

Present status of medium saline 'bheri' fishery and integrated mangrove-aquaculture in West Bengal, India: A short study: Part 2

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Growing mangrove plants in mangrove park at Canning Town.

Brackishwater polyculture in South 24 Parganas

In August 2022, the author met Sri Kaushik Sardar, a progressive brackishwater fish farmer at Krishnachandrapur Village, Gram Panchayat and P.O. Karanjali, PS and Block Kulpi, South 24 Parganas. His farm area (a 'fishery' in local dialect) is a single 2.1 ha, elongated water body 1.2-1.4 m deep, taken on lease (@ INR 83,000/year). The farming practice is modified-extensive type brackishwater polyculture, practiced commercially but not recognised under the term 'bheri fishery' or 'bheri farming'. He cultures *Labeo catla*, *L. rohita*, *Lates calcarifer* (only in very small amount), *Mystus gulio*, *Metapenaeus brevicornis*, *Macrobrachium rosenbergii*, *Liza tade*, *L. macrolepis*, *Penaeus monodon*, and *P. vannamei* – all at the same time. Water from the Bhagirathi (Hooghly) River

is taken in via a nearby canal and sluice gate. He uses the sluice to take a great quantity of tidal water into his plot, when felt necessary.

He believes that if production of shrimp goes down unexpectedly due to disease (though rare), market sized healthy fish production will compensate for the loss. Details of seeds stocked are as follows:

- Riverine *P. monodon* 8-10 mm, INR 0.60/piece.
- *P. vannamei* 3-4 mm, brought from hatchery in Madhya Pradesh, INR 0.20/piece.
- Riverine *M. rosenbergii* 48 mm, INR 5/piece.
- Riverine *L. calcarifer* 75-100 mm, INR 10-12/piece.



A view of a medium-saline bheri at Minakhan.

- Riverine *L. parsia* 24 mm, *L. catla* and *L. rohita* 100-150 g each, INR 140/kg.
- Wild entry of *M. brevicornis* 4-5 g in good amount.
- *L. tade* 48 mm, INR 5/piece.

There is no auto-stocking except for *M. brevicornis*. Hence this is a modified-extensive polyculture system. A proper stocking density is not maintained for shrimp species and commercial aquaculture products are not used. Home-made formulated feed is used in the form of dough balls comprising a mixture of mustard oil cake, maize dust and rice bran/wheat flour. The *P. monodon* reach 15-20 g after 70-75 days of culture, *P. vannamei* reach 20 g on day 90 of culture. After 180 days, *L. macrolepis* and *L. tade* grow to 50-75 g and 300-350 g respectively, and *M. gulio* 50-75 g. After one year, his *M. rosenbergii* attain 100-150 g body weight.



Well-maintained mangrove park at Canning Town.

Sri Saiful Piyada and Sri Shyamapada Mondal, fish farmers at Rangafola-Aripara Village, Gram Panchayat and P.O. Belpukur, PS and Block Kulpi informed the author that conduct brackishwater fish farming with emphasis on *M. rosenbergii*, *P. monodon* and *P. vannamei* (PL-20 stage stocked), all simultaneously in an old 880 m² pond (150-180 cm deep) taken on lease, and in an adjacent beel of just under 2.4 ha in proximity to the Hooghly River. Water is drawn into the pond and beel at high tide via a canal. Indian major carps and *Tilapia nilotica* are also stocked. Optimum stocking density is not maintained, but culture systems are sparsely populated with a low biomass of fish and shrimp at stocking.

In August 2022, the author went to view medium-saline brackishwater 'bheri' aquaculture at Shyamaprosadpally Village, Canning Bridge Road, Canning town. Here, a total



A small chamber connected to main bheri.

area of a single bheri or 'Jalkar' is about 5.28 ha with 0.9-1.1 m water depth, having influence of tidal water from the Matla River on both sides of road bridge connecting Canning town and Basanti. A farm technician informed that from January-February onwards, hatchery-produced *P. monodon* seeds of 12 mm are stocked @ 7,000 / 0.132 ha bought @ INR 500-600/1,000 pieces. Local riverine seeds also stocked, which cost INR 500-700/1,000 pieces. Those are first reared in a 2,640 m² nursery chamber within the vast bheri for a month, and thereafter released into the main plot. Harvest of *P. monodon* begins from the end of March at 30-35 g size, with seed released once per month. Feeds are not used. The shrimp grow only on natural food produced by and over submerged aquatic weeds ('jhanjhee' in local dialect) and submerged aquatic grass. Tidal water from the Matla River, around 100 m away, is exchanged at fortnightly intervals, more frequently if needed.

