

Hatchery-Based Mass Seed Production of Nutrition-Sensitive Mola Carplet (*Amblypharyngodon mola*)

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Contents

Introduction	1
1. Mola Broodstock Pond Preparation and Management	2
2. Taxonomic identification	3
3. Mola Broodstock Harvesting and Conditioning	4
4. Mola Induced Breeding Arrangement	4
4.1 Breeding and Incubation Tank	4
4.2 Hapa Arrangement	6
4.3 Aeration Tower	7
5. Hormone Dose and Administration	8
Box 1. Hormone Dose Calculation	11
6. Spawning and Egg Incubation	12
7. Harvesting Spawn or Hatchlings	12
8. Packaging and Transportation	14
9. Nursery rearing of mola hatchlings	14
9.1 Nursery Pond Preparation	14
9.2 Stocking Hatchlings	15
9.3 Supplementary Feeding and Fertilization	16
9.4 Harvesting	16
9.5 Fry Transportation	16
References	18

Introduction

The mola carplet (*Amblypharyngodon mola*) is a small indigenous fish species commonly found in freshwater habitats such as ponds, canals, beels, ditches, reservoirs, flooded paddy fields, and wetlands. It is widely distributed across South and Southeast Asia, including Bangladesh, India, Nepal, Pakistan, Afghanistan, Myanmar, and Cambodia. In Bangladesh, it is simply known as mola and has long been recognized as a culturally important, affordable, and accessible food source for rural communities. Historically, mola was abundant in rivers and floodplains and was regularly harvested by small-scale fishers. However, its natural populations have declined significantly in recent decades due to overfishing, habitat degradation, water pollution, and rising salinity in coastal areas—pressures linked to climate variability and upstream changes in water flow.

Mola is a surface-feeding fish that relies on plankton as its primary food source. It has an extended breeding season, from February to November, and exhibits partial spawning behavior influenced by climatic conditions, rainfall patterns, and broodstock management practices. As the species becomes less available in natural waters, its market price has increased, now exceeding the price of cultivated species such as rohu, tilapia, and pangas. This rise in cost has reduced access for low-income households that traditionally depended on mola as a vital source of nutrition.

The species is highly valued for its distinctive taste and exceptional nutritional benefits. Mola is rich in vitamin A, iron, zinc, calcium, fatty acids, and essential amino acids—nutrients crucial for preventing deficiencies among children, adolescents, and pregnant women (Bogard et al., 2015). Because of its high nutritional value, mola plays an important role in nutrition-sensitive aquaculture. It is frequently integrated into carp–mola polyculture systems, which help maintain total fish yields while improving the nutritional quality of pond harvests (Ali et al., 2016; Shepon et al., 2020). This approach increases household consumption of nutrient-rich fish, particularly among women and children, and supports improved community nutrition ((Ignowski et al., 2023).

Despite its potential, the absence of a standardized, hatchery-based seed production method has been a major constraint to expanding mola farming. To address this challenge, WorldFish, through the CGIAR initiative on Scaling for Impact (S4I) program, has developed a simple and scalable induced-breeding technique for mass seed production of mola in hatcheries. This practical manual provides a step-by-step guideline that can be easily adopted by existing hatchery operators. The nine-step guideline offers a valuable tool for anyone interested in mola seed production and contributes to the broader expansion of nutrition-sensitive aquaculture practices in Bangladesh and beyond.



Photo 1. A mature female mola carplet broodfish. **Photo credit:** Ahmed Jaman, WorldFish.

1. Mola Broodstock Pond Preparation and Management

Proper preparation and management of the broodstock pond are essential for successful mola breeding. The pond should first be drained completely, and the bottom soil kept moist until lime is applied. Calcium oxide (CaO) should be used at a rate of 247 kg per ha, with adjustments based on the soil pH. The optimal pH range for pond soil is 6.5 to 7.0; therefore, acidic soils require higher lime doses, while ponds with pH above 7.0 need less. After liming, the pond should be dried for about one week to disinfect the bottom and eliminate predators.

Once the pond is ready, it should be gradually filled with borewell or surface water to a depth of 0.7–1.0 m. Ensuring ideal conditions for broodfish also requires proper management of natural food sources, particularly phytoplankton and zooplankton, which support their nutrition and health. 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) at 37 kg per ha should be sprayed evenly over the water surface to further boost natural food availability.

