Homestead modular hatchery technology of brackishwater catfish, *Mystus gulio*: A potential alternate livelihood option for small and marginal farmers of Sunderban

Prem Kumar[1], T.K. Ghoshal[1], Sanjoy Das[1] and M. Chandda[1]

[1]Kakdwip Research Centre of ICAR- Central Institute of Brackishwater Aquaculture, Kakdwip, South 24 Parganas, West Bengal 743 347, India.

The long whiskers catfish, *Mystus gulio*, a member of the family Bagridae, is a euryhaline fish, commonly called *nona tengra* in Bangladesh and West Bengal, India (Kumar et al., 2019). *M. gulio* is usually found in canals, lakes, rivers, estuaries (Ganges-Brahmaputra estuary), and *bheri* (constructed impoundments in coastal wetlands/brackish-water tide-fed areas) of the Sunderban delta of Bangladesh and India (Kumar et al., 2019). It is a small indigenous fish species with a high nutritional value due to relatively high protein, micronutrient, vitamin, and mineral content (Ross et al., 2003). The domestic market price of this fish depends on size, which ranges from $ 2.18-6.55 kg^{-1} (Kumar et al., 2019). Attributes such as its high nutritional value, market demand, hardy nature and fast growth make this species a desirable candidate for aquaculture in Southeast Asia (Ross et al. 2003). As a euryhaline species, it is suitable for culture in both fresh and brackishwater environments (Siddiky et al., 2015). It is co-cultured with other brackishwater fishes in paddy fields and *bheris* of the Sunderban. However, expansion of culture in pond systems has stumbled because of the unavailability of hatchery produced seed (Kumar et al., 2019). Wild seed availability is limited, unpredictable, time-consuming to collect and uneconomical. Seed production through induced breeding techniques is the only option to overcome such problems. In this connection, the Kakdwip Research Centre of the ICAR-Central Institute of Brackishwater Aquaculture, West Bengal, India has developed and popularised a cost effective, farmer-friendly Homestead Modular Hatchery and farming technology of *M. gulio*. We have also investigated the current status of farming and marketing of this species in the Sunderban of India.

Operation of the Homestead Modular Hatchery

Broodstock maintenance

Smaller sized earthen ponds (500-1,000 m^2) are ideal for maintaining the broodstock of *M. gulio*. Broodstock need to be fed at the rate of 5% of body weight twice daily with supplementary feed (25% protein, 8% lipid). One month before the onset of spawning season (April-August), broodstock are fed once daily with chicken liver to satiation.

Adult Mystus gulio.

Water supply system

Water from the broodstock pond/canal is pumped to a reservoir tank (1,000 litres) and treated with bleaching powder (200 kg ha^{-1} or 20 ppm). After de-chlorination, water is pumped from the reservoir tank to the overhead tank (500 litres). During breeding, water is supplied to the breeding unit continuously from the overhead tank to maintain constant flow.

Breeding unit

Plastic containers (capacity 100 litres) are used as a breeding unit arranged in rows. In each tub, water is supplied from the overhead tank through a perforated PVC pipe. To create constant water flow in breeding tubs, each is perforated on top and covered with fine mesh to facilitate flow while retaining the eggs. In each breeding tub, three to four egg collectors are kept submerged with the help of a weight fixed at one end. The egg collectors are made from a bunch of nylon fibers, each consisting of around 500-600 strips of around 15 cm length.

Homestead modular hatchery breeding unit for Mystus gulio.