L. tade seed of around 72 mm are stocked here in a small quantity @INR 6-7/piece; *L. parsia* seed of around 24 mm enter along with tidal water from December onwards. *L. tade* is harvested at 400-500 g, and *L. parsia* in the next November at 30-40 g body weight. Lime and inorganic fertilisers are not applied during the culture period. During November-December, the entire plot is dewatered, the bottom soil dried and raked; inorganic fertilisers, lime and mustard oil cake are applied to the water body before seed stocking. Final harvest of *P. monodon* is done in August. *T. nilotica* adults are released once in the bheri plot in January, with young self-recruiting. The water is kept 'rolling' (in the words of technician) in this very large bheri, with exchange done frequently, thus natural food and nutrients are supplemented via intake from time to time, and good water quality is maintained inside. Sources of hydrogen sulphide, ammonia, nitrite, methane are removed when bheri is allowed to dry.

Integrated mangrove-aquaculture

The MS Swaminathan Research Foundation (MSSRF) held the International Conference on Sustainable Development in Hill and Coastal Ecosystems in Chennai, 7-9 August 2022. Dr S. Velvizhi, Scientist and Head of the MSSRF Fish for All Research and Training Centre in Tamil Nadu, discussed integrated aquaculture in mangrove areas with sea bass *L. calcarifer* and mud crab *Scylla* sp. At Minakhan Block, integrated mangrove-aquaculture (IMA) has been implemented by the Nature, Environment and Wildlife Society (NEWS), a well-known NGO in Kolkata. The Project 'Sustainable Aquaculture in Mangrove Ecosystems' is a multi-stakeholder partnership to strengthen transformative processes in shrimp trade as a basis for the protection of mangrove ecosystems in South Asia. The project receives cooperation from the Global Nature Fund.

Mangrove ecosystems provide food and livelihood to Sundarbans' dwellers in the two coastal districts of West Bengal. Mangroves protect people and land from frequent environmental hazards like cyclonic storms, violent winds, waves and soil erosion. Polyculture of shrimp and mullet using modified-extensive methods can be taken up in IMA systems and can become a fruitful alternative livelihood for women in the Sundarbans region of West Bengal. IMA practices aim to support the restoration of mangrove ecosystems in this region. By culturing economically important species of shrimp, mud crabs, mullet and other fish in an integrated way along with mangrove plants, IMA can support the livelihoods of farming families, and the well-developed root system of mangrove trees will facilitate protection of coastal lands and embankments of IMA plots from erosion.

IMA is a modified-extensive brackishwater fish and shrimp polyculture system, involves no application of commercial products, antibiotics or chemical compounds, and a minimum



Integrated mangrove-aquaculture plot of Sri A. Mondal at Minakhan Village.

and judicious use of inorganic fertilisers, feeds, mustard oil cake, lime, and seed. Like bheri fisheries, IMA starts after desiltation of plots and embankment strengthening on all sides. Shrimp feed @ INR 90/kg and that of mullets @ INR 45/kg may be used. In every 0.132 ha IMA water body, *L. parsia* seed are stocked @ 3/m³ (24-36 mm, INR 4/piece); *L. tade* seed @ 2/m³ (48-72 mm, INR 12/piece) and *P. monodon* @ 5/m³ (PL-20, INR 1/piece). *L. parsia* will grow up to 40 g, and *P. monodon* 30 g at the end of five months of culture. Wholesale rates of mullets and *P. monodon* at Canning town and Malancha fish markets are INR 300/kg and INR 650/kg respectively.

