Hatchery-Based Mass Seed Production of Nutrition-Sensitive Tengara Catfish *(Mystus tengara)*

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We also recognize the continued support and collaboration of national and regional partners, whose engagement ensures that the solutions developed are responsive to local needs, strengthen innovation systems, and contribute to building more resilient agrifood systems.

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Contents

Introduction

Mystus tengara, commonly known as tengara catfish and simply referred to as tengra in South Asia, is a small freshwater species belonging to the family Bagridae under the order Siluriformes (FishBase, n.d.; ScotCat, n.d.). It is a facultative air-breathing fish widely distributed across Bangladesh, India, Nepal, Pakistan, and Afghanistan, typically inhabiting both flowing and stagnant water bodies such as rivers, ponds, inundated fields, and derelict wetlands (FishBase, n.d.; Majumder et al., 2024). Tengra is a bottom-dwelling, carnivorous species that primarily feeds on zooplankton, particularly rotifers, and in captivity, readily accepts live or frozen foods such as bloodworms, as well as formulated feeds (Majumder et al., 2024; Mondal et al., 2017).

The species exhibits single spawning behavior, with an extended reproductive period from May to August, which may vary depending on rainfall, climate conditions, and water quality (Taylor & Jhingran, 1991; Mondal et al., 2017). Tengra is highly valued for its excellent taste and rich nutritional profile, commanding a premium price in local markets. It is a rich source of protein, calcium, iron, zinc, vitamin A, and Omega-3 fatty acids (Bogard et al., 2015). Its attractive golden-yellow coloration also makes it a potential candidate for export-oriented ornamental fish trade (Mondal et al., 2017).

Despite its commercial and nutritional significance, the culture of tengra in ponds, particularly in combination with carp species, has received limited attention. The species is well suited for inclusion in freshwater polyculture systems under a nutrition-sensitive aquaculture approach, which can enhance overall fish production, increase household income, and improve access to nutrient-dense small fish—critical for addressing micronutrient deficiencies, especially in low-income communities (Majumder et al., 2024; Mondal et al., 2017).

A major constraint to the wider adoption of tengra in aquaculture has been the lack of a standardized, scalable hatchery-based seed production method. To address this challenge, WorldFish, under the CGIAR Scaling for Impact (S4I) program, has developed a simple, low-cost, and scalable method for induced breeding and mass seed production of tengra. This manual provides practical, step-by-step guidelines for induced breeding, enabling large-scale seed production in hatcheries. The breeding protocol is simple, cost-effective, and easily adoptable by hatchery operators, offering a valuable tool to promote the expansion of nutrition-sensitive aquaculture in Bangladesh and beyond.

Photo 1. A mature female tengra broodfish. **Photo credit:** Harun Or Rashid, WorldFish.

1. Tengra Broodstock Pond Preparation and Management

Proper preparation and management of the broodstock pond are essential for the successful breeding of tengra. The process begins with completely draining the pond and keeping the bottom soil moist until lime is applied. Calcium oxide (CaO) should be applied at a rate of 247 kg per ha, with the quantity adjusted according to soil pH. The optimal pH range for pond soil is 6.5 to 7.0; acidic soils require higher doses of lime, whereas soils with pH above 7.0 require less. After liming, the pond should be allowed to dry for approximately one week to disinfect the soil and remove potential predators.

Once this period is complete, the pond should be gradually filled with borewell or surface water until it reaches a depth of 0.7–1.0 m. Maintaining ideal conditions for natural food is crucial, as phytoplankton and zooplankton serve as essential nutritional sources for the broodfish. To enhance natural productivity, inorganic fertilizers such as urea and triple super phosphate (TSP) should be applied at rates of 25–37 kg per ha each. In addition, fermented mustard oil cake (MOC) can be sprayed evenly over the pond surface at a rate of 37 kg per ha to further supplement the natural food supply. After about one week, when phytoplankton density reaches an optimal level and the water turns green—indicated by a Secchi disk reading of 25–30 cm—the pond is ready for stocking broodstock. Tengra broodstock should be collected from diverse sources, preferably large and permanent waterbodies, to ensure genetic diversity and good health. Prior to stocking, broodstock should be disinfected by dipping them in a potassium permanganate ($KMnO_4$) solution prepared at 0.5 g per 100 L of water. Following acclimatization to the pond water, the broodstock should be stocked at a density of 200,000–250,000 fish per ha.

