900-1,000 in the same area, achieving larger sizes.

Experience on decrease in profit margin

Since 2015, the price of high-quality supplementary fish feed for major carp in Purba Medinipur has steadily risen, making it increasingly unaffordable. Similarly, the annual lease payments for large water bodies have also escalated. Recently, Mrs. Barman has noticed a decrease in profit margins compared to previous years in her grow-out carp farming operations. Each of her fish farm water bodies employs two permanent workers, paid INR 10,000-12,000 per person per month. The lease for her 83.2 ha water bodies costs INR 6,000,000 per year. In the mid-1980s, mustard oil cake was priced at just INR 3/kg; now, it ranges between INR 28-30/kg. Diesel fuel is essential for operating machinery used in dewatering and refilling water in large fish farming areas, as well as for oxygenation using paddle-wheel aerators. The price of diesel has increased from INR 30-35/litre to INR 100/litre. Daily wages for farm labourers engaged in netting have risen from INR 40-50/person/day to INR 500-550/person/day. However, the market price of large major carps, when sold at auction markets after harvesting, has not seen a comparable increase.

C. catla 750 g at stocking in Mrs. Barman's water body.

C. mrigala 300 g at stocking.

L. rohita 500 g at stocking.

Success of Mrs. Barman - a lesson for beginner carp farmers

Mrs. Barman's husband was a farmer with 1.664 ha of land, but their agricultural production and income were unsatisfactory. They decided to construct a fish farming water body on this large tract by manually digging out the earth. Workers filled earth-moving containers at the digging site, lifted them onto their heads, and carried them to the dumping site. Today, this process is carried out using tractors and JCB excavators.

Before starting fish farming after her marriage, Mrs. Barman earned a meager income by selling a popular dish called 'oil cakes' at temporary stalls set up during village fairs throughout the year. These snacks were made from brinjal slices, boiled potato mixed with spices, or thinly sliced onions coated in a batter of concentrated gram flour paste and fried in mustard oil. With an initial capital of INR 30,000 saved from this venture, she ventured into fish farming by leasing small freshwater ponds in Dwariberia. There, she began producing and selling live carp fingerlings. Later, she expanded into grow-out carp farming in a 1.664 ha freshwater body, realising that both investment and profit were significantly higher in this practice compared to fingerling production.

Device to keep adult carp alive in wholesale fish market.

Over the years, Arati Barman has overcome numerous challenges to earn respect in Haldia and nearby blocks. Her fish farming water bodies provide sustainable livelihoods to many rural youths of Purba Medinipur who work there, generating employment opportunities. Until 2004-2005, there were only 4-5 professional fish farmers in Haldia and nearby blocks engaged in commercial-scale carp farming. Mrs. Barman was among them, initiating large-scale carp farming in Haldia Block with high embankments constructed on all

Mrs. Arati Barman receiving Award from Fisheries Minister, West Bengal.

sides. Since then, the number of fish farmers has significantly increased. During harvest seasons, fish traders from Singur in Hooghly District, Kharibari in South 24 Parganas, Contai, Mecheda, and Haldia towns in Purba Medinipur, along with other nearby places and wholesale markets near Purba Medinipur, including Balasore in Odisha and Bihar, gather on the embankments to purchase large quantities of fish. These fish are loaded into mini-trucks and transported live from Dwariberia and Garughata over long distances to their respective destinations.

On June 16, 2016, Mrs. Barman received the State-level 'Meen Mitra Award' from the Minister of Fisheries, Government of West Bengal. The ICAR-Central Inland Fisheries Research Institute, Barrackpore, honored her with the Platinum Jubilee Award on March 17, 2018. Her achievements were recognised by Haldia Energy Limited Power Station on World Women's Day in 2015. On January 22, 2015, she was awarded a 'Certificate of Appreciation' by the Block Development Officer, Haldia Block, for her outstanding contribution to fishery and aquaculture development in the area. Mrs. Barman has mentored local youths interested in fish farming and encouraged homemakers in nearby villages to engage in fish farming. Several college students who trained at her farm now work in reputable companies producing fish feed and other aquaculture products. During the COVID-19 lockdown starting from March 16, 2020, she faced significant financial setbacks as fish markets, hotels, and restaurants closed, and the lock gate of Hooghly River prevented freshwater from entering her ponds. Mrs. Barman lives with her three sons, daughters-in-law, two granddaughters, and four grandsons.

End note

The role of women in small-scale family fish farming has long been significant (BOBP, 1980). According to Sri S. Maity, owner of a small-scale fish hatchery in Shibramnagar Village, Haldia, many women are now trained in hatchery seed production of medium carps and other high-value freshwater fishes. New eco-hatchery structures, smaller than conventional Chinese systems, enable women to rear and sell fish spawn and fingerlings profitably from small ponds while managing household duties. In a recent issue of a respected magazine, an elderly Scheduled Caste woman was pictured releasing carp fingerlings in Kheyadaha-I Gram Panchayat, Sonarpur Block, South 24 Parganas (April-June 2024, Page 6). In another instance, 11 members of Elajaner Kuthi Disha SHG near Coochbehar town were seen harvesting *Anabas testudineus*, *L. bata*, and *C. mrigala* from a leased pond (English daily, 25/09/2015).

On July 10, 2024, the author highlighted notable examples of women freshwater fish farmers and their dedication in an audio-visual presentation at the Training Hall of Bishnupur-II Development Block, South 24 Parganas, West Bengal, during the 'Observation of Fish Farmers Day' 2024 program. The aim was to inspire 70 male and female fish farmers, both young and old. Among the 342 blocks in West Bengal, Haldia and Moyna stand out as leaders in successful commercial freshwater aquaculture and fish production, showcasing both innovative and traditional aquaculture practices—an ideal environment for learning.

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Captive breeding of *Ompok bimaculatus* (pabda): An indigenous catfish of North East India

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Assam stands out as the most abundant state of India in terms of fisheries resources. Among the 315 diverse fish species found in the North East region, Assam hosts the highest count, ranging from 197 to 217 species. These species serve various purposes, including food, ornamental, or sport fishing, with some showing promising potential for aquaculture. Approximately 40 species in the region are deemed suitable for commercial aquaculture, yet only a handful are presently cultivated.

While Indian major carps dominate aquaculture, constituting 90-95% of India's total freshwater fish production, Assam also features numerous indigenous medium and minor carp species, small indigenous fishes, chital, catfish, among others, commanding higher market prices and demand compared to major and exotic carps. Thus, there is an opportunity to enhance aquaculture profitability by integrating high-value and nutritious species into farming systems.

However, there has been a notable decline in the abundance of indigenous fish species such as *Ompok bimaculatus*, attributed to habitat modification, climate shifts, altered weather patterns, and overexploitation. To address this, promoting scientific methods such as controlled breeding, scientific rearing, and releasing fish seed through ranching in open waters can aid in restoring the population of *O. bimaculatus*, which is classified as a near-threatened species per the IUCN report.

Ompok bimaculatus (pabda) broodstock.

Pabda broodstock tanks.

Ompok bimaculatus - a new candidate species

O. bimaculatus, locally known as pabda catfish, is widely distributed in the natural water resources of Assam and other northeastern states of India. It is a preferred indigenous non-airbreathing catfish with high market demand compared to Indian major carps and exotic carps. Due to its soft body structure, high protein, and low fat content, it is highly sought after by people in West Bengal, Assam, and the Northeast.

According to the IUCN report, the species is classified as threatened due to alterations in breeding habitats, changes in weather patterns, and overexploitation, leading to a decline in its abundance. Given its economic importance and potential for aquaculture, conserving this fish species is crucial. Therefore, efforts have been made to breed the species in captivity at a renowned fish farm called Pabhoi Fish Farm located in Biswanath Chariali, Assam, India.

A Brief profile of Pabhoi Fish Farm

Pabhoi Fish Farm is a meticulously managed facility dedicated to fish breeding, seed production, and carp culture management. Established in 1996, a Chinese Eco Hatchery was introduced at the farm for induced breeding of carps.

This hatchery includes nursery, rearing, and grow-out ponds spanning 14 hectares of water area. With the implementation of the breeding and seed production unit, the farm has earned recognition for its high-quality seed production not only in Assam but also across the northeastern region.

The farm primarily focuses on Indian major carp seed production, as well as fry, fingerling, and yearling rearing, and grow-out culture. Annually, the farm produces over 150 million fish spawn, along with 10-15 tons of fry, fingerlings, and yearlings collectively, and 8-10 tons of grow-out fish. Additionally, murrel (*Channa striatus*), chital (*Chitala chitala*), and ari (*Sperata seenghala*) seed are produced using traditional methods due to the self-recruiting nature of these fish.

As a registered Network Hatchery of NFDB, Hyderabad, Pabhoi Fish Farm engages in breeding Indian major carps, exotic carps, and has recently initiated breeding programs for amur common carp, Jayanti rohu, and improved catla. To promote the farming of indigenous fish species, the farm has set up a hatchery unit for locally important fish such as magur, pabda, and singhi with financial backing from NFDB, Hyderabad.