Sri A. Mondal is one of the two beneficiaries (members) in an IMA adopted by the project implementing authorities at Minakhan Gram Panchayat (GP) of Minakhan Block. It is at Minakhan Village. Prior to this, more local brackishwater fish, shrimp and prawn farmers were adopted as beneficiaries at Chaital GP of this Block. All of them have been practicing brackishwater polyculture in bheris for the 15-20 years. The project implementing authorities provide the major share of inputs, namely *P. monodon* (22-24 mm) and mullet seed, feed, and lime. They also analyse and monitor soil and water quality parameters in IMA water bodies. Member farmers contribute a portion of the total input requirements. Sri Mondal's own IMA plot is 1.04 ha with 0.9 m water depth. A blue nylon net and bamboo fencing at 2 m height has been constructed around the plot to prevent the entry of cattle and

goats that may eat planted mangrove saplings. Bidyadhari water is let in through inlet as and when felt necessary; water exchange done once or twice a month during the culture period.

In June 2022, under the initiative of the project, tropical mangrove saplings of *Rhizophora apiculata* ('gorjon' in Bengali), *Heritiera fomes* ('sundori'), *Sonneratia apetala* ('keora'), *Nypa fruiticans* ('golpata'), and *Xylocarpus granatum* ('dhudhul'), 15-60 cm in height have been planted on all sides near the banks on the slopes of IMA water bodies and on embankments at Sri Mondal's plot. He explained that at the time when leaves shed from grown-up mangrove plants in the near future, it will fall over water body where fish and shrimp are under culture, decompose and contribute detritus to increase fertility by providing more nutrients. This will promote fish and shrimp growth. Water in IMA plots remain in good and purified condition. Leaves of the plants are thick and don't pollute the water. The mangroves assist in protecting the environment and maintaining environmental balance. Mangrove trees absorb carbon emissions in greater amounts than other trees. They strengthen the embankment and keep the soil intact. In this project, Sri Mondal has learned the importance and procedure of analysis of essential water parameters of brackishwater aquaculture plots.



Integrated mangrove-aquaculture plot of Sri Shankar Baz at Joygram Village.

In the Sundarbans region, each mangrove sapling normally costs INR 50. Four- to ten-month-old saplings of familiar mangrove trees 30-60 cm in height can be used for planting in IMA plots. A full-grown *S. apetala* tree may attain 20 m in height, *H. fomes* 10-25 m, *Avicennia* sp. 2-10 m.

IMA plot of Sri Shankar Baz

Like Sri Mondal, Sri Shankar Baz is an elderly brackishwater fish farmer, second of the two IMA farmers adopted by project implementing authorities at Joygram Village, Minakhan GP. His bheri is around 1.05 ha, 90-150 cm deep, and has been developed into an IMA system. While giving an account of his plot and species cultured, Sri Baz informed that he procures:

- Hatchery-produced *P. monodon* seeds of 20-22 mm from Chennai/Vishakhapatnam, @ INR 600-700/1000 pieces, stocked at an interval of 20-22 days @ 1,000 pieces / 0.132 ha. His *P. monodon* are sold @ INR 500-800/kg at 30-45 g, harvested at 75-90-day intervals.
- Riverine *M. rosenbergii* seed of 30-50 mm @ 1000 pieces / 0.132 ha in two lots two times in a season (i.e., total 16,000). Seed cost INR 1 per piece and are sold at a marketable size of 50-100 g at the end of culture duration @ INR 400-700/kg.
- Wild-collected crab seed of *S. olivacea* are released in the plot at 20-30 g size, obtaining a good growth rate.
- Low amounts of *M. brevicornis* and *M. monoceros* enter the plot along with tidal ingress and sold @ INR 300-350/kg at 5-10 g size.
- Riverine paddy-grain sized *L. parsia* seeds are stocked @ 200 pieces / 0.132 ha during March end, bought @ INR 2,000/kg. At the end of the year, it achieves 30-50 g, caught in December-January when the plot is completely dewatered.
- *T. mossambicus* adults are stocked at 75-100 g and self-recruit 3-4 times/year, growing to marketable size of 50-100 g, sold locally @ INR 120-150/kg.
- Riverine *L. tade* seeds of 72 mm, bought @ INR 7-10/piece and stocked @ 50 pieces / 0.132 ha during March-April are harvested in January at 400-500 g size, with a market price of INR 150-200/kg.
- Major carp fingerlings are stocked @ 20kg / 0.132 ha during June-July at 100-200 g, bought @ INR 100-120/kg; those weigh 1,000-1,200 g at harvest, sold @ INR 140-150/kg.