During the rearing period, broodstock should be fed a commercial pelleted feed containing 35%–40% crude protein to support steady gonadal development. To further stimulate gonadal maturation, soft water from a river or stored rainwater can be added to the broodstock pond as needed. Weekly application of urea and TSP at 12–18 kg per ha each, along with fermented mustard oil cake at 19 kg per ha, helps maintain optimal phytoplankton density. The frequency and quantity of these applications should be adjusted according to observed water productivity. It is important to keep the pond dike free of grasses and aquatic weeds up to one foot above the highest water level, especially during the monsoon season, to prevent broodfish from hiding and to minimize disturbances during harvesting. Finally, strict biosecurity measures must be maintained at all times to prevent disease outbreaks, ensuring the health and survival of the broodstock throughout the breeding period.

Photo 2. Biosecurity in a tengra broodstock pond. **Photo credit:** Harun Or Rashid, WorldFish.

2. Taxonomic identification

The key morphological and sexual characteristics of *Mystus tengara* are presented below in Table 1:

Table 1. *Basic morphological characteristics of tengra (Mystus tengara)*

Characteristic	Description
Body shape	Scaleless, elongated body, slightly laterally compressed with a terminal mouth.
Body color	Dark yellow to brown body with an oval tympanic spot bordered by a distinct margin. The body has four brown stripes separated by three pale interspaces.
Spines	Equipped with strong pectoral spines and a single dorsal spine.
Caudal fin	Caudal fin is asymmetrical; the upper lobe is longer than the lower lobe.
Blotch/spot	A distinct dark spot is visible on the shoulder region.
Barbels	Four pairs of barbels are present. In adults, the maxillary barbels extend at least to the end of the anal fin base; in juveniles, they often reach or extend beyond the tip of the caudal fin.
Lateral line	Complete and runs mid-laterally along the body.
Adipose fin	Short adipose fin; the origin does not touch the base of the last dorsal fin ray.

Accurate identification of mature male and female tengra broodfish is essential for successful induced breeding. Mature individuals can be distinguished based on external physical features and behavior, as outlined below in Table 2

Table 2. *Identification of mature females and males*

Characteristic	Female	Male
Genital papilla	Absent.	Present; elongated and located in front of the anal fin. Becomes highly prominent during the breeding season.
Size and color	Larger in size; lighter body coloration.	Smaller in size; brighter body coloration.
Abdomen	Soft and clearly distended.	Not distended.

Note: These distinguishing features, especially the presence of an elongated genital papilla in males and a distended abdomen in females, are most apparent during the breeding season and are critical for selecting broodfish for induced breeding.


Photo 3. A mature female (top) and male (bottom) tengra broodfish. **Photo credit:** Harun Or Rashid, WorldFish.

3. Tengra Broodstock Harvesting and Conditioning

Proper harvesting and conditioning of tengra broodstock are essential for ensuring their health and successful breeding. It is recommended to use a dedicated broodstock pond exclusively for tengra to minimize the risk of injury from larger fish species, such as carp, during harvesting. Harvesting should be scheduled early in the morning, before pond temperatures rise, to reduce stress on the fish.