Moreover, the farm conducts numerous training programs for fish farmers, supported by Krishi Vigyan Kendras of Assam and Arunachal Pradesh, as well as farmers backed by the Department of Fisheries, Government of Assam and

Arunachal Pradesh. Additionally, students from the College of Fisheries, Assam Agricultural University, Raha, visit the farm annually for practical hands-on training in fish breeding and hatchery management.

Breeding season and maturity of *Ompok bimaculatus*

At Pabhoi Fish Farm, breeding of pabda was conducted in June, coinciding with the onset of the monsoon season. The peak breeding period for pabda catfish in northeastern India typically spans from May to June. The fish were reared for one year in fish ponds, each measuring 0.15 hectares. Brooders reached maturity after one year of rearing under pond conditions.

Pabda brooders exhibited distinct sexual dimorphism, with females generally longer and heavier than males of the same age group. Female brooders typically displayed a bulging abdomen with a fleshy, round, and reddish genital opening. The male-to-female sex ratio was maintained at 1:1. During the study, fish reached a size of 20–23 cm and weighed 20–40 g at first maturity in captivity.

Variation in fecundity was observed during captive-induced spawning, with reported differences among research groups. During breeding operations at the fish farm, a relative fecundity ranging between 20,000-22,000 eggs per 100 g of fish body weight was recorded.

Broodstock maintenance

Rectangular ponds with an area ranging from 0.20 to 0.50 hectares and an average water depth of 1.0 to 1.2 meters are considered suitable for broodstock raising. Prior to releasing fingerlings for broodstock development, pond management measures are implemented. These measures include liming the ponds at a rate of 250 kilograms per hectare and applying cow dung at a rate of 1,300 kilograms per bigha (equivalent to 0.13 hectares). Broodstock ponds are covered with netting to prevent bird predation.

To prepare the broodstock, fingerlings are reared at a density of 35,000 fingerlings per hectare for 12 months. During broodstock development, fish are fed a supplementary diet with a crude protein content of 30–35% daily, at a rate of 3–5% of their body weight. This diet typically comprises ingredients such as mustard oil cake, boiled chicken viscera/ fish wastes, rice polish, and so on.

Captive breeding

Artificial breeding in captive conditions was conducted without sacrificing male brooders. The breeding took place in rectangular cemented cisterns measuring 50 square meters with a depth of 1.5 meters. To prepare the tanks for breeding, they were cleaned with $KMNO_4$ and salt solution to remove the algal slime layer from the walls and bottom. After cleaning, the tanks were rinsed with clean tap water and dried to eliminate any residues of salt and potassium, making them ready for the induced breeding programme.

Mature female brooders weighing 80-100 grams and male brooders weighing 60-80 grams were kept in a hapa for 6 hours prior to injection. The brooders underwent a dip treatment in potassium permanganate solution as a prophylactic measure to ensure their better health status. Fish handling was conducted carefully to prevent possible injury and secondary infection.

Injecting broodstock with hormones to induce spawning.

Breeding hapa installed in cement cistern.

Fertilised pabda eggs.

A single injection of inducing hormone was administered to all the brood fish. The fish were injected intramuscularly above the lateral line towards the dorsal fin using a 1ml syringe. The needle was inserted horizontally at an angle of approximately 45 degrees from the head. Pabda were injected with the inducing agent Ovatide at a recommended dose of 2.5 ml per kilogram body weight for females and 0.5 ml per kilogram body weight for males.

After a latency period of 9–10 hours, the injected brooders were removed and stocked in the earthen ponds. The fertilised eggs were collected and temporarily placed in an aluminium container. The eggs were washed with clean water and transferred to a flow-through system for hatching.

To facilitate hatching, a framed fine-mesh nylon net screen was spread horizontally in the bottom of the cemented cistern, approximately 5–10 cm above the bottom, and fertilised eggs were evenly distributed over the screen. The eggs were maintained under mild water flow and aeration to ensure better survival. Hatchlings emerged after 18–24 hours of incubation at a water temperature ranging from 27 to 30 degrees Celsius. Once most of the eggs had hatched, the screen and any unfertilised eggs were removed from the breeding tank to prevent water fouling.

Larval rearing

The hatched larvae are transferred to circular hatching chambers after being collected from the cemented tanks. Newly hatched larvae are cylindrical, transparent, and lack a mouth, but they possess pectoral fins and body pigments. They also have a large yolk sac, which is pale greenish in color and is absorbed within 2–3 days. At this stage, the rudiment of one pair of maxillaries and two pairs of mandibular barbells begins to appear.

During the first two days after hatching, the larvae rely on their yolk-sac reserves as a food source. By the second day, their mouths open, allowing them to consume small quantities of feed provided in the rearing system. The amount of feed given depends on the larval density and growth.

After two weeks, the larvae are provided with a nutritious and balanced formulated diet consisting of egg custard and fish meal.

Acknowledgement

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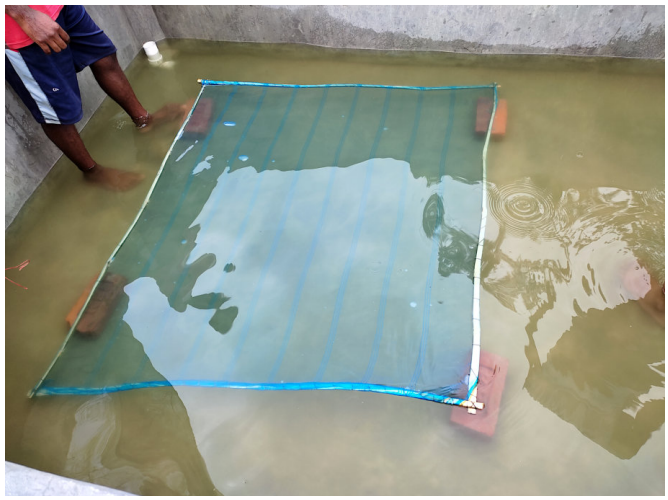

A framed nylon mesh net for incubation of eggs.

15 day old pabda hatchlings.

Pabda seed ready for sale at Pabhoi Fish Farm.

Reaching out to the unreached through diversified aquaculture in Nagaland

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Nagaland is one of the eight sister states in northeast India. It is a mountainous region, home to diverse indigenous tribes with distinct cultures celebrated through various festivals. The most famous of these is the Hornbill Festival, held in December each year. Nagaland is a land shrouded in mystery, characterised by its mountains, valleys, forests, water bodies, and streams. These natural features form the backdrop for the vibrant people who live there—dancers, warriors, and former head-hunters who zealously protect their heritage. The mere mention of Nagaland evokes images of these unique cultures.

However, with changing times, Nagaland is also evolving. Modernity is slowly making its way into tribal cultures, particularly in urban and peri-urban areas, though it has yet to fully reach the more remote villages where traditional ways of life are still fiercely maintained. The people of Nagaland are believed to be embracing this subtle modernity while preserving their cultural traditions, creating a unique blend of unity in diversity.

Nagaland, with a geographical area of 16,579 km² (Bhattacharya et al., 2018), has a population of 2.28 million, and Kohima is its capital. The total potential area for aquaculture is estimated to be around 30,000 hectares, but only 10.45% of this has been effectively utilised, leaving nearly 90%

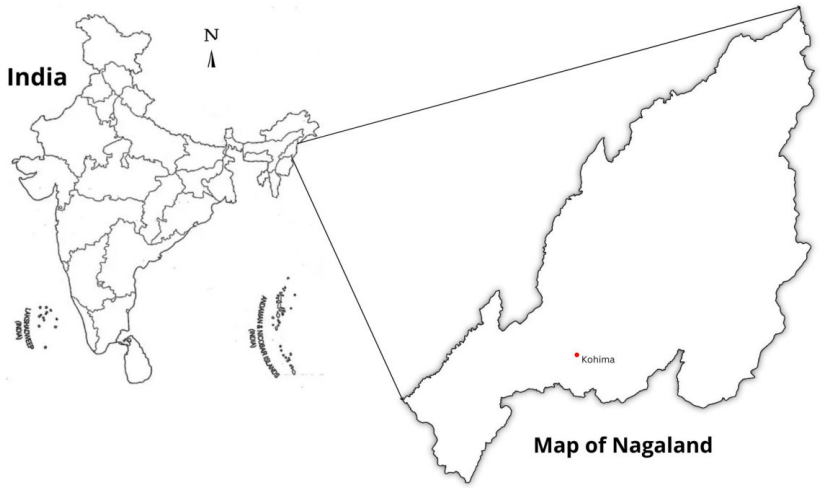
Scattered narrow trenches with water lying in the field after crop harvest.

untapped (Paul et al., 2021). Water is a crucial natural resource in Nagaland, essential for ensuring food security, maintaining ecosystem integrity and health, and supporting the religious and cultural life of the Naga people. It will continue to play inclusive and multifaceted roles in the developmental planning of the state.