Maturity assessment and injection

Sexual dimorphism in *M. gulio* is distinct and prominent, a muscular papilla with reddish-pink tip is present in males, and it is absent in females. During the spawning season, mature *M. gulio* are collected from the broodstock ponds. An ovarian biopsy of the female is performed to assess maturity. However, without ovarian biopsy, maturity can be judged through morphological observation of vent; a swollen belly and swollen reddish vent indicates maturity. Mature males can be identified by the presence of an elongated papillae with a pinkish tip. Generally, females and males in the range of 75-150g and 25-75 g, respectively, are selected for breeding. The operational sex ratio of males and females is 2:1. A single intramuscular injection of either human chorionic gonadotropin (HCG), leutinizing releasing hormone (LhRHa) or a commercial hormone at the dose of 10 IU g^{-1}, 5 µg g^{-1} and 20 µl g^{-1} body weight of the female, respectively, induce the fish to spawn. Males are injected simultaneously with half the dose of females. After hormone administration, one set (one female and two males) is released in one tub. Aeration and water flow is maintained cround the clock after hormone injection.

Mystus gulio male (top) and female (bottom) with elongated genital papillae and round vent, respectively.

Egg collection and incubation

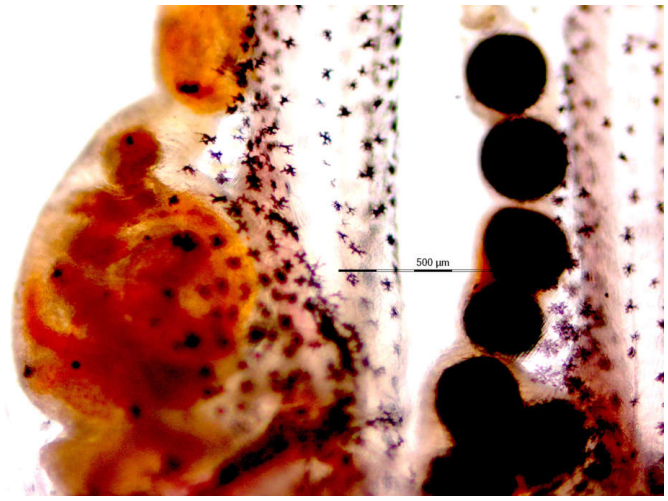
The latency period between injection and spawning ranges from 8-10 h, depending on the stage of maturation and water temperature. Fertilised eggs are round, demersal, and sticky, and demand provision of substrate in the form of the egg collector. Egg-bearing collectors are transferred to incubation units with provision for water flow to improve hatching and survival. Around the clock aeration is a must. Incubation period of *M. gulio* ranges from 16-18 hours.

Egg collector with eggs.

Larval rearing

One day before larval rearing begins, larval rearing tanks are filled with clean water and aerated. To avoid mortality and stress, the newly hatched larvae are gently transferred to larval rearing units as soon as possible. The newly hatched larvae start feeding two days post hatching, before the yolk sack is fully exhausted, which occurs on day three. Larvae

Newly hatched Mystus gulio larvae.



Gut of larvae filled with feed.

are stocked at a density of 25 per litre. They are fed from the second day onwards with freshly hatched *Artemia* nauplii at a density of 3,000 nauplii per litre, four times per day (Kumar et al., 2018). *Artemia* nauplii feeding continues until the seventh day. After that, larvae are fed twice daily with *Artemia* nauplii and twice with a 500 µ larval feed. After 30-35 days post hatching, larvae attain a size of 35-48 mm. During larval rearing, 0.5-1% of fast growing 'shooters' are typically seen in the first seven days, which are cannibalistic. Shooters must be manually removed for the first seven days to improve the survival of larvae.

Nursery rearing

Nursery rearing is essential to produce stockable sized seed for farming. Larval nursery is carried out either in net cage hapa, tanks or small ponds. Nursery rearing in hapa is easy to monitor and economical, and rearing for 60 days in hapa is a suitable system to produce fry for stocking. To carry out

Mystus gulio fry after nursery rearing.

nursery rearing, seven- to ten-day old larvae (0.01-0.02 g) are stocked in hapa (2 x 1 x 1) at an ideal density of 500 larvae/ hapa. Larvae are fed four times daily with larval feed at the rate of 10% of total biomass. After 60 days of rearing, larvae attain around 1.30-1.50 g with an average survival of 45%.