Broodstock should be handled gently during collection and transported promptly in cool, oxygenated water to the conditioning tanks. To prevent the fish from jumping during transportation, leafy plant branches can be placed inside the containers. Upon arrival, the broodstock should be transferred into pre-installed fine-mesh hapas within the conditioning tanks. A continuous water shower should be applied to the broodstock for a full day to help acclimate them to their new environment and to encourage readiness for spawning. This one-day conditioning period also allows the fish to clear their digestive tracts, maintaining a clean environment and reducing the risk of disease during breeding. Finally, the hapa should be secured with a fine-mesh mosquito net to prevent the broodstock from escaping, ensuring a controlled and safe conditioning period.

Photo 4. Mature male and female tengra in a fine mesh hapa inside a conditioning tank. **Photo credit:** Dr. Hazrat Ali, WorldFish.

4. Tengra Induced Breeding Arrangement

Successful induced breeding of tengra requires a controlled environment that supports optimal spawning, fertilization, and hatching. This involves the proper setup of dedicated breeding tanks, incubation units, hapas, and a reliable aeration system to maintain suitable water quality and oxygen levels throughout the breeding process.

4.1 Breeding and Incubation Tank

The breeding and incubation tank is central to the induced breeding process, serving multiple functions including broodstock conditioning, hormone-induced spawning, egg incubation, and hatchling maintenance. In small-scale hatcheries, breeding is typically conducted in a fiber-reinforced plastic (FRP) rectangular tank (see Photo 5). A standard FRP tank measures 2.5 m in length, 1.25 m in width, and 0.6 m in height. The tank floor is constructed with a 1% slope toward an outlet pipe to facilitate efficient water flow and drainage. An iron frame is fixed along the top edges of the tank to support two nested hapas. Above the tank, a ¾-inch shower pipe with 1 mm holes spaced at 1 cm intervals is installed to provide a continuous, gentle water spray over the broodstock. This system ensures that the broodstock remain well-oxygenated and comfortable, creating optimal conditions for successful spawning.

For larger commercial-scale hatcheries, a concrete tank is recommended (see Photo 6). The tank should have internal dimensions of 3.0 m × 1.5 m × 0.6 m, providing a water-holding capacity of approximately 2.25 m³ at a water depth of 50 cm. As with the FRP tank, the concrete tank floor should be constructed with a 1% slope toward a 1.5-inch vertical drainage outlet, allowing efficient water removal. The drainage outlet can be easily detached for cleaning and routine maintenance, ensuring proper hygiene and optimal operational efficiency.