Nagaland receives an average annual rainfall of 1,715 mm, with 80% of it occurring during the pre-monsoon and monsoon months (June-August). The heavy rain, combined with the state's hilly topography, results in high surface runoff. Despite the abundance of water bodies such as ponds, lakes, reservoirs, canals, rivers, and seasonal water bodies, the potential for exploiting these resources for commercial fish farming to support the livelihood of the common people remains largely unfulfilled.

The ICAR-Central Institute of Freshwater Aquaculture (CIFA) has made significant efforts to establish aquaculture as a viable livelihood option for the people of Nagaland through the following programmes:

- Paddy and amur carp farming, utilising the extensive water resources available during paddy cultivation.
- The establishment of a large aquarium unit to familiarise people with ornamental fish and the distribution of aquariums to schools to develop an interest in ornamental fish species and farming among school children.



A paddy field landscape, water-filled trenches can be seen in the mid field.

Paddy and amur carp farming – a challenging task in Nagaland

Introducing aquaculture as a livelihood option in Nagaland poses several challenges. The people of Nagaland traditionally prefer pork as their primary protein source, followed by poultry. Fish does not typically feature in their daily meals, but it is gradually being accepted as a substitute protein food. Despite the substantial water resources available, these resources are scattered across the uneven terrain of farming land surrounded by hills. Water from hilly terrain flows down to the plains, where it is stored in shallow tracks of paddy fields with an average depth of 0.3 m. Farmers primarily use these water resources for paddy cultivation.

In this context, the ICAR-Central Institute of Freshwater Aquaculture (ICAR-CIFA), with the help of the Department of Fisheries and Aquatic Resources, Government of Nagaland, has implemented a project on amur carp farming as a diversified aquaculture practice under the Northeast Program. The project initially surveyed the possibilities of aquaculture in Nagaland and selected suitable fish species for this agro-climatic region, where temperatures can drop to around 2°C in peak winter. Amur carp (*Cyprinus carpio haematopterus*), a subspecies of the common carp, was selected based on the following criteria: (i) tolerance to low temperatures below 5°C, (ii) fast growth, averaging 500 g within 6-8 months, and (iii) omnivorous feeding habits, consuming all types of food available in water bodies.

With this backdrop, the project selected 140 farmers from different hilly terrains who own paddy fields and are interested in integrating amur carp farming with paddy cultivation. This method is referred to as integrated paddy and amur carp farming. Each farmer was given 1,000 fry, each measuring an average of 1.5 cm in length and weighing 1.25 g. The peculiarity of amur carp rearing lies in its practice as a three-tier culture system.

1st tier cultivation practice: Amur carp fry released into paddy fields

The amur carp fry given to the farmers in August were sampled in the last week of November, showing promising results with an average length of 5.0 cm and a weight of 6.0 g per fish, and a survival rate of 50%. This survival rate highlights the potential for aquaculture in Nagaland due to several factors: (i) the farmers' enthusiasm and care for amur carp farming, (ii) their eagerness to learn more about the practice, and (iii) the utilisation of previously untapped water resources for amur carp farming.

Scientists with farmers during field survey.

A scientific approach was used for stocking the amur fry at a density of 1,000 per hectare when releasing them into the paddy fields. The presence of amur carp fry in the fields coincided with the healthy growth of paddy saplings and a substantial amount of periphyton growth on the paddy tillering. The water depth in these paddy fields ranged from 0.2 to 0.45 meters.

2nd tier cultivation practice: Amur carp fingerlings released into shallow water bodies in the paddy fields

During the peak winter, after the paddy has been harvested, scattered shallow water bodies filled with water remain in the dry paddy fields. The water recedes from the paddy fields and is stored in these scattered low-lying areas connected to each field. These water bodies, continuously fed by falling water from the hilly terrains, provide a perennial water resource for both refuge and rearing of amur carp fingerlings. The fingerlings migrate to these shallow water bodies, reaching an average weight of 20 g. The staddles of paddy, which remain submerged after harvest, act as suitable substrata for periphyton growth, providing a grazing and feeding surface for the amur fry.

3rd tier cultivation practice: Growing amur carp to 'table size' in ponds and their harvest

The fingerlings that grow in shallow water within paddy fields are mostly transferred to ponds for further growth in larger water areas. However, many of these ponds have a maximum water depth of only 0.5 m with uneven bottom beds. The plankton populations in these ponds appear suitable for feeding amur fingerlings. The amur fingerlings, which grow to an average of 150 g from an initial average of 20 g, are reared to 'table size' before harvest.

In Nagaland, harvesting amur carp is different from ponds on flat land where fish are typically caught using drag nets. Instead, Nagaland fish farmers are accustomed to draining water from one outlet of the pond through a narrow canal. They use locally made bamboo contraptions placed at the outlet mouth to trap fish as they flow out with the water stream. This method presents challenges in catching a desired quantity of fish effectively.

The concept of 'farm-made feed' involves preparing feed using locally available ingredients such as Tapioca powder, rice bran, *Azolla* powder, maize powder, etc., supplemented with Mustard oil cake sourced externally. The feed preparation follows various ratios of ingredients to meet the nutritional needs of the fish:

- Mustard oil cake: Rice bran (60:40).
- Mustard oil cake: Tapioca powder : Rice bran (60:10:30).
- Mustard oil cake: Rice bran : *Azolla* powder : Maize powder (50:25:15:10).
- Mustard oil cake: Broken rice : Tapioca powder : *Azolla* powder : Rice bran (50:10:10:15:15).
- Mustard oil cake: Maize powder : Tapioca powder : Rice bran (50:15:10:25).

A total of 140 cartons each having 1,000 amur carp fry.

Scientists handing over carton to farmer.

Farmers transport cartons to their respective fields by car

These formulations can be adjusted based on the availability of feed ingredients at different times and locations. Farmers are encouraged to use cost-effective farm-made feeds to promote profitable and sustainable aquaculture practices (Paul et al., 2021).

CIFA's contribution to aquaculture development in Nagaland

Prior to CIFA's intervention, seasonal water bodies in paddy fields were left unused, dedicated solely to paddy cultivation. Water resources in the narrow trenches of paddy fields remained idle without significant use. Ponds also lay fallow, devoid of cultivable fish species.

CIFA has effectively utilised these underutilised water resources for fish rearing, encouraging fish farmers and promoting aquaculture. Amur carp has proven to be a suitable species capable of tolerating temperatures below 5°C during peak winter months. Farmers are now able to cultivate two crops—paddy and amur carp—simultaneously on the same cultivable area, thereby increasing overall yield per unit area. Amur carp farming aims to supplement the protein source in the aquatic food available to the people of Nagaland.

A farmer displays amur fry after receipt.

Dissemination of knowledge on aquarium-based farming and ornamental fish species

ICAR-CIFA has initiated efforts to promote aquarium farming of ornamental fish species, aiming to engage and educate the public about fish species and their cultivation in confined environments. This initiative includes two key initiatives:

Establishment of a 'capacity building program'– an attractive display for the public

One large aquarium unit, housing 42 aquariums displaying both indigenous and imported ornamental fish species, was established by ICAR-CIFA in a department-owned building at Brooders Fish Farm, Half Nagarjan Dimapur, Nagaland, for students, research scholars, and the public. The establishment of this ornamental unit aims to achieve the following objectives: (i) fostering curiosity about ornamental fish species and their farming as household activities among common people, (ii) promoting the trading of ornamental fish

A pair of amur fingerlings.

A view of pond used for amur carp farming.

species as a livelihood option, and (iii) inspiring common people to collect indigenous ornamental species from natural water bodies for farming or hobby purposes, considering Nagaland's status as a hotspot for a variety of indigenous ornamental fish species (Box 1).

Distribution of aquariums along with ornamental fish species to high schools

ICAR-CIFA has adopted an innovative approach to promote aquarium farming and educate school students about ornamental fish species. Initially, 20 high schools were selected, and each school received a modular glass aquarium made of crystal-clear glass with a thickness of 1.2 cm, measuring 120 cm in length, 45 cm in width, and 45 cm in height. The aquariums were stocked with a variety of ornamental fish species, including indigenous ones. This initiative aimed to spark interest among young minds in ornamental fish farming and its potential as a source of revenue in the future. School representatives, mainly comprising teaching staff, were trained on aquarium maintenance and care within the school premises. This approach has proven effective, as students and their guardians have shown keen interest in promoting ornamental fish farming in their own homes.