- A small amount of *M. gulio* seeds are autostocked via entry with tidal water, grow to 50-70 g, and sold locally @ INR 400-700/kg, along with *Scatophagus argus* and *Glossogobius giuris* that enter the plot.

The water body is made ready for new culture at the beginning of February, on the 30th day of harvest of one crop. The bottom soil is dried, ploughed, and organic manure applied. A mixture of wheat flour byproduct, powdered broken rice and groundnut oil cake is used as feed for *M. rosenbergii* @2-5 kg/day. Cow dung is applied in small amounts once a month. Mangrove saplings are planted on four sides of the IMA plot, and strong erect nylon net fencing is set around from 30 cm deep inside ground. Fish within the will not be able to escape if floodwater enter during super-cyclones and natural calamities. Sri Baz mentioned that many farmers in this region will have to depend upon production and sale of fish to keep up their commercial brackishwater polyculture system, as production of *P. monodon* is not up to expectations.

He explained that brackishwater aquaculture in West Bengal may be semi-intensive to intensive *P. monodon* or *P. vannamei* monoculture in 1,000-1,200 m² brackishwater ponds (as mainly done in brackishwater blocks of Purba Medinipur), small- to medium-scale brackishwater fish and shrimp culture or shrimp monoculture in brackishwater blocks of North and South 24 Parganas districts in 0.132-0.264 ha ponds with daily use of home-made feed. The third system is brackishwater bheri/gheri polyculture with *P. indicus*, *P. monodon*, *L. parsia*, *L. tade*, and *M. rosenbergii*. In conditions there are losses in shrimp production, the fish harvest will protect the farmer.

The project provided financial support for earth excavation, fencing and IMA preparation works, as well as procurement of shrimp and *M. rosenbergii* seeds, and mangrove saplings. Saplings of 3-4 mangrove species, about 45 cm tall, were planted in June 2022 keeping a space of 1.2-1.5 m laterally. Those will grow to about 2.5 m in next two years.

One permanent labourer stays at Sri Baz's IMA plot all the time, entrusted with overall management and care. At the end of one year, more labourers will be engaged for the purpose of excavating sediment from the dewatered plot, until the entire area is deepened. Project personnel test of IMA plot soil and water parameters, provide prophylactic medicines, and organise a monthly meeting with 25-30



Night shelter under construction for watchman.

member IMA farmers in both Minakhan and Chaital GPs in Minakhan Block. Organic manures are applied to achieve good mangrove growth on embankments. Limestone powder is applied over the bottom in February during pre-stocking management, eliminating emission of harmful gases. Lime also increases an IMA plots capacity to be more productive, enhances the decomposition rate of organic matter, destroys pathogenic organisms, and increases the amount of utilisable nitrogen, Sri Baz stated.

Information on bheri fishery from published articles

Some information could be gathered after a perusal of some publications on bheri fisheries. Before seed stocking, quicklime CaO should be applied @ 200-300 kg / 0.132 ha in saline bheri(s) for culture of *P. monodon*¹. In brackishwater ponds, exchanging water too frequently during tidal action may reduce the concentration of nitrogen, phosphorus and other nutrients required for photosynthesis, and thus primary productivity is hampered. Water exchange is needed to remove ammonia and excessive natural food particles. It should be done only when required². In brackishwater polyculture ponds, finfish production gives a certain percentage of return even during the disease outbreak in shrimp. Polyculture of *P. monodon* with *L. parsia* and *L. tade* has emerged to be an effective alternative to brackishwater shrimp monoculture system in ponds. A combination of these three species is most popular among traditional brackishwater fish farmers of North 24 Parganas. Naturally occurring fry of mullets can be procured from fish seed markets at Ghatak-pukur, Canning, Sonakhali, Kakdwip, Namkhana, Frasergunj in South 24 Parganas. Maintaining a species ratio of 21:3:1 *P. monodon* (above PL-20) : *L. parsia* (4-6 cm) : *L. tade* (8-10 cm) seed are stocked @ 25,000/ha. In five months with supplementary feed and proper management, *P. monodon* reach 65 g, *L. parsia* 100-110 g, *L. tade* 500 g³.

