New mud crab hatcheries for Bangladesh – design concepts and draft budget for a demonstration-scale and full-scale commercial hatchery

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C. Shelley, YH & CC Shelley Pty Ltd. March 2013
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Introduction

In discussion with FfF-AQ it was requested that different design concepts be outlined for consideration. The main consideration is the size and productive capacity of the hatchery. Hatcheries are typically designed to produce a certain number of crablets per month or per year.

As mud crab hatchery operations are at an earlier stage of development than shrimp hatcheries, percentage survival and reliability are both less than for shrimp. As such a conservative approach needs to be taken for their design, when considering productive capacity to ensure as far as possible that production targets are met. The advantage of this approach is that whilst production costs and related economics are based on a relatively low survival rate, as survival rates improve the cost of production and subsequent profitability of the hatchery can also improve. This is particularly the case in larval rearing, as most production costs per tonne of water are fixed, independent of the number of larvae raised and crablets produced.

Design Concepts

1. Low cost demonstration mud crab hatchery

If it is the intention of the WorldFish Center just to demonstrate the technology involved in mud crab aquaculture technology, then a very small facility could be constructed. This could also be used as a training facility for small groups.

An example of such a facility is as constructed in Micronesia for the state of Kosrae, which is a very small island, which only had the capacity for a very small, local mud crab farming industry to export to adjoining island states. To minimise costs this was constructed within a pre-fabricated building (Figure 1). The building, tanks, plumbing supplies, filters, equipment, tools and everything required to operate the hatchery were all packed within 2 shipping containers. On arrival the structure was erected and totally fitted out ready for operation within 4 weeks by 2 aquaculture specialists brought in specifically to do the job, with help from a few local labourers.

The hatchery was sited so as to tap into an existing high quality seawater supply (from an adjacent aquaculture marine hatchery), mains freshwater and connected to the local power supply without significant cost.

The size of such demountables and hence hatchery size can be increased to meet demand, in other words the design can be considered modular and can be scaled up to meet demands. Multiple units can be erected either adjacent to each other or with an overlapping design, so that a large internal span is achieved.
Figure 1. Mud crab hatchery constructed by YH and CC Shelley on Kosrae, Micronesia.

Figure 2. Insulated larval rearing tank area under construction, Kosrae Micronesia
This hatchery was designed to produce approximately 40,000 crablets per run. As such if it had 9 runs per year it could produce approximately 360,000 crablets per year. It used concrete tanks from the adjacent aquaculture centre for the nursery production of crablets.

The price to transport, construct and build the hatchery, adjusted for inflation, would be US$73,500 and its yearly operational costs US$ 40,300, excluding staff and utility costs.

Significant savings for such a demonstration-sized facility would be achieved if it could be sited to utilise existing water infrastructure, for example adjacent to a shrimp hatchery, either in Cox’s Bazar or southwest Bangladesh.

A single skilled technician (US$25,000) could operate such a facility, with the assistance of a couple of hatchery workers (US$7300). Therefore annual salary costs would be approximately US$32,300, plus travel and accommodation costs if an expatriate technician from Vietnam or Philippines were brought in.

In summary a rough estimate of the costs of establishing such a unit and operating it for one year would be as detailed in Table 1. below.
Table 1. Estimated cost of establishing a demonstration mud crab hatchery and operating it for one year

<table>
<thead>
<tr>
<th>Cost Centre</th>
<th>US$</th>
<th>Million BDT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turnkey mud crab hatchery</td>
<td>73,500</td>
<td>5.835</td>
</tr>
<tr>
<td>One year operational costs</td>
<td>40,300</td>
<td>3.199</td>
</tr>
<tr>
<td>Staff costs</td>
<td>32,300</td>
<td>2.564</td>
</tr>
<tr>
<td>Utility costs</td>
<td>20,000</td>
<td>1.588</td>
</tr>
<tr>
<td>Contingency costs (20%)</td>
<td>33,220</td>
<td>2.637</td>
</tr>
<tr>
<td><strong>Total</strong>*</td>
<td><strong>199,320</strong></td>
<td><strong>15.826</strong></td>
</tr>
</tbody>
</table>

* Note: If this facility could not be constructed adjacent to and make use of existing water infrastructure, additional items including water storage, treatment tanks and pumps would be required. A crude estimate of the additional costs to address this situation would be US$50,000. If the facility were constructed in southwest Bangladesh, transportation of saltwater to the site would also be an additional operational cost.

2. **Commercial scale hatchery**

The hatchery shown in Figure 4 is designed to produce approximately 500,000 crablets per run, based on a survival rate of 5% from zoea to crablet. It consists of functional units, with appropriate flow between units to maximise biosecurity within the facility.

**Broodstock Maturation Room**

This room is kept under a low-light regime. 40 broodstock tanks will be established with a recirculating system to keep water quality high. The recirculating system will include heating, sand filtration, cartridge filtration, UV sterilisation, carbon filtration and protein skimming. The system will be designed so that all water in tanks is passed through the system twice a day.