Box 1. List of indigenous ornamental fish species available in Nagaland (Anonymous, 2005)

1. *Amblyceps mangois*, 2. *Badis badis*, 3. *Balitora brucei*, 4. *B. burmanica*, 5. *Barilius barna*, 6. *B. bendelisis*, 7. *B. vagra*, 8. *Batasio batasio*, 9. *Danio aequipinnatus*, 10. *D. dangila*, 11. *D. devario*, 12. *D. nagaensis*, 13. *Gagata cenia*, 14. *Glyptothorax cavia*, 15. *G. indicus*, 16. *G. manipurensis*, 17. *G. platypogonoides*, 18. *G. siaisii*, 19. *G. telchitta*, 20. *G. triliniatus*, 21. *Nemacheilus beavani*, 22. *N. botia*, 23. *N. manipurensis*, 24. *N. multifasciatus*, 25. *N. reticulofasciatus*, 26. *Psilorhynchus balitora*, 27. *P. homaloptera*, 28. *Puntius clavatus*, 29. *Sisor rabdophorous*, 30. *Xenentodon cancila*

Farmer showing advanced amur carp fingerling.

Training for scientific aquaculture

The training's aim is to enhance skills and knowledge among stakeholders involved in fish farming. ICAR-CIFA has organised several sessions for officials and farmers to impart knowledge essential for the sustainable management of fish farming practices.

Training at Kohima: Ornamental fish farming

A one-day workshop titled 'Species Diversification in Freshwater Aquaculture in Nagaland' was jointly organised in Kohima, Nagaland by ICAR-CIFA and the Directorate of Fisheries & Aquatic Resources, Nagaland. The event drew more than 50 participants, including officials. Scientists from ICAR-CIFA conducted training sessions focused on ornamental fish culture and farming aimed at generating revenue. They highlighted the importance of collecting indigenous ornamental fish from natural water bodies in Nagaland and emphasised their domestication. ICAR-CIFA reaffirmed its commitment to the development of fisheries in Nagaland and reviewed past aquaculture practices in the state. The workshop also included interactive sessions between scientists and farmers.

Training at the Directorate of Fisheries, Nagaland: Paddy and fish farming

In this training, two major subjects were discussed: (i) paddy cum amur carp farming, and (ii) water quality management in paddy fields to sustain amur carp. Scientists with expertise in paddy cum carp farming shared their experiences on how carps are reared in paddy fields. They discussed carp feeding strategies, including the application of exogenous feeds

Director of ICAR-CIFA, Dr Pramoda Kumar Sahoo, flanked with principal scientists inside the aquarium unit.

School showing one aquarium supplied by CIFA.

Training programme for capacity building of fish farmers.

alongside natural foods available in paddy fields. Participants were encouraged to adopt these practices for amur carp rearing in paddy fields. Additionally, water quality management was addressed to ensure sustainable farming practices that promote the growth of both amur fish and paddy saplings without disturbance.

Training at Dimapur: A way of revenue generation

The discussion on how ornamental fish farming contributes to revenue generation was a key issue during the interactive training session. State fisheries officials actively participated in both the training and discussions. The training covered various aspects such as the morphology and identification of different ornamental fish species, feeding practices, breeding techniques, management strategies, and the isolation of juveniles from brooders. These discussions aimed to rejuvenate fishery officials and encourage them to promote ornamental fish farming as a small-scale industry within

Participants in a training programme on paddy and amur carp farming.

households. Ornamental fish farming is in high demand due to its trade value, making it a lucrative opportunity for small-scale farmers.

Conclusion

The efforts of ICAR-CIFA are poised to diversify livelihood options for economically disadvantaged small-holder farmers in the region and enhance revenue through profitable aquaculture practices. With abundant fisheries resources, there is potential for aquaculture to significantly contribute to the economic balance of the state. This initiative holds promise for improving livelihoods and generating employment. However, a significant challenge lies in the lack of familiarity among local people with fish farming, necessitating continuous training in scientific aquaculture practices, particularly in paddy cum amur farming. Amur carp, well-suited to the region's agro-climatic conditions, offers the opportunity to integrate fish farming with paddy cultivation, enabling dual crop harvests within the same cultivable area. Additionally, promoting small-scale fish farming of ornamental fish species in enclosed environments could provide another avenue for livelihood improvement among local communities.

Participants in a training programme on ornamental fish farming.

Acknowledgement

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Fish cooperatives: Development and performance through sustainable development goals for food and feed ecosystems

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India ranks second in global fish production and holds the second position in aquaculture production and inland capture fisheries. The fisheries sector provides livelihoods to over 16 million people. In 2017-18, our total fish production was 12.59 million metric tonnes, with an average annual growth of 10.14% (Handbook on Fisheries Statistics, Ministry of Fisheries, Animal Husbandry & Dairying, Government of India, 2018). India has abundant fishery resources with great potential for substantial progress. According to FishBase (Froese and Pauly, 2013), 862 species of freshwater fish are found in India. In 2017, 788 marine fish species were landed along Indian coasts. We possess more than 10% of global fish biodiversity.

Moreover, the fisheries sector contributes more than 5% of the agricultural GDP. However, despite being a 'sunrise sector', the fishing industry faces many constraints.

Some constraints in the fisheries sector are as follows:

- Most people engaged in fisheries for their livelihood belong to socio-economically disadvantaged communities.
- There is a lack of proper institutional support, such as infrastructure and finance.
- Quality seed is not readily available.
- The sector suffers from a lack of organised marketing.
- Quick transport facilities are unavailable.
- Fish farmers often have poor technical skills.
- There is a paucity of funds and bank credits.
- Participatory fisheries management is lacking.
- Social issues also pose significant challenges.

It was realised that fishermen and women should be organised at the community level to overcome these problems and improve their socio-economic status. This can be achieved by incorporating appropriate inputs from education, finance, marketing, communication, technology, transport, seed availability, health, and government policies. This idea led to the birth of Fisheries Cooperative Societies in India. As early as 1913, the fishery cooperative movement in India began when the first fisher's society, the Karla Machhimar Cooperative Society, was organised in Maharashtra.

Efforts to strengthen fishery cooperatives by various entities

The National Cooperative Development Corporation (NCDC), New Delhi, played a significant role in strengthening fishery cooperatives by assisting them to build their share capital and establishing service and repair centres for boats. NCDC also supported the setting up of canning units, fish oil and meal plants, net-making units, and the construction of godowns (storage facilities) and drying yards. To enhance the development of fishing cooperatives, NCDC formulated a comprehensive policy for assisting fishery cooperatives for various purposes. These include purchasing operational inputs such as fishing boats, nets, and engines, creating infrastructure facilities for marketing like transport vehicles, cold storages, and retail outlets, setting up processing units including ice plants and cold storages, and developing inland fisheries, seed farms, and hatcheries. Additionally, NCDC assists in preparing feasibility reports, appointing experts under technical and promotional cell schemes, and implementing integrated fisheries projects for marine, inland, and brackish water fisheries.

The National Fisheries Development Board (NFDB), Hyderabad, established in 2006, also plays a crucial role. NFDB aims to realise the untapped potential of the fisheries sector, augment fish culture, and promote fish processing and marketing. It focuses on the application of modern tools of research and development to optimise fish production. Furthermore, NFDB provides special care and financial assistance to fisher's societies, cooperative bodies, women, Scheduled Castes and Schedule Tribe communities, weaker sections, and underdeveloped regions.

International entities supporting the fisheries sector

The International Cooperation (IC) Division serves as a focal point to facilitate communication and interaction between the Department of Fisheries/Ministry of Agriculture & Farmers Welfare and international organisations, as well as foreign countries. This role helps the fisheries sector in India stay updated on the latest technological developments and advancements occurring globally, especially in technologically advanced countries. The objective is to leverage this knowledge to increase production and productivity in the livestock sector. Additionally, the division acts as a bridge

between India and less technologically advanced nations, sharing knowledge and providing technological assistance to strengthen friendly relations.

The Sustainable Development Goal 14: Life Below Water aims to conserve and sustainably use the oceans, seas, and marine resources for sustainable development.

Given the challenges and efforts by various entities, there is a need for a roadmap for the overall development of the fisheries sector through institutional building via cooperatives. The objectives of this study were framed to guide research in this area:

- To study the performance of fish cooperatives in India during NITI.
- To examine the Government of India's schemes for fish cooperatives.

To investigate the finance, marketing, and capacity-building needs and associated problems of fish cooperatives.

Methodology

The research study employed a straightforward approach using factual data and literature from the NITI Aayog era. Secondary data were gathered from the inception of NITI Aayog in 2015 to July 2023. The collected information was analysed using simple tabular analysis (refer Table 1 below) to profile fish cooperatives in India.

Findings

Table 1 outlines the performance of fish cooperative societies at the primary, district, and state levels in India from 2015 to 2023. It also presents data on the memberships of fishery societies and the number of insured fishers across all levels of the cooperative structure.

Fishery cooperatives in India

The fisheries sector in India is diverse, encompassing marine, inland, brackish water, cold water, and ornamental fisheries. This sector holds significant economic potential, supported by India's extensive coastline of over 8,000 km, an exclusive economic zone exceeding 2 million square km, and numerous freshwater bodies.