During the 1960s and later on at Minakhan and other places in the two districts, adequate numbers of naturally occurring seeds of *L. parsia*, *L. tade*, *L. calcarifer*, *Eleutheronema tetradactylum*, *Setipinna phasa*, *Pseudapocryptes lanceolatus*, *M. monoceros*, *P. monodon*, and *P. indicus* entered into medium- to large-sized bheri(s) along with tidal water of Bidyadhari, Raimangal, Matla and other rivers. Dissolved nutrients and food matter were in high concentration in river water. Shrimp achieved good growth within 2-3 months. Brackishwater 'bheri' farmers got fess and shrimp production @ 50-200 kg/ha in 8-10 months with very little investment.

In low-saline areas having 1-10 ppt salinity, small-sized plots are dried in November and limestone powder applied. Small earthen nursery enclosures are created at the side and *P. monodon* seeds brought from outside are stocked 50,000-60,000 / 0.132 ha. Salinity levels of water of this enclosure must be the same as that in which seeds have been transported to avoid shock. After 15-20 days, larger-sized seeds enter into main plot after a 1.0-1.5 m cut is made in the nursery embankment, creating a narrow water channel. Submerged aquatic weeds *Najas* sp., *Ceratophyllum* sp. are allowed to grow in the main bheri plot before shrimp seed is released. Leaves of palm and date palm trees are placed over bottom soil, upon which periphyton is produced and also living organisms such as algae, which are used by growing



Small chamber connected to main bheri with embankment cut.

shrimp as a natural food source. Fresh tidal water is allowed to enter frequently on every spring tide, favouring the growth of *P. monodon* and facilitating moulting. Production is around 700-800 kg fish (including major carps) and 70-80 kg shrimp and *M. rosenbergii* per year per hectare.

In areas of higher salinity (10-30ppt) in these two districts, stocking of major carp fingerlings is avoided, and only that of *L. parsia*, *L. tade*, *P. lanceolatus*, *S. phasa*, *P. monodon*, *M. monoceros* and their rearing is made in medium-sized brackishwater bodies or 'nona gheri'. Along with tidal water enters the seed of predatory and piscivorous fish such as *L. calcarifer*, *Terapon jarbua*, *E. tetradactylum*, *G. giuris* and others, which are unwanted and thus water is let in carefully. Otherwise, farmers will get a very low shrimp production. Fish and shrimp seed are procured and stocked from outside; mullets @ 1,000-1,500 pieces / 0.132 ha and *P. monodon* 1,500 pieces / 0.1320 ha. Harmful gases are avoided by avoiding build-up of organic matter in the bottom soil. Frequent water exchange is essential. Supplementary feed is provided to growing fish and shrimp @ 2-5% of body weight daily in feeding trays. Brackishwater fish production from such system is around 450-650 kg/year per hectare, *P. monodon* 80-90kg/year per hectare. A medium-sized brackishwater body of 7-10 hectare in area gives good production as it is easy to manage and protect.

A greater part of Sundarbans region in West Bengal is subjected to tidal fluctuation throughout the year. Estuarine region of the Sundarbans in North and South 24 Parganas districts was known as the 'goldmine' of naturally-producing early stages of *P. monodon*, mullets and other economically-important shrimps and brackishwater fishes. But this natural repository has markedly declined over time. According to the late Dr K. R. Naskar, Bidyadhari water is contaminated with organic sewage and enriched with a considerable amount of nutrients from the domestic wastewater of Kolkata city carried via sewage pumping stations of Kolkata Municipal Corporation on the eastern border of Kolkata. Bidyadhari water enriches bheri soils with nitrogen and organic carbon, promoting the production of natural food sources for stocked animals². But presently the situation is different. Raw domestic sewage now enters the Bidyadhari in much greater quantities, carrying pollutants of inorganic origin. The brackishwater fish farmers at Minakhan, having a strong traditional knowledge base, no longer consider it suitable and proper to be let into bheris for fish and shrimp farming. Fish farmers and possessors of medium-saline bheris at Minakhan are trying their level best to keep up brackishwater finfish production for local consumption as well as raising *P. monodon* for export.

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V-shaped bamboo grating at a bheri as observed from behind.

Small chamber main bheri and one of the canals of Bhagirathi.



Indigenous basket for keeping harvested animals.



Split-bamboo box for catching and keeping harvested shrimp and fish.