After one week, when phytoplankton abundance is adequate and the water color turns green—indicated by a Secchi disk reading of 25–30 cm—the pond is ready for stocking. Mola broodstock should be collected from diverse sources, preferably from large and permanent waterbodies, to ensure good genetic diversity and overall health. After acclimatizing the fish to pond water, they should be stocked at a density of 200,000–250,000 fish per ha. Before stocking, the fish must be disinfected by dipping them in a potassium permanganate (KMnO₄) solution prepared by dissolving 0.5 g of KMnO₄ in 100 liters of water.

To support steady gonadal development, powdered feed containing 35%–40% crude protein should be provided. Gonadal maturation can be further stimulated by adding soft water from a river or stored rainwater into the pond when necessary. Weekly applications of urea and TSP at 12–18 kg per ha each, along with 19 kg per ha of fermented mustard oil cake, help maintain optimal natural food levels. The amount and frequency of these inputs should be adjusted based on the observed density of phytoplankton.

During the monsoon season, it is important to keep the pond dike completely free of grasses and aquatic weeds up to one foot above the highest water level. This reduces hiding places for fish and minimizes disturbances during harvesting. Throughout the culture period, strict biosecurity measures should be maintained to prevent disease outbreaks and ensure the health and survival of the broodfish.



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

2. Taxonomic identification

Accurate identification of mature male and female mola broodfish is essential for successful induced breeding. Mature individuals can be distinguished based on external physical features and behavior, as outlined below in Table 1.

Table 1. Identification of mature female and male mola broodfish

Characteristics	Female	Male
Body Size	Larger	Smaller and thinner
Body color	Lighter	Brighter
Abdomen	Soft and visibly distended	Not distended
Pelvic fin	Smooth	-
Caudal fin (tail fin)	Deeply forked	Yellowish in color
Behavior	-	More active swimming behavior

Note: Males and females broodfish should be selected based on full maturity and health to ensure higher breeding success and seed quality



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

3. Mola Broodstock Harvesting and Conditioning

Proper harvesting and conditioning of mola broodfish are essential for maintaining their health and ensuring successful breeding. A dedicated broodstock pond should be used exclusively for mola to reduce the risk of injury from larger fish species, such as carp, during harvesting. Harvesting should be carried out early in the morning, before the pond temperature rises, to minimize stress on the fish.

Broodfish must be handled gently during harvesting and transported immediately in cool, oxygenated water to the conditioning tanks. To prevent the fish from jumping during transportation leafy plant branches may be placed inside the containers. Upon reaching the conditioning tanks, the breeders should be transferred into a fine-mesh hapa that has been set up in advance.

The broodstock should then be kept under a continuous water shower for a full day to help them acclimate and prepare for spawning. This one-day conditioning period also allows the fish to empty their digestive tracts, helping maintain a cleaner environment and reducing the risk of disease during breeding. Finally, the hapa should be securely covered with a fine mosquito net to prevent the breeders from escaping.



Photo 4. Mature male and female mola broodfish in a fine mesh hapa inside a conditioning tank. **Photo credit:** Harun Or Rashid, WorldFish.

4. Mola Induced Breeding Arrangement

Successful induced breeding of mola 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 $\frac{3}{4}$ -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.