Types of fishery cooperative societies:

- **Producer's cooperative societies:** Aim to produce goods and services based on common ownership and management by workers, eliminating the employee-employer relationship.
- **Fish consumer's societies:** Composed of agricultural workers and middle-class individuals who operate consumer stores. These societies purchase fish at wholesale prices and sell them at market or lower prices to their members.
- **Fisheries credit societies:** Voluntary associations providing credit to members based on personal security or nominal security.
- **Marketing cooperative societies:** Managed by small producers to promote their trade by selling goods at reasonable prices, bypassing middlemen.
- **Insurance cooperative societies:** Negotiate with insurance companies to minimise risk for members and their produce. They purchase individual and group insurance policies at lower premiums.
- **Transport cooperative societies:** Provide vehicle and transport services to members at reduced rates.
- **Storage cooperative societies:** Offer storage facilities for perishable items to their members.

These cooperative societies play a crucial role in enhancing the economic viability and sustainability of the fisheries sector in India by facilitating collective action and shared benefits among their members.

Role of fishery cooperatives

Fishery cooperatives play a crucial role in providing livelihood security, nutritional security, and social security to vulnerable groups in society. In India, approximately 4 million people derive economic benefits from primary fishery cooperatives.

These cooperatives are pivotal in the current economic landscape and should receive support at every level. Funding is essential to develop infrastructure and establish progressive supply chains and value chains that ensure sustainability. By bolstering fishery cooperatives, India can enhance economic resilience and social well-being among its coastal and inland fishing communities.

Table 1. Performance of the fish cooperatives in India, 2015-2022.

Fishery Cooperatives	2015-16	2016-17	2017-18	2020-21	2021-22	2022-23
Number of primary fishery cooperatives	18,559	18,357	20,639	21,714	25,301	27,906
Number of regional / district fishery cooperative societies	130	132	144	132	152	138
Number of state federation of fisher's cooperatives	22	21	21	28	23	33
Membership (million)	2.8	2.9	3.2	3.3	3.8	3.9
Fishermen insured	4,671,124	4,214,220	4,214,220	NA	NA	NA

Fishery development: Government of India's thrust

The Government of India has placed significant emphasis on the development of the fisheries sector through various initiatives:

- **Atmanirbhar Bharat Abhiyaan:** A Rs 20 trillion economic package aimed at creating jobs in the fisheries sector.
- **Pradhan Mantri Matsya Sampada Yojana (PMMSY):** Launched in 2019-20 with a total project outlay of Rs 200.5 billion to boost India's economy through the fisheries sector. Learn more about PMMSY.
- **Fisheries & Aquaculture Infrastructure Development Fund (FIDF):** A dedicated fund of Rs 75.22 billion established to develop fisheries and aquaculture infrastructure.
- **Blue Revolution:** Introduced in 2014, it aims to enhance fish production and develop infrastructure in the fisheries sector.

These initiatives underscore the government's commitment to bolstering the fisheries sector, promoting economic growth, and improving livelihoods across India.

Fishery cooperative movement in India

The fishery cooperative movement in India dates back to 1913, with the establishment of the first fisher's society named the 'Karla Machhimar Cooperative Society' in Maharashtra. Since the establishment of the Ministry of Cooperation, fisheries cooperatives have received significant attention and focus.

National database of fisheries cooperatives

Efforts are underway to organise fishery cooperatives across every panchayat in India, aiming to reach a total of 200,000 cooperatives in the next five years. The National Fisheries Development Board (NFDB) and FISHCOPFED are working closely with state and union territory authorities to expedite this initiative. The database will help identify sectoral gaps, with concerted efforts to address them.

Fishery success stories

Fishery cooperatives have gained prominence since the establishment of the Ministry of Cooperation in 2021. Some notable examples include:

- **Matsyafed-Kerala:** Established in 1984, this state-level federation excels in fish sales, exports, and operates its own mat-making and processing plants.
- **Gujarat Fisheries Central Cooperative Association (GFCCA):** Registered in 1956, GFCCA manages diesel outlets for fishing boats and operates successful fish retail outlets in Delhi.

These success stories highlight the positive impact of cooperative models in enhancing fishery operations, sales, and economic outcomes across different states in India.

Enhanced access to agricultural credit

Ensuring seamless access to affordable credit has been a paramount goal of the Government of India, particularly through initiatives like the Kisan Credit Card Scheme (KCC).

Kisan Credit Card Scheme

Introduced in 1998, the KCC scheme empowers farmers to access credit for agricultural inputs and services at any time. As of 30 December 2022, banks have issued KCCs to 389 million eligible farmers, with a total credit limit of ₹4.51 trillion. The scheme was extended to fisheries and animal husbandry sectors in 2018-19, resulting in the issuance of 100,000 KCCs to fisheries and 950,000 to animal husbandry farmers as of 4 November 2022.

Interest Subvention Scheme (ISS) / Modified Interest Subvention Scheme (MISS)

To ensure affordable credit, the government introduced the ISS, now known as MISS, offering short-term agricultural loans up to ₹300,000 at a subsidised interest rate of 7% per annum. Farmers engaged in agriculture and allied activities, including animal husbandry, dairying, poultry, and fisheries, benefit from this scheme. An additional 3% subvention (prompt repayment incentive) is provided to farmers who repay loans promptly, reducing the effective interest rate to 4% per annum.

Agriculture credit flow

Due to these initiatives and strengthened policies, there has been a consistent increase in agricultural credit flow, surpassing targets each year. In 2021-22, credit flow exceeded the ₹16.5 trillion target by approximately 13%. The target for 2022-23 aims to further increase credit flow to ₹18.5 trillion, supporting agricultural growth and rural livelihoods across India.

Fisheries catching up in recent years

The allied sectors of Indian agriculture—livestock, forestry and logging, and fishing and aquaculture—are increasingly contributing to buoyant growth and promising farm incomes. From 2014-15 to 2020-21, the livestock sector grew at a compound annual growth rate (CAGR) of 7.9% (at constant prices), boosting its share of total agriculture GVA (at constant prices) from 24.3% to 30.1%. Similarly, the fisheries sector has maintained an annual average growth rate of about 7% since 2016-17, now accounting for 6.7% of total agriculture GVA. This higher growth in allied sectors compared to traditional crops underscores their rising importance in agricultural economics. Acknowledging this trend, the Committee on Doubling Farmers' Income (DFI, 2018) identifies dairying, livestock, poultry, fisheries, and horticulture as key growth drivers, recommending focused policies and support systems for these sectors.

Pradhan Mantri Matsya Sampada Yojana (PMMSY)

In May 2020, as part of the Aatmanirbhar Bharat stimulus package, the Government of India launched the Pradhan Mantri Matsya Sampada Yojana (PMMSY) with a total outlay of ₹200.5 billion. PMMSY represents the largest-ever investment in India's fisheries sector, planned for

implementation over five years from FY21 to FY25 across all States and Union Territories. The aim is to foster sustainable and responsible development while promoting the socio-economic well-being of fishers, fish farmers, and fish workers. Prior to this initiative, efforts focused on addressing infrastructure gaps through the Fisheries and Aquaculture Infrastructure Development Fund (FIDF), established from 2018-19 to 2022-23 with an investment of ₹75.22 billion. As of 17 October 2022, proposals amounting to ₹49.239 billion have been approved under FIDF, benefiting over 940,000 individuals through direct and indirect employment in fishing and allied activities.

Sahakar-Se-Samriddhi: From cooperation to prosperity

The cooperative societies, particularly in agriculture, dairy, and fisheries sectors, offer rural populations livelihood opportunities and financial security through community-based approaches. Cooperatives are pivotal in transforming rural economies. The country hosts 850,000 registered cooperatives with over 290 million members, primarily from marginalised rural communities. Primary Agriculture Credit Societies (PACS) cover 98% of villages. To realise the vision of "Sahakar-se-Samriddhi," the cooperative sector has received renewed attention. Currently, cooperatives account for approximately 19% of agricultural financing. The Ministry of Cooperation, established in July 2021, focuses on enhancing the cooperative sector. Government initiatives include computerising 63,000 functional PACS and enabling their expansion through by-laws. The *Multi-State Cooperative Societies Act, 2002* replaced the 1984 Act, promoting democratic and autonomous functioning. Currently, there are 1,528 registered societies under this Act, including 66 Multi-State Cooperative Banks holding deposits of approximately ₹2.6 trillion. Maharashtra leads with 661 cooperatives, followed by Delhi and Uttar Pradesh.

The food processing sector plays a crucial role in India's development by fostering strong linkages between industry and agriculture. Over the last five years leading up to FY21, the food processing industries sector has grown at an average annual rate of approximately 8.3 percent. According to the latest Annual Survey of Industries (ASI) for 2019-20, 12.2 percent of individuals in the registered manufacturing sector were employed in food processing. Furthermore, agri-food exports, including processed food exports, accounted for about 10.9 percent of India's total exports during the fiscal year 2021-22.