**Spawning and Hatching Areas**

This area will also be a low-light regime area. There is no feeding of mud crabs in spawning or hatching tanks. Water will be maintained at the highest quality. Water will be treated as per broodstock, however water will not be recirculated.

**Rotifer Room**

Tank systems to produce rotifers at high densities will be set up within the rotifer area. Rotifers will be fed for to zoea until day 2 of zoea 2. Rotifer and Artemia areas are well separated to minimise the risk of cross-contamination.
Figure 4. Concept plan for 144 tonne larval rearing capacity mud crab hatchery (dimensions in metres)

**Artemia Room**

This is used for hatching and growing *Artemia* for different times, depending on the size required by the mud crab larvae. *Artemia* are used from the zoea 2 stage through to the end of the megalops larval stage.

**Larval Rearing Room**

This area will have natural lighting. Use will be made of polycarbonate sheets on the ceiling and large windows if the sidewalls are solid. If the shed design is such that the larval rearing area has open sides, a solid roof will be adequate.
The larval rearing room consists of 12 x 12 t tonne parabolic tanks. These provide optimal water circulation for larvae. Typically these tanks are made of fibreglass. The tanks will either be double layered or insulated to assist in keeping water at a stable temperature within the tanks. Water for larval rearing will be heated, sand filtered, cartridge filtered to 1µm, UV sterilised, carbon filtered and protein skimmed.

**Saltwater storage**

Outside of the main hatchery shed there will need to be significant water storage. Water supply will be such that up to 50% of water can be exchanged per day. Ideally water storage of approximately 1500 tonnes will be held in a plastic lined pond or tanks, which can be topped up during the production cycle.

A header tank and pump system will be established to gravity feed water through the hatchery.

**Freshwater storage**

Dependent on the source of freshwater, an appropriate treatment system will need to be installed. As a minimum the water will need to be sand and carbon filtered prior to mixing with seawater in the system. Further filtration or sterilisation may be required.

**Store and Laboratory**

There is a store for feeds, chemicals and spare pieces of equipment. The laboratory is used for observations and counting of larvae and live feeds. In addition microbalances are used for weighing out of artificial feeds and chemicals. The laboratory can also be used for preparation of probiotics. In addition water analysis can be undertaken in the laboratory.

**Office and staff room**

A small office is available for record keeping, communicating with suppliers and other hatchery management activities including keeping of financial records. A staff room is available for staff meetings, training, meal breaks and accommodating staff staying overnight. A toilet and shower is also provided for staff.

**Workshop**

A small separate shed will be required to accommodate a workshop. This is where running repairs to screens, plumbing and other pieces of equipment can be made. Hatcheries regularly make minor modifications to tank and system design. Gluing, plastic welding, woodwork and cutting can be undertaken without the risk of any fumes, waste or airborne particles impacting on the animal production area.

**Nursery tanks**

Plastic, fibreglass or concrete ‘raceway tanks’, covered with a waterproof roof are required for the nursery stage when megalops larvae settle and become crablets. Approximately 500 sq. m of tank space will be required for. This could be made up of
20 tanks that are 10 m (long) x 2.5 m (wide) and 0.5 m (deep). These tanks with a total volume of 250 tonnes would be set up with a recirculating system, as per the broodstock set up (Includes heating, sand filtration, cartridge filtration, UV sterilisation, carbon filtration and protein skimming).

**Estimated budget**

The detailed design for a hatchery of this scale including engineering, hydraulic, aeration, electrical, water treatment and detailed fit-out would take 3-4 weeks to complete and utilise the skills of a number of professionals. As such it is unrealistic to suggest a detailed budget here, given the time set aside for this exercise. However, a visit to a new nauplii shrimp hatchery, which would be a similar size to this hatchery, was costing 55 million BDT (US$ 693,000) to construct. As a mud crab hatchery of this size would include significantly more in the way of water treatment than the shrimp hatchery visited, I would suggest a budget in the range of US$750,000 (60 million BDT) to US$1,250,000 (100 million BDT) would be required for a totally fitted out hatchery of this size, ready to go.

**What is an appropriate sized commercial mud crab hatchery for Bangladesh?**

Most early stage shrimp hatcheries in Bangladesh are around 30 tonne capacity, with larger capacity for the nauplii hatcheries. As mud crab hatcheries can’t produce so many larvae per unit volume as a shrimp hatchery, to achieve a financially viable operation, mud crab hatcheries need to operate a large volume of tanks. It may be that 50 tonne or 100 tonne larval rearing capacity hatcheries for mud crabs may be useful sizes for Bangladesh, which would produce 175,000 to 350,000 crablets per run at 5% survival. Hatcheries viability will depend on many variables, however if prices of crablets are minimised to ensure sale of stock, margins may be tight. Larger operations, because of certain economies of scale may have slighter better margins, than the smaller players.