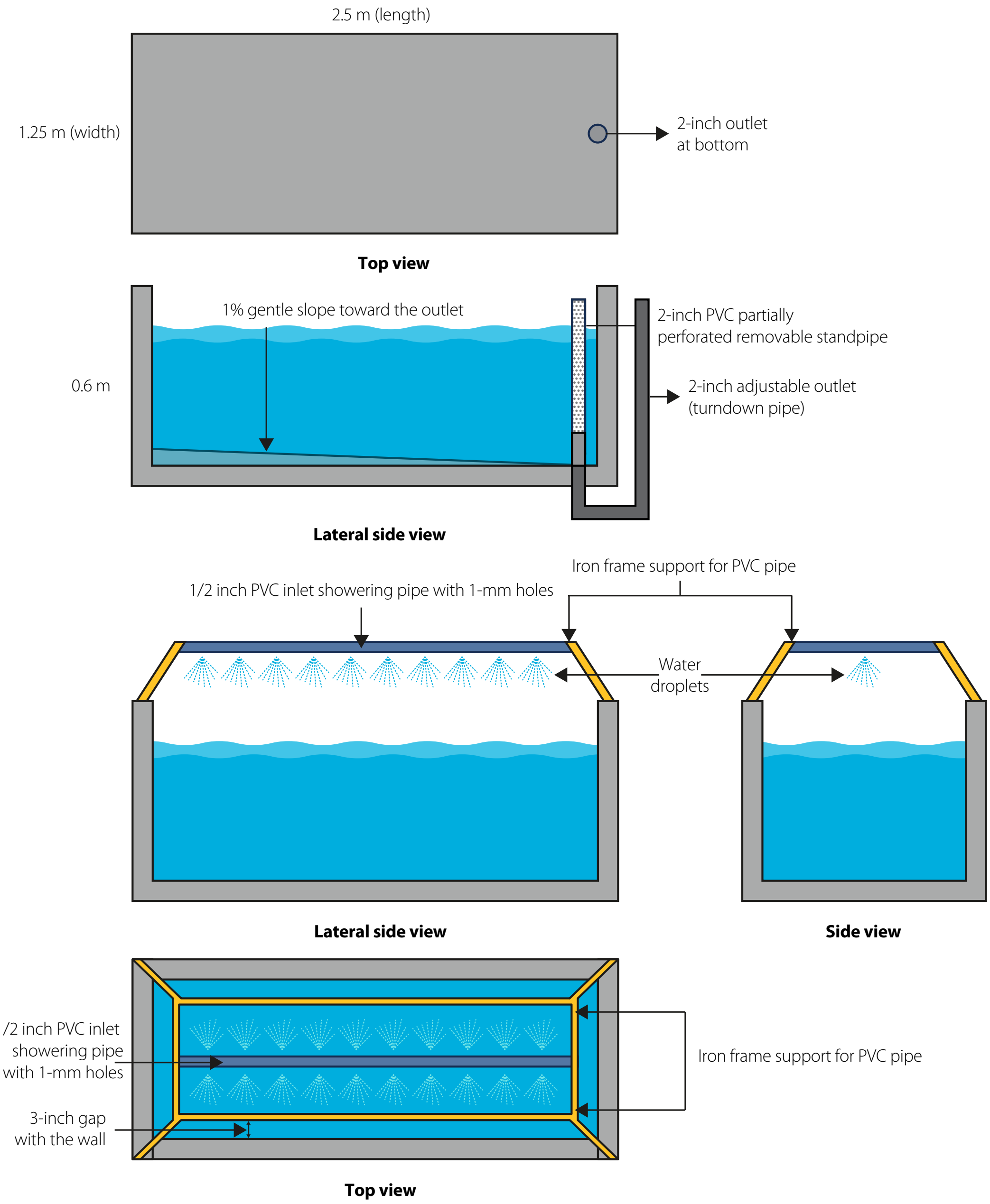

Photo 5. FRP model of a breeding and incubation tank (modified from Rajts et al., 2024).

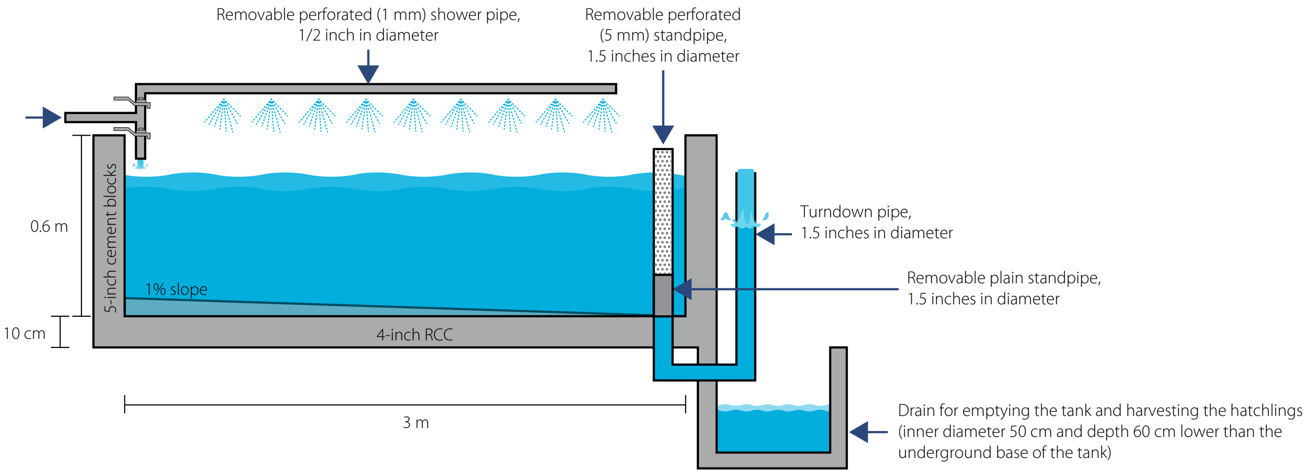

Photo 6. Concrete breeding and incubation tank (modified from Rajts et al., 2024).