The increasing significance of processed food items in the consumer market opens new horizons for both agriculture and industry sectors. This shift promotes diversification and commercialisation in farming, improves resource efficiency, enhances farmers' incomes, expands avenues for exporting agro foods, and creates employment opportunities. Optimal development of the food processing sector can address various developmental challenges, including disguised rural unemployment in agriculture, rural poverty, food security, food inflation, improved nutrition, and prevention of food wastage. These outcomes underscore the sector's pivotal role in India's socio-economic development.

To facilitate the unfettered growth of the food processing sector, there is a continuous need for extensive investment in cold chain infrastructure and to address logistical challenges. The NITI Aayog Strategy for New India identifies the lack of adequate and efficient cold chain infrastructure as a critical supply-side bottleneck that leads to massive post-harvest losses (mostly of perishables) estimated at approximately ₹925.61 billion annually. The uneven geographic distribution of cold storage infrastructure also contributes to regional-level disparities. Given that countries worldwide have stringent guidelines for importing food and agricultural products, the probability of exports from India getting rejected increases with the lack of adequate cold chain infrastructure. Further, logistical barriers relating to connectivity also pose supply-side challenges. For instance, Indian national highways, while accounting for 2 per cent of the total road network, carry 40 per cent of all cargo – exemplifying the burden on the existing road networks and potential for congestion, which is detrimental to food (and particularly perishables) transport.

Recognising the abundant potential of the sector, the Government has been at the forefront with various interventions aimed at the development of food processing in the country. The Ministry of Food Processing Industries, through the component schemes of Pradhan Mantri Kisan SAMPADA Yojana (PMKSY), provides financial assistance for the overall growth and development of the food processing sector. Under PMKSY, 677 projects were completed by 31 December 2022. The Ministry also launched the Prime Minister's Formalisation of Micro Food Processing Enterprises (PMFME) Scheme in 2020 as part of the ANB Abhiyan to enhance the competitiveness of individual micro-enterprises in the unorganised segment and promote the formalisation of this sector by providing financial, technical, and business support for upgrading/setting up 200,000 micro units in the country. As of 31 December 2022, 15,095 loans totaling ₹14.026 billion were sanctioned. The scheme adopts the One District One Product (ODOP) approach to benefit from economies of scale in procuring inputs, using shared services, and marketing products. So far, 713 districts with 137 unique products were approved under ODOP in 35 states/UTs. The Production Linked Incentive Scheme for Food Processing Industry (PLISFPI), launched in March 2022, aims to incentivise investments to create global food champions. Sectors with high growth potential, such as marine products, processed fruits & vegetables, and 'Ready to Eat / Ready to Cook' products, are covered for support. In phase I, 149 applications have been selected for assistance under PLISFPI. Subsequently, a PLI Scheme for millet-based products was introduced with an outlay of ₹8 billion. In phase II, 33 applications (both organic and millet products) have been selected. To focus on transporting perishable food products, including horticulture, fishery, livestock, and processed products, from hilly areas, northeastern states, and tribal areas, Krishi UDAN 2.0 version was launched in October 2021 as a six-month pilot project. The Airports Authority of India (AAI) provides a full waiver of landing, parking, terminal navigational landing charges (TNLC), and route navigation facility charges (RNFC) for Indian freighters and P2C (passenger-to-cargo) aircraft. The scheme covers around 25 airports focusing on northeastern, hilly, and tribal regions, and 28 airports in other regions/areas. Thus, the scheme assists farmers in transporting agricultural products and improves value realisation.

To study finance, marketing, and capacity building needs and associated problems of fish cooperatives, a training needs assessment was carried out at Thane and Palghar fish marketing federations. Maharashtra Fishery Cooperative Federation operates at the apex level, District Central Fishery

Cooperative Society at the tier two level, and primary fishery cooperative societies at the village level. There are a total of 57 primary fishery cooperative societies under District Central Fishery Cooperative Society, Palghar.

There is an annual monsoon fishing ban from 1 May to 1 August 2023 to facilitate breeding of fish during the spawning season. Normally, societies have a varied number of small boats for fishing, but only a few societies harvest fish for more than 15 days. Most of the societies engage in daily harvests from morning to afternoon, adhering to the government's harvesting limit of 8 nautical miles.

Problems and suggestions

- **Unscrupulous practices:** Non-licensed individuals engage in night-time fishing using narrow mesh nets (LED and Percy nets), resulting in the capture of young fish before they reach economic maturity. Suggestions: Implement government regulations on the production, use, and manufacturing of fishing nets, and enhance monitoring of nighttime fishing activities.

- **Land tenure:** Lease tenures for land used in prawn and crab culture have expired. Suggestion: Extend lease periods to sustain prawn and crab culture and diversify business activities.

- **ONGC & MIDC activities:** Oil drilling by ONGC causes ocean environmental pollution, adversely affecting fish population growth. Suggestion: Advocate for government intervention as necessary to mitigate environmental impacts.

- **Tax burden on inputs:** Heavy taxes on bulk diesel cooperative purchases affect fisherfolk. Suggestion: Consider tax exemptions to support the betterment of fisher communities.

- **Compensation for fishing ban period:** Annual monsoon fishing bans from 1 May to 1 August hinder regular fishing activities, necessitating income assistance during this period. Suggestion: Extend income assistance similar to the PM-KISAN Yojana to fishers who are excluded from its benefits.

- **Skilled labour shortage:** Local skilled labourers are drawn to higher wages offered by entities under MIDC, leaving fish cooperatives struggling to recruit manpower at standard wages. Suggestion: Regulate wages in the area similar to the norms followed by the Food Corporation of India to address labour shortages.

- **Windbreak and JT Platform:** Heavy currents necessitate the construction of concrete windbreak walls and removal of JT platforms. Suggestions: Construct concrete wind-break walls and consider removing JT platforms to mitigate the effects of heavy currents.

The fisheries sector represents a sunrise industry in India with substantial economic potential. Fishery cooperatives are pivotal in ensuring access to nutritious food and creating employment opportunities. The Government of India is dedicated to advancing the fishery cooperative sector through robust policy frameworks and financial backing. The coordinated efforts between the Ministries of Cooperation and Fisheries are poised to catalyse the sector's expansion.

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NACA Newsletter

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NACA and Thailand's Department of Fisheries Strengthen Collaboration

On June 28, NACA's newly appointed Director General, Dr. Eduardo Leano, along with staff, paid a courtesy call to Mr. Bancha Sukkaew, the Director General of the Department of Fisheries (DOF), Thailand, and directors of DOF's divisions.

Dr. Leano expressed his gratitude for Thailand's ongoing support to the organisation. For more than 30 years, Thailand has hosted the NACA Secretariat and provided both office facilities and supported the administrative staff.

Mr. Sukkaew congratulated Dr. Leano on his new role as NACA Director General. Discussions centered on ongoing projects between NACA and DOF and explored opportunities for collaboration both in Thailand and the wider region.

Mr. Sukkaew emphasised the need to improve food security in the Asia-Pacific region and the importance of cooperation in information sharing and R&D to enhance productivity and reduce costs. He noted that feed costs, which can represent over 70% of total production costs, are a particular concern. Additionally, he highlighted the need to address climate change issues and promote gender equality in the aquaculture industry.

Mr. Bancha Sukkaew, Director General DOF (centre), Dr Eduardo Leano, Director General NACA, next left.

Dr. Leano thanked Mr. Sukkaew for his cooperation and looked forward to further strengthening NACA's partnership with Thailand. He welcomed Thailand's participation in the current project on knowledge brokering for nature-based solutions in aquaculture transformation in Asia-Pacific. The Thai team was working to identify and document innovations and nature-based solutions in the aquaculture industry as a contribution to the Aquaculture Innovation and Investment Hub, presently in development.

Full-degree scholarships and research internship grants from Prince of Songkla University, Thailand

The Faculty of Science at Prince of Songkla University is offering two opportunities:

- Ten full-degree scholarships (PhD, Masters) provided by the Faculty of Science, including full tuition and on-campus dormitory cost: https://sites.google.com/psu.ac.th/sci-ir/collaborations/scholarship
- Research Internship Grant for collaborative graduate research work, available for 4-6 months until September 2025, available to graduate students worldwide: https://sites.google.com/psu.ac.th/sci-ir/collaborations/research-internship

Applications for both programmes close **31 July 2024**, don't miss out!

Manual on *Artemia* production and use

Van Stappen, G., Sorgeloos, P. & Rombaut, G. (eds.)

This FAO publication on brine shrimp is a manual for all those who are using *Artemia* or have an interest in this organism, whether as a source of live food in the hatchery, as a model organism in research, or for other purpose. It is intended for those who wish to update their knowledge on *Artemia* biology, production or its use, but also for those who want to learn about *Artemia* for the first time.