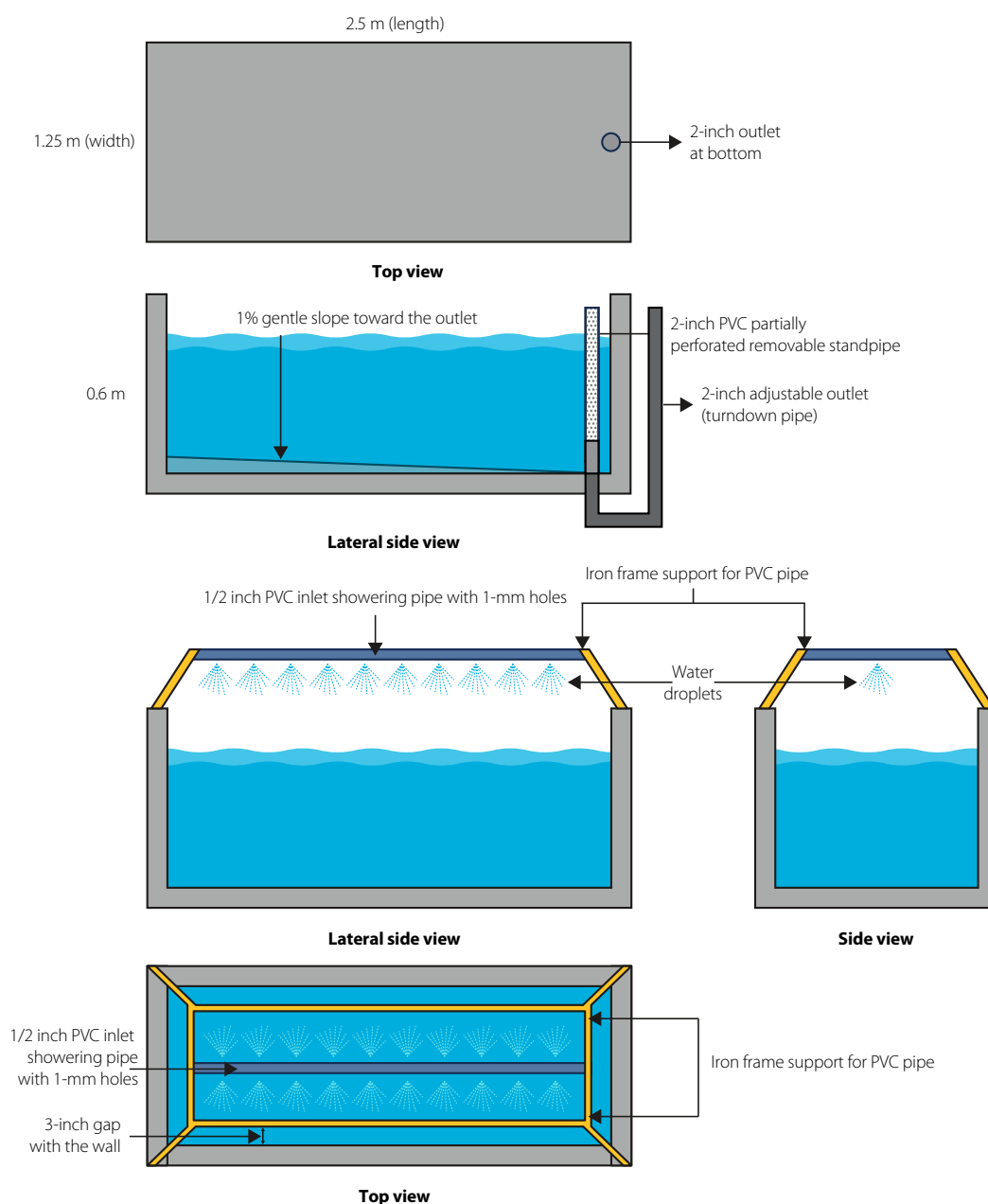


Photo 5. FRP model of a breeding and incubation tank (modified from Rajts et al., 2024).

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.

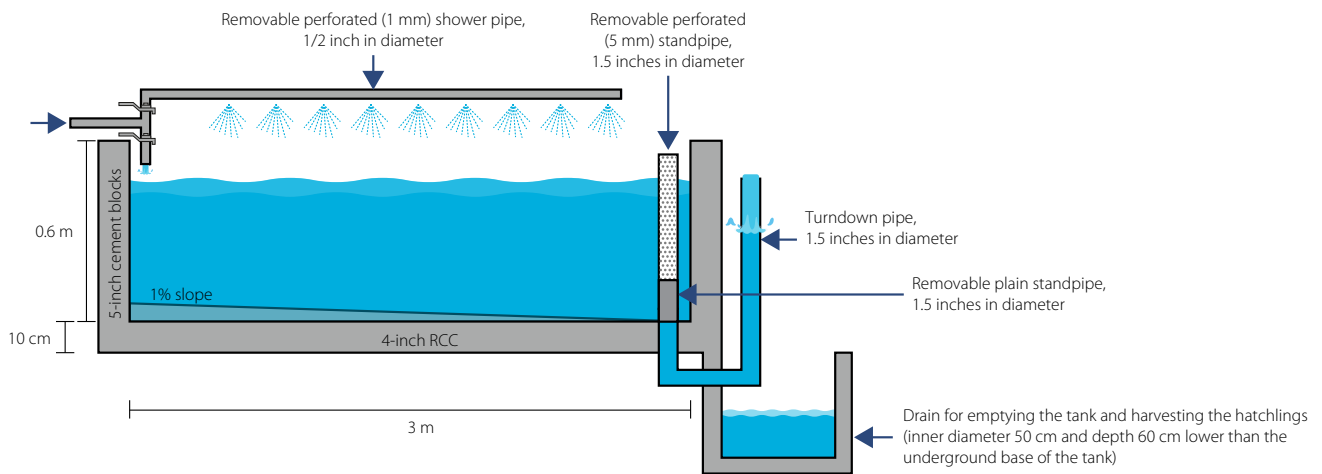


Photo 6. Concrete breeding and incubation tank (modified from Rajts et al., 2024).