4.2 Hapa Arrangement

Hapas play an essential role in separating and managing broodstock at different stages of the breeding process. A conditioning hapa should first be installed in the conditioning tank to hold broodfish prior to breeding. This setup facilitates efficient waste removal and allows the fish to acclimate properly before hormone induction. In the breeding tank, two hapas are used to securely hold the hormone-injected breeders. The outer hapa is made of 250-micron monofilament mesh, into which a smaller inner hapa with a 10 mm mesh is fixed using the iron support frame. This nested arrangement ensures effective containment of the broodstock while allowing optimal water flow and egg collection.

A gentle water shower from the overhead tank should be maintained continuously over the hapas to enhance oxygen availability and simulate natural breeding conditions. When using surface water from ponds, rivers, or canals, the water must be filtered through a 100-micron monofilament mesh to remove sediment, plankton, and other debris before entering the system.

Photo 7. Installation of inner and outer hapas in an FRP tank. **Photo credit:** Dr. Hazrat Ali, WorldFish.

Photo 8. Installation of 100-microon monofilament mesh to filter water prior to use for hatchery operation. **Photo credit:** Harun Or Rashid, WorldFish.

4.3 Aeration Tower

An aeration tower is used to enrich the oxygen content of borewell or surface water before it enters the breeding and conditioning tanks. This structure enhances dissolved oxygen (DO) levels efficiently while reducing energy consumption by eliminating the need for electric aerators. The tower is typically a metallic unit mounted on top of an overhead water tank.

It is constructed from four perforated galvanized iron sheets, each fitted with 10 mm holes that break the incoming water into fine droplets as it descends through the tower. This droplet formation increases the surface area for gas exchange, allowing carbon dioxide and other harmful gases to be stripped from the water. As a result, CO_2 levels can be reduced by up to 70%, while dissolved oxygen levels rise close to saturation. This process significantly improves water quality and creates ideal conditions to support breeding operations and tengra broodstock health.

Photo 9. An aeration tower in an overhead water reservoir tank at a hatchery. **Photo credit:** Harun Or Rashid, WorldFish.

5. Hormone Dose and Administration

Any commercially available synthetic gonadotropin-releasing hormone analogue (S-GnRHa), combined with a dopamine antagonist and marketed under various trade names, can be used to induce breeding in tengra. The recommended dosage is 1.0 ml/kg body weight for males and 2.0 ml/kg body weight for females. Hormone potency and broodfish readiness may vary across batches and brands; therefore, it is advisable to conduct a small-scale trial before applying hormones on a larger scale.

A male-to-female ratio of 2:1 should be maintained during hormone-induced breeding. Due to the high viscosity of the hormone and the small quantities required for tengra, dilution is necessary. The hormone should be mixed with sterile water or a 0.65% sterile saline (NaCl) solution before administration. For example, to prepare an inducing solution for 1 kg of female tengra, dilute 2.0 ml of hormone with 4.0 ml of sterile water, resulting in a total of 6.0 ml of diluted solution per kg body weight of tengra.

Hormone injections should be administered into the dorsal musculature—specifically above the lateral line and below the dorsal fin—using a 1-ml insulin syringe with 50 fine graduations to ensure accurate dosing. Injections are best given between 17:00 and 19:00, when environmental conditions favor optimal breeding response. Immediately after injection, the broodfish should be transferred to a 10-mm mesh breeding hapa and securely covered with a nylon mosquito net to prevent escape or injury. A continuous, gentle water shower must be maintained over the hapa to simulate natural rainfall and stimulate spawning behavior.