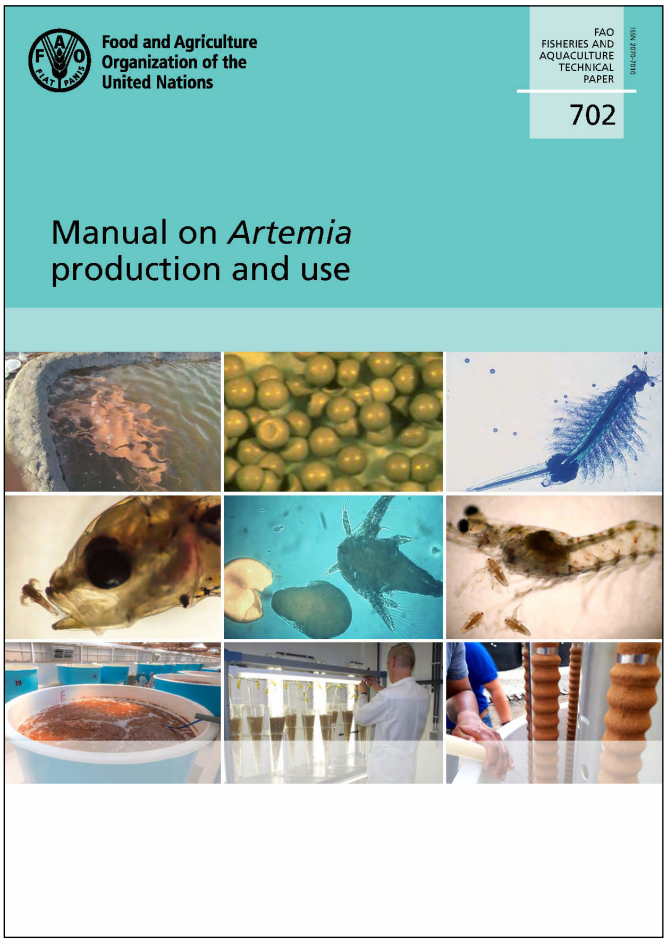
A team of leading *Artemia* experts from around the globe with diverse backgrounds, expertise and working in research, education and/or the industry have jointly contributed to its writing. This manual presents in a concise form essential information on *Artemia* biology and the most important natural cyst resources that find their way to the aquaculture market. It also provides detailed information on general principles and practical procedures to produce *Artemia* in ponds and in tank systems.

Finally, the manual offers a compilation of state-of-the-art guidelines and methodologies related to the use of this crucial live food organism in aquaculture. The illustrations, tables and practical worksheets will help the reader to implement the correct procedures in the production and use of *Artemia*. This publication is a must for anyone working with this unique organism.

Supplementary material (in excel format) that accompanies this publication is available for download separately.

Download the manual from:

- https://enaca.org/?id=1335



The Grass Carp Aquaculture Manual

Ana Silvia Pedrazzani, Nathieli Cozer and Antonio Ostrensky

This manual provides valuable information on grass carp production. It covers everything from grass carp's natural distribution and reproductive behaviours to its biology and anatomy. This manual also explores diseases that can affect grass carp and emphasises the crucial connection between animal welfare and stress in fish.

With a detailed discussion on cultivation systems, this manual includes pond structures and fish farming techniques in both polyculture and monoculture. It provides practical insights into important aspects such as water quality monitoring, feeding, nutrition, health checks and behaviour assessments at every stage of grass carp farming from broodstock management to pre-slaughter and slaughter processes. The emphasis is on responsible harvesting techniques, transportation considerations and humane slaughter methods.

With its extensive range of topics, from the intricacies of grass carp biology to the practical aspects of pond management and sustainable farming practices, this manual offers a comprehensive guide for both novice and experienced fish farmers, and enthusiasts interested in cultivating grass carp sustainably and ensuring optimal animal welfare.

Download the manual courtesy of FAI Farms from:

- https://enaca.org/?id=1338

Pacific oyster farming: A practical manual

Mark Mercer, Leorenzo Gennari, and Alessandro Lovatelli

The purpose of this manual from FAO is to give the reader a foundation of practical knowledge regarding all aspects of Pacific oyster cultivation. It is targeted at new entrants to the market wishing to establish a farm, and existing operators who wish to develop their farms and explore new cultivation techniques. The methodologies described can be applied to both low-tech, low budget, small-scale farming operations and to high-tech, big budget, industrial-scale aquaculture production enterprises.This guide focuses on the functional expertise and technical equipment required to construct and manage an operational farm in the diverse environmental and physical locations in which they can be situated, from the initial stages of finding and selecting a suitable site, to the conclusion of the first production cycle and harvesting the crop.

The manual contains a brief introduction which describes the relevance of the species with regards to global aquaculture production figures and how it can form an important part of future food production strategies.

Chapter 2 describes the anatomy and biology of *Crassostrea gigas* and gives an indication as to the environmental conditions in which the species thrives as well as the pathologies and predators that can result in poor health leading to potential mortalities. Quality assessment parameters are also discussed with regards to desirable attributes when selling final product into the market and what is necessary to be aware of when considering consumer safety.

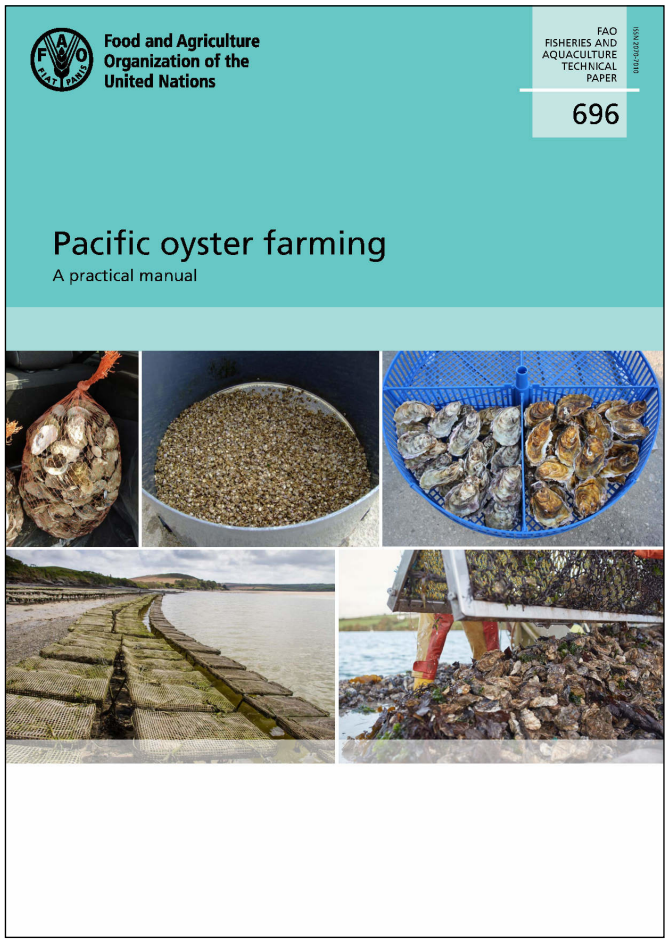
Chapter 3 deals with all aspects of undertaking a survey of potential oyster farming sites and what data should be collected and examined in order to both assess a site's suitability, but also which areas are best suited to different cultivation techniques.

Chapter 4 introduces the main farming techniques that will be described in detail in the following chapters, which includes off-bottom cultivation, on-bottom cultivation, and suspended cultivation, and also gives details of some of the most common cultivation equipment necessary to undertake these operations. The techniques and strategies necessary to procure seed oysters and how to develop them through the nursery stage are also introduced. This includes the basic principles of upwelling.

Chapter 5 provides a detailed description of how to build and operate one particular example of a Floating Upwelling System (Flupsy) which is suitable for use in remote but sheltered conditions. A section on the best practices to be adopted when handling and transporting oysters is also included in this chapter.

Chapters 6, 7 and 8, constitute the main body of the manual and provide an in depth look into the three major cultivation techniques that this guide concentrates on:

- Farming with trestles and bags in the intertidal zone.
- On-bottom cultivation in the intertidal or subtidal zone.
- Offshore long-line cultivation.



These represent three of the most common farming techniques adopted in a multitude of locations and, although other techniques are utilised, are responsible for the majority of oyster production around the globe. In each chapter, all aspects of the farming process are explored including site selection, farm design, farming practices and main constraints.

Finally, the manual finishes with some suggestions for further reading, a glossary and appendixes which includes information on food safety in regard to bivalve molluscs and some further details about cupped oyster production figures.

The manual is available for free download from:

- https://enaca.org/?id=1336

The State of World Fisheries and Aquaculture 2024: Blue Transformation in action

The 2024 edition of The State of World Fisheries and Aquaculture, published by FAO, features the Blue Transformation in action, illustrated by activities and initiatives, led by FAO in collaboration with Members, partners and key stakeholders, to integrate aquatic foods into global food security and sustainability, enhance policy advocacy, scientific research and capacity building, disseminate sustainable practices and technological innovations, and support community involvement.

Part 1 of this edition of The State of World Fisheries and Aquaculture benefits from significant improvements in data collection, analytical and assessment tools and methodologies to present the most up-to-date review of world fisheries and aquaculture production and utilisation.