Farming of *M. guio*

Ponds are prepared following the standard procedure of drying (7-10 days), liming (agriculture lime at the rate of 200-250 kg ha^{-1}), filling (depth 1 m), bleaching (bleach powder @ 500 kg ha^{-1}) and fertilisation. Ponds are fertilised after dechlorination (5 to 7 days after bleaching) with organic

Preparation of pond for farming.

and inorganic fertilisers. Mustard oil cake, urea, and single super phosphate are applied at the rate of 250, 50, and 50 kg ha^{-1}, respectively. Farmers also practice the application of fermented 'juice' made up of molasses, 8-10 kg; probiotic, 50 g, wet yeast, 100 g; rice bran, 1 kg; mustard oil cake, 5 kg and water, 200 litres. This juice is kept for fermentation in a tank covered with polythene for seven days, and is sufficient to treat 1,300 m^2 of pond area. Nursery-reared fry of 30-35 days age are stocked at a density of 10 fry m^{-2}. Either floating or sinking feed having a protein content of 28-30% is fed at the rate of 5-8% of body weight. In six months of culture, fish attain an average marketable size of 50 to 60 g with the production of 1.2 to 2.4 tonnes ha^{-1}. The cost of production comes in around \$1.06-1.19 kg^{-1} and it has a ready market price of a minimum of \$3.31-3.97 kg^{-1}, which is economically lucrative. High-density farming (10-20 fish m^{-2}) in RAS and polythene-lined small backyard ponds (300 to 500 m^2) are suitable farming practices.

Paddy-cum-fish culture of *M. gulio* is common in the Sunderban area of West Bengal and India. In monsoon months along the coastline, high rain-fed regions are used for freshwater rice cultivation, which is mono cropped. After this crop, fields remain fallow due to highly saline soil, and are used for farming of salt tolerant rice varieties and brackishwater fish. In another system of farming, *M. gulio* along with other brackishwater fishes are farmed in low lying ponds with paddy on the upper area. Along with commercial feed, farmers also use low cost dried shrimp as feed for *M. gulio*. Dried shrimp soaked in water for a few minutes before fedding. Sampling and partial harvesting with cast net is practised, however, it is advisable to go for complete harvesting.

Physico-chemical parameters of water

To avoid stress, physico-chemical parameters such as temperature, pH, salinity, dissolved oxygen, and total ammonia of broodstock ponds, breeding tanks, incubation and larval rearing tanks must be uniform. In brackishwater systems, the ideal physico-chemical parameters of water such as salinity, temperature, dissolved oxygen and ammonia range from 7-18 ppt, 29-31°C, 4.5-5.0 ppm, and 0.02-0.05 ppm, respectively in the broodstock pond, hatchery, and larval rearing systems.

Popularisation and adoption homestead modular hatcheries

This homestead modular hatchery technology for growing *M. gulio* has been popularised among farmers of the Indian Sunderban through hands-on training and demonstration. More than one hundred farmers have received hands-on training at the Kakdwip Research Centre of CIBA. The technology has been demonstrated to farmers of the Sunderban

Paddy cum fish culture of Mystus gulio.

Table 1: Economic analysis of *Mystus gulio* homestead modular hatchery operation producing 50,000 30-day old fry in one cycle (16 females+32 males). Total production capacity is 200,000 fry in four months.

Fixed costs	Description and rate	Cost ($)
Water intake system	Electric water pump (2 HP), overhead tank (1,000 L) and PVC items	132.46
Air blower	Aeration, filter and accessories	39.74
Broodstock holding pond (500-1000 m^2) on lease	To maintain sub-adult and brood fishes	66.23
Breeding unit	Round plastic tub (100 L) x 15	132.46
Incubation cum hatching unit	Round plastic tub (100 L) x 15	132.46
Larval rearing unit	Rectangular or round cement tanks (500 L x 6)	397.39
False shed	Size: 50 X 50 m	198.69
Total fixed cost (A)		**1,099.43**
Operational costs		
Broodstock fish	Total broodstock required: 4 kg @ Rs. 700/-	37.09
Electricity / diesel	Operation of pump and blower for one cycle	13.25
Inducing agents and chemicals	Hormone, sanitiser and chemicals	9.27
Artemia cysts	~200 g	52.98
Larval feed	~250 g	1.32
Labour	For 35 days@Rs.500	231.81
Total operational cost (B)		**345.73**
Total cost of production (C) = A+B		**1,445.16**
Revenue / return		
Gross return (D) **Total fry ~50,000 are produced in one cycle (16 sets of breeding).** **Sale price @ $ 0.0099/fry (30 days old)**		**496.73**
Net return (E)= D-B		**151**
Operating ratio or benefit cost ratio (D/B)		**1.43**