Photo 10. Synthetic hormone and 1-ml syringe used for tengra induced breeding. **Photo credit:** Dr. Hazrat Ali, WorldFish.

Photo 11. Administering the inducing solution into the dorsal musculature, just above the lateral line and below the dorsal fin of tengra breeder. **Photo credit:** Dr. Hazrat Ali, WorldFish.

Photo 12. Placing breeders in a 10 mm mesh inner hapa immediately after administering the inducing solution. **Photo credit:** Harun Or Rashid, WorldFish.

Photo 13. Covering the breeding tank after administering the hormone to prevent escape or injury of tengra breeder. **Photo credit:** Dr. Hazrat Ali, WorldFish.

Box 1. Hormone Dose Calculation

Standard hormone dose

The required dose of a synthetic gonadotropin-releasing hormone (S-GnRHa) is 1.0 ml/kg of body weight for males and 2.0 ml/kg for females.

How to prepare and calculate the dose

For 1 kg of female tengra breeders, dilute 2.0 ml of hormone with 4.0 ml the amount of water. This means 2.0 ml hormone + 4.0 ml sterile water = 6.0 ml inducing solution for 1 kg of tengra.

For example:

- 1000 g of tengra = 6.0 ml
- 1 g of tengra = 6.0 ÷ 1000 = 0.006 ml
- 5 g of tengra = 5 × 0.006 = 0.030 ml
- 10 g of tengra = 10 × 0.006 = 0.060 ml
- 15 g of tengra = 15 × 0.006 = 0.090 ml
- 20 g of tengra = 20 × 0.006 = 0.120 ml
- 25 g of tengra = 25 × 0.006 = 0.150 ml
- 30 g of tengra = 30 × 0.006 = 0.180 ml

Administering the solution

Inject the prepared inducing solution into the dorsal musculature, positioned just above the lateral line and below the dorsal fin of the tengra. The preferred method is to use a 1-ml diabetic insulin syringe with 50 fine graduations to ensure accurate dosing. Each graduation of the insulin syringe represents 0.02 ml (1 ÷ 50 = 0.02 ml).

For example:

- 5 g of tengra: 0.030 ÷ 0.02 = 1.50 graduations of a syringe
- 10 g of tengra: 0.060 ÷ 0.02 = 3.00 graduations of a syringe
- 15 g of tengra: 0.090 ÷ 0.02 = 4.50 graduations of a syringe
- 20 g of tengra: 0.120 ÷ 0.02 = 6.00 graduations of a syringe
- 25 g of tengra: 0.150 ÷ 0.02 = 7.50 graduations of a syringe
- 30 g of tengra: 0.180 ÷ 0.02 = 9.00 graduations of a syringe

6. Spawning and Egg Incubation

Spawning and egg incubation are critical steps in the successful breeding of tengra. Proper timing, careful handling, and maintaining suitable environmental conditions during this stage ensure healthy embryo development and improve hatchling survival. After hormone injection, all injected tengra breeders should be removed the following morning between 09:00 and 11:00 by lifting the inner hapa and transferring them to a separate recovery pond. Spawning generally occurs 8 to 10 hours after hormone administration, especially when the water temperature is around 29.5°C. Hatching typically takes place within 18 to 19 hours of fertilization at temperatures between 29°C and 30°C. During this period, the outer hapa should be inspected for eggs, which settle at the bottom on the 250-micron mesh. Fertilized eggs appear clear, are demersal (sinking to the bottom), and have adhesive properties that help them attach to the mesh during incubation.

Photo 14. Eggs attached to the bottom part of the outer hapa. **Photo credit:** Harun Or Rashid, WorldFish.