Part 2 highlights the role of FAO and its partners to catalyse the transformational changes required to support aquaculture expansion and intensification, effective management of global fisheries and upgrading of aquatic value chains.

Part 3 covers the high-impact challenges and opportunities of the untapped potential of utilising whole fish and by-products to improve food security and nutrition, expounds on the role of aquatic food systems in providing critical climate, biodiversity and environmentally sound solutions, and highlights the importance of their integration into national and multilateral processes. It also presents an outlook on future trends up to 2032 based on projections.

The State of World Fisheries and Aquaculture 2024 provides the most up-to-date and evidence-based information, supporting policy, scientific and technical insights on challenges, opportunities and innovations shaping the present and future of the sector, for the benefit of a wide and expanding audience of policymakers, managers, scientists, fishers, farmers, traders, civil society activists and consumers.

Download the report from:

- https://enaca.org/?id=1337

Safeguarding salt lake brine shrimp (*Artemia*) resources for aquaculture: A training project

A training project addressing *Artemia* management and conservation from hydrological, biological, ecological, aquaculture, wildlife and legislative perspectives will be held in Rome, Italy, from 2-6 September 2024. The training is being organised by the Food and Agriculture Organization of the United Nations (FAO) and the Network of Aquaculture Centres in Asia-Pacific (NACA), with the financial support of the Alliance of National and International Science Organizations for the Belt and Road Regions (ANSO) and the Royal Academy for Overseas Sciences (RAOS), in cooperation with the International Artemia Aquaculture Consortium (IAAC). The project will address hydrological, biological, ecological, aquaculture, wildlife and legislative aspects of *Artemia* management and conservation.

Many salt lakes on different continents are under threat of drying up because of human interventions and/or climate change events. Different species of brine shrimp are the sole zooplankton developing in dense monocultures in these inland salt lakes and play crucial roles in wildlife survival and are an important resource to the global fish/shellfish farming (aquaculture) industry:

- *Artemia* biomass is a crucial source of high-protein food for millions of migrating birds foraging in transit during certain periods of the year.
- Thousands of tonnes of *Artemia* cysts (0.5-mm inactive embryos) are harvested from salt lakes in North America and Asia annually for use as a vital zooplankton substitute in the larval rearing of over 900 billion larvae and fry of

different aquatic species that eventually yield more than 10 million tonnes of seafood produced in the aquaculture industry.

In recent decades, a few terminal salt lakes have already dried up (e.g. Aral Sea in Uzbekistan, Urmia Lake in Iran, Owens Lake in the United States of America) with very significant impacts on wildlife and human health, as well as important economic losses (in the billions of USD). On the other hand, new salt lakes may emerge or be restored in new or dried-up locations due to climate change.

Multidisciplinary efforts to better understand hydrological, biological, and ecological events - with the Great Salt Lake in Utah as a unique test case - can deliver insights and allow the formulation of specific legislative measures to safeguard the fate of terminal salt lakes and at least delay their terminal status.

The gene pool of *Artemia* species and strains occurring in salt lakes worldwide need to be safeguarded and better characterised for use in aquaculture. The ecological heterogeneity and dynamics of salty lakes, influenced by climate change and human intervention, have left genetic signatures in the *Artemia* genome that require an integrated/coordinated approach.

Through this training session, the International Artemia Aquaculture Consortium (IAAC), a subject-oriented network of NACA, is following up on recommendation 16 of the 11th Session of the Sub-Committee on Aquaculture of the Committee on Fisheries (COFI:AQ) (Rome, May 2022) "...The Sub-Committee appreciated the work on *Artemia* and supported FAO efforts to explore development of technologies and sustainable management of *Artemia* resources" and paragraph 69 of the 12th Session of COFI:AQ (Hermosillo, May 2023) "...recommended the preparation of protocols on sustainable harvesting practices of wild resources, ...and certification of cyst products...furthermore, new initiatives are vital to conserve *Artemia* biodiversity...".

Objectives of the training

- Identify inland salt lakes with *Artemia* populations that either have disappeared in recent years, or that are under (short/long-term) threat, and in both cases try to identify the causes for their disappearance or threat with focus on hydrological, biological ecological and climate changing aspects.
- Evaluate methodologies that have been developed to safeguard lost habitats.
- Review the long-term approach taken by different organisations in the State of Utah (United States of America) to protect the Great Salt Lake habitat and its resources (for wildlife and for the aquaculture industry).
- Review similar approaches undertaken for the protection of other salt lakes in Asia.
- Review the characterisation, monitoring and safeguarding of the gene pool of native and non-native *Artemia* species and stocks occurring in salt lakes, including guidelines for characterisation of genetic resources and the establishment of an *Artemia* cyst bank.
- Brainstorm development of knowledge products that can enhance future management of inland salt lakes including protocols, suitable legislation and training programs, leading to improved water and nutrient management to protect the endemic *Artemia* gene pool and manage the resource effectively.

The detailed programme is available for download from the link below.

- https://enaca.org/?id=1334

Reported Aquatic Animal Diseases in the Asia-Pacific Region during the Fourth Quarter of 2023

Listed below are the reported aquatic animal diseases submitted by countries in the Asia-Pacific region, which covers the fourth quarter of 2023. The original and updated reports can be accessed from the QAAD page at: https://enaca.org/?id=8

Finfish Diseases

- Infection with epizootic haematopoietic necrosis virus (EHN): Australia in wild adults and juveniles redfin perch (*Perca fluviatilis*).
- Infection with *Aphanomyces invadans* (EUS): Bangladesh in mrigal (*Cirrhinus mrigala*) and rohu (*Labeo rohita*); and India in snakehead (*Channa marulius*).
- Infection with red seabream iridovirus (RSIV): Chinese Taipei in hybrid grouper (*Epinephelus fuscoguttatus* x *E. lanceolatus*), seabass (*Lates calcarifer*) and silver seabream (*Rhabdosagrus sarba*); and, India (reported as ISKNV) in seabass (*Lates calcarifer*).
- Infection with tilapia lake virus (TiLV): India in tilapia (*Oreochromis niloticus*), and Philippines in fingerlings, grow-out and adult tilapia (*Oreochromis* sp.).
- Viral encephalopathy and retinopathy (VER): Chinese Taipei in hybrid grouper and giant grouper (*E. lanceolatus*).
- Grouper iridoviral disease (GIV): Chinese Taipei in hybrid grouper and giant grouper (*E. lanceolatus*).

Molluscan Diseases

- Infection with *Perkinsus olseni*: India in mussel (*Perna viridis*) and clam (*Arca* sp.).

Crustacean Diseases

- Infection with white spot syndrome virus (WSSV): Chinese Taipei in whiteleg shrimp (*P. vannamei*); India in *P. vannamei*; and, the Philippines in *P. vannamei* (fry, PL, grow-out culture, and adult) and wild crabs.
- Infection with infectious hypodermal and haematopoietic necrosis virus (IHHNV): Philippines in *P. vannamei* (PL).
- Acute hepatopancreatic necrosis disease (AHPND): The Philippines in *P. vannamei* (PL).
- Infection with Infectious myonecrosis virus (IMNV): India in *P. vannamei*.
- Hepatopancreatic microsporidiosis caused by *Enterocytozoon hepatopenaei* (EHP): Chinese Taipei in *P. vannamei*; India in *P. vannamei*; and, the Philippines in *P. vannamei* (PL and grow out culture) and *P. monodon* (PL).

Amphibian Diseases

- Infection with *Batrachochytrium dendrobatidis*: Australia in *Myxophyes australis*, *Lymnodynastes peronii* and an unknown frog species in Victoria.

Other Diseases

- Bangladesh reported Infection with *Aeromonas* spp. in stinging catfish (*Heteropneustes fossilis*), gulsha (*Mystus cavasius*), pangas catfish (*Pangasianodon hypophthalmus*), pabda (Ompok bimaculatus). India reported Infection with tilapia parvovirus in *O. niloticus*.

E.M. Leaño
Director General and Senior Programme Officer, Health and Biosecurity

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First International Artemia Aquaculture Consortium Conference, 9 September (hybrid event)

The first conference of the International Artemia Aquaculture Consortium (IAAC) will be organised on 9 September as part of the same premises as the Larvi '24 Conference, in Ostend, Belgium. This is a hybrid event, with participation possible both in person and online via Zoom.

In the morning session (open to all larvi participants), the following IAAC members will give presentations: Yeong Yik Sung (Malaysia), Patrick Sorgeloos (Belgium), Simon Wilkinson (Thailand), Sui Liying (China), Stephanie De Vos (Belgium), Brad Marden (USA), Phil Brown (USA), Yathish Ramena (USA) and David Johanson (Belgium). A detailed programme will be available shortly.

Participation in the IAAC conference is free, but people attending in person are requested to indicate your interest to attend it on the Larvi registration form linked below. Details of the Zoom meeting will be posted on the NACA / IAAC websites shortly.

https://aquaculture.ugent.be/larvi/registration.htm

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