Trainees and faculties in Mystus gulio hatchery yard.

Distribution of hatchery produced Mystus gulio seed to Mr. Kamanashish Sarkar, West Bengal, India.

Release of reading materials on Mystus gulio seed production and farming technology.

Marketable size of Mystus gulio in West Bengal, India.

Demonstration of homestead modular hatchery to Sri Aniruddha Das, from Namakhana, West Bengal, India.

Marketing of Mystus gulio in Namkhana, West Bengal, India.

Demonstration of homestead modular hatchery technology to Sri Dipankar Bera, Pathatr Pratma, West Bengal, India.

Marketing of Mystus gulio in Nischintpur, West Bengal, India.

as an alternate livelihood option. Further, to popularise the technology, seed of *M. gulio* has been distributed among small and marginal farmers of the Indian Sunderban area.

Economic analysis of homestead modular hatcheries and marketing status

M. gulio has low fecundity, ranging from 12,000 to 25,000. We have observed that a mature female (70-100 g) after administration of hormone typically releases around 10,000-12,000 eggs. In homestead modular hatcheries, one female generates around 4,000-5,000 fry at thirty days of age. The price of thirty-day fry varies with a minimum of $0.0066 and average of $0.013. Economic analysis of the system is shown in table 1. The price of *M. gulio* depends on market fluctuations, month, season, freshness, size and consumer demand. Recently, we conducted a survey of *M. gulio* in a few markets (Namkhana, Nischitpur, Kakdwip) of the Sundarban area and found that this fish has a very high market demand with prices ranging from $2.18-6.55 kg^{-1}. The price of *M. gulio* is also influenced by size. Smaller (50-70 g), medium (50-70 g), and larger fish (more than 100 g) are sold at $2.18, 5.10 and 6.55 kg^{-1}, respectively by wholesalers to retailers who in turn sell to consumers with a mark-up of $ 0.44 to 0.73 kg^{-1} (CIBA, 2015).