7. Harvesting Spawn or Hatchlings

Timely harvesting of hatchlings is essential for ensuring their survival and preparing them for successful nursery rearing. Hatchlings are generally ready for collection 60–72 hours after hatching, just before the yolk sac is fully absorbed. Harvesting is done by gently lifting one end of the outer hapa while splashing water on the outside so the hatchlings loosen from the mesh. Once they detach, they should be carefully scooped using a clean measuring cup. The collected hatchlings must then be transferred into a leak-proof polythene bag filled with clean, cool, oxygen-rich water to maintain their health and viability during transportation.

Photo 15. Collecting and corralling tengra hatchlings in an outer hapa. **Photo credit:** Dr. Hazrat Ali, WorldFish.

Photo 16. Harvested tengra hatchlings from the breeding tank. **Photo credit:** Dr. Hazrat Ali, WorldFish.

8. Packaging and Transportation

Proper packaging and transportation are essential to maintain the health and survival of hatchlings during transportation. A polythene bag should be filled one-third full with clean water, after which the hatchlings are added and the remaining space above the water is filled with compressed pure oxygen before sealing the bag tightly with a jute rope or strong rubber band to ensure it is completely airtight. The sealed bags should be placed horizontally to maximize the contact surface between water and oxygen, improving oxygen availability for the hatchlings. For long-distance transport and to prevent punctures or physical damage, each airtight bag should be placed inside a sturdy cardboard box or protective carrying bag, which also helps maintain temperature stability. With proper oxygenation and slightly cooled water (kept below 30°C), hatchlings can be safely transported for up to 24 hours. The stocking density inside the transport bag should not exceed 25 grams—approximately 50,000 to 75,000 hatchlings—per 10 liters of water, with adjustments made depending on travel duration and environmental conditions. Upon reaching the destination, the hatchlings must be gradually acclimated by slowly mixing pond water into the transport bag to equalize temperature and water quality before releasing them into the nursery pond.

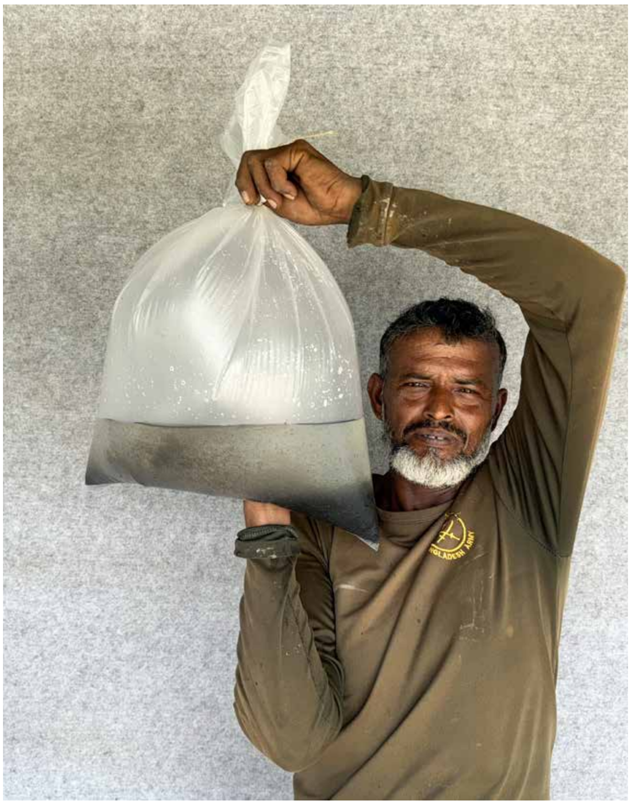

Photo 17. Tengra hatchlings in plastic bags with oxygen for transportation. **Photo credit:** Dr. Hazrat Ali, WorldFish.