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 (see Step 3). 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-micron 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, CO₂ 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 mola 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

Hormone-induced breeding in mola requires careful selection, accurate dosing, and proper handling to achieve successful spawning. Any commercially available synthetic gonadotropin-releasing hormone analogue (S-GnRHa) combined with a dopamine antagonist may be used for induction, as these products are widely available under different trade names. The recommended dosage is 0.5 ml per kg of body weight for males and 1.0 ml per kg body weight for females.

Hormone potency and broodfish readiness can vary across batches and brands; therefore, it is advisable to perform a small-scale trial before carrying out full-scale induction. A male-to-female ratio of 2:1 should be maintained during hormone-induced breeding. Owing to the hormone's high viscosity and the very small dose required for mola, dilution is essential. The hormone should be mixed with sterile water or a 0.65% sterile saline (NaCl) solution prior to injection. For example, to prepare an inducing solution for 1 kg of female mola, dilute 1.0 ml of hormone with 9.0 ml of sterile water, producing 10 ml of diluted solution per kg of body weight.

Injections must 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 precise dosing. The ideal time for administering hormone injections is between 17:00 and 19:00, during the late afternoon to early evening.

After injection, the broodfish should be transferred to a breeding hapa made of 10-mm mesh and securely covered with a nylon mosquito net to prevent escape or injury. A continuous gentle water shower should be maintained over the hapa to simulate natural rainfall and promote spawning behavior.



Photo 10. Synthetic hormone and 1-ml syringe used for mola 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 mola breeder. **Photo credit:** Harun Or Rashid, WorldFish.



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



Photo 13. Covering the breeding tank after administering the hormone to prevent escape or injury of mola 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-GnRH α) is 0.5 ml/kg of body weight for males and 1.0 ml/kg for females.

How to prepare and calculate the dose

For 1 kg of female mola breeders, dilute 1.0 ml of hormone with 9 ml of water. This means 1.0 ml hormone + 9.0 ml sterile water = 10.0 ml inducing solution for 1 kg of mola.

For example:

- 1000 g of mola = 10 ml
- 1 g of mola = $10 \div 1000 = 0.01$ ml
- 3 g of mola = $3 \times 0.01 = 0.03$ ml
- 5 g of mola = $5 \times 0.01 = 0.05$ ml
- 7 g of mola = $7 \times 0.01 = 0.07$ ml
- 10 g of mola = $10 \times 0.01 = 0.10$ ml
- 13 g of mola = $13 \times 0.01 = 0.13$ 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 mola broodfish. 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 ($1 \div 50 = 0.02$ ml).

For example:

- 3 g of mola: $0.03 \div 0.02 = 1.5$ graduations of a syringe
- 5 g of mola: $0.05 \div 0.02 = 2.5$ graduations of a syringe
- 7 g of mola: $0.07 \div 0.02 = 3.5$ graduations of a syringe
- 10 g of mola: $0.10 \div 0.02 = 5.0$ graduations of a syringe
- 13 g of mola: $0.13 \div 0.02 = 6.5$ graduations of a syringe

6. Spawning and Egg Incubation

Spawning and egg incubation are critical steps in the successful breeding of mola. 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 mola 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 6 to 8 hours after hormone administration, especially when the water temperature is around 29.5°C. Hatching typically takes place within 12 to 14 hours of fertilization at temperatures between 29.5°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 are typically light brown to yellowish, transparent, demersal (sink to the bottom), and semi-adhesive in texture.



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 corraling mola hatchlings in an outer hapa. **Photo credit:** Harun Or Rashid, WorldFish.



Photo 16. Harvested mola hatchlings from the breeding tank. **Photo credit:** Harun Or Rashid, 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. Placing hatchlings in plastic bags with oxygen for transportation. **Photo credit:** Harun Or Rashid, WorldFish.

9. Nursery rearing of mola hatchlings

9.1 Nursery Pond Preparation

Proper nursery pond preparation is essential for successful mola 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

Mola 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 meter at its deepest point, ensuring optimal growth conditions for the fry.



Photo 20. Acclimatizing mola hatchlings prior to stocking in the nursery pond. **Photo credit:** Ahmed Jaman, WorldFish

9.3 Supplementary Feeding and Fertilization

During the nursery phase, mola 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.

9.4 Harvesting

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



Figure 22. Oxygen-packed mola fry ready for transport from nursery to grow-out pond. **Photo credit:** Harun Or Rashid, WorldFish.

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