References

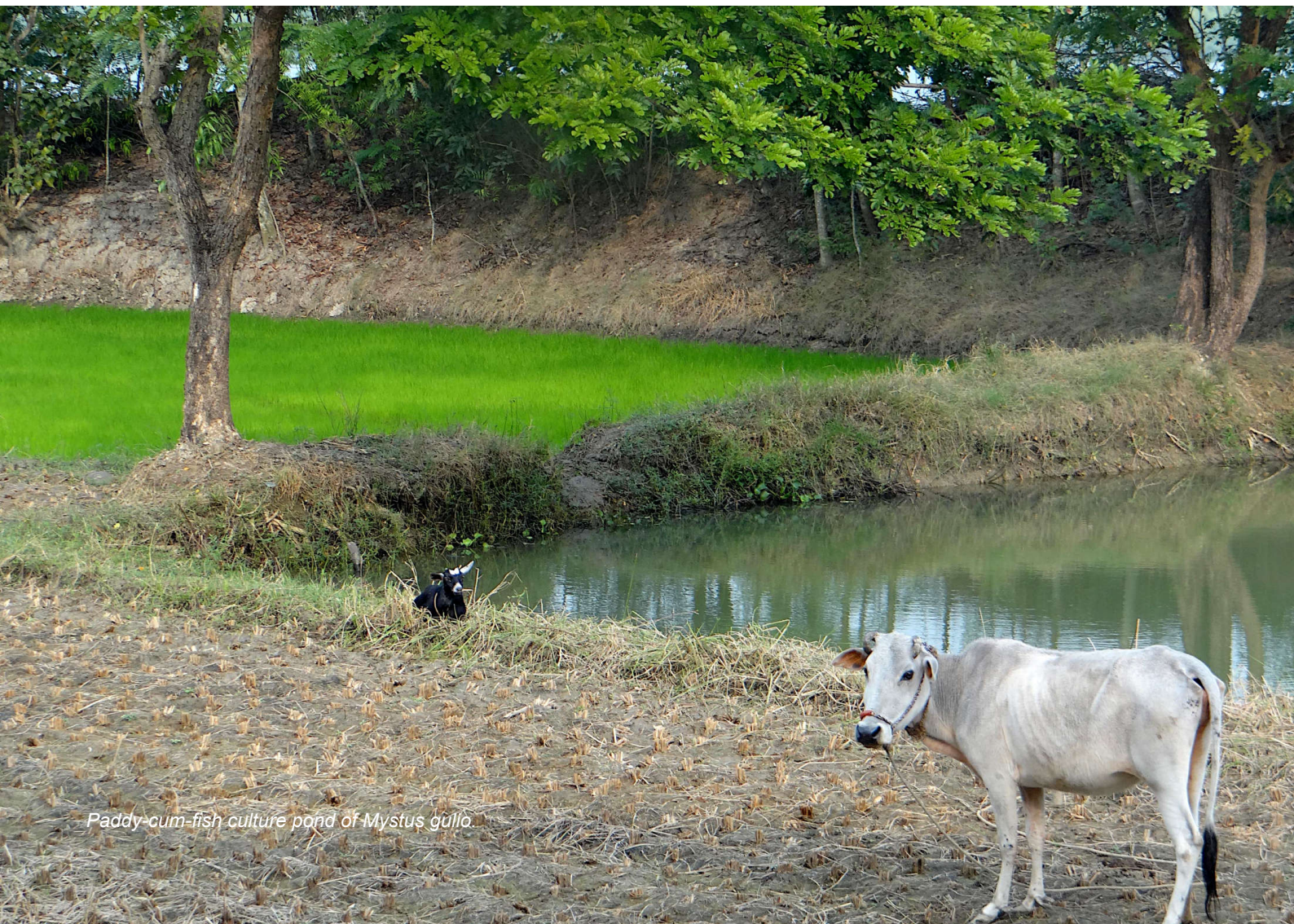
CIBA-2015. Annual report 2015-16. Central Institute of Brackishwater Aquaculture, Chennai, Tamil Nadu, India. pp. 242.

Kumar, P., Biswas, G., Ghoshal, T.K., Kailasam, M., Christina, L., Vijayan. K.K., 2019. Current knowledge on the biology, captive breeding and aquaculture of the brackishwater catfish, *Mystus gulio* (Hamilton, 1822): A review. Aquaculture 499, 243-250.

Kumar, P., Biswas, G., Ghoshal, T.K., Kailasam, M., Vijayan, K.K., 2018. Embryonic and larval developments of brackish water catfish, *Mystus gulio* (Hamilton and Buchanan, 1822) induced with human chorionic gonadotropin and consequent larval rearing. Aquaculture research 49 (7), 2466-2476.

Ross, N., Islam, M., Thilsted, S.H., 2003. Small indigenous fish species in Bangladesh: Contribution to vitamin A, calcium and iron intakes. Journal of Nutrition. 133: 4021- 4026.

Siddiky, M. N. S. M., Saha, S. B., Mondal, D. K., Ali, A., Washim, M. R., 2015. Optimization of stocking density of *Mystus gulio* (Brackishwater catfish). International Journal of Natural and Social Sciences 2, 60-63.



Paddy-cum-fish culture pond of Mystus gulio