9. Nursery rearing of hatchlings

9.1 Nursery Pond Preparation

Proper nursery pond preparation is essential for successful tengra fry production. The pond should be completely drained, leaving the bottom soil moist before applying lime. Calcium oxide (CaO) is then applied at a rate of 247 kg per ha, with adjustments made according to the soil pH; an ideal range is 6.5–7.0, requiring higher lime levels for acidic soils and reduced amounts when pH exceeds 7.0. After liming, the pond should be dried for about one week to disinfect the bottom and eliminate predators. Once dried, the pond is gradually filled to a depth of 0.60 m using borewell or filtered surface water. When using pond, river, or canal water, it must be screened through a 100-micron monofilament mesh to prevent the entry of predatory insects or unwanted fry. To enhance natural productivity and stimulate the growth of phytoplankton and zooplankton, urea and TSP should be applied at 25–37 kg per ha each, along with 37 kg per ha of fermented mustard oil cake (MOC), sprayed uniformly across the pond surface. Before stocking the hatchlings, the pond should be netted several times with a mosquito net to remove backswimmers and other predatory insects and larvae.

Photo 18. Preparing the nursery pond after drying. **Photo credit:** Harun Or Rashid, WorldFish.

Photo 19. Applying lime in the nursery pond. **Photo credit:** Harun Or Rashid, WorldFish.

9.2 Stocking Hatchlings

Tengra hatchlings should be stocked on the third or fourth day after fertilization. Stocking is best carried out in the morning, gradually acclimating the hatchlings by balancing the temperature between the transport water and the pond water to minimize stress. The recommended stocking density is 200 hatchlings per m², equivalent to approximately 2 million per ha. Proper biosecurity measures should be implemented, including installing bird fencing around the nursery pond to protect the hatchlings from predators. Additionally, it is recommended to add 5–6 cm of fresh water daily until the pond reaches a maximum depth of 1.0 m at its deepest point, ensuring optimal growth conditions for the fry.

Photo 20. Acclimatizing tengra hatchlings prior to stocking in the nursery pond. **Photo credit:** Harun Or Rashid, WorldFish.

9.3 Supplementary Feeding and Fertilization

During the nursery phase, tengra hatchlings should initially be fed microencapsulated duck or chicken eggs at a rate of 3–4 eggs per 100,000 hatchlings per day, divided into four feedings. After five days, egg feeding should be discontinued and replaced with fine fish meal or a formulated powdered nursery feed containing 40% protein, applied as supplementary feed. To maintain optimal natural productivity, urea and triple super phosphate (TSP) should be applied weekly at 12–18 kg per ha each, along with 19 kg per ha of fermented mustard oil cake (MOC). Fertilizer application should be adjusted based on phytoplankton density, which can be monitored using a Secchi disk reading of 25–30 cm. Care must be taken to avoid over-fertilization, as excessive nutrients can rapidly deteriorate water quality, negatively affecting hatchling survival and growth.

Photo 21. Applying supplementary feed in nursery pond. **Photo credit:** Harun Or Rashid, WorldFish.

9.4 Harvesting

Tengra fry should be harvested after three weeks of nursery rearing and stocked in grow-out ponds at a density of 5–10 fry per m², equivalent to approximately 50,000–75,000 per ha. Timely harvesting within this three-week period is essential to prevent parasite infestations, disease outbreaks, and unnecessary mortality. By this stage, the fry will have consumed most of the available zooplankton in the pond, which cannot be replenished quickly enough to sustain their continued growth.

9.5 Fry Transportation

For transportation, feeding of the fry should be stopped one day prior to harvest. The fry must be carefully collected using a fine-mesh seine net to minimize injury and scale loss. Immediately after harvesting, the fry should be transferred to a conditioning tank fitted with a fine-mesh hapa and maintained under a continuous water shower for at least three hours, allowing them to clear their gut contents. Following conditioning, 1,000–1,500 fry can be packed into a 10 L polyethylene bag filled with oxygen for safe transportation, as described in Section 8.

Photo 22. Packed tengra fry ready for transport from nursery to grow-out pond. **Photo credit:** Ahmed Jaman, WorldFish.

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