

WATER REQUIREMENT AND EFFICACY OF A PROTOTYPE HATCHERY FOR SELECTIVE BREEDING OF ROHU, *LABEO ROHITA*

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A prototype hatchery was constructed at Central Institute of Freshwater Aquaculture (CIFA), Kausalyaganga, Bhubaneswar, India to produce spawn of fullsib families of rohu (*Labeo rohita*) carp and mass production of genetically improved rohu spawn. While following combined selection method, fullsib families have to be produced and reared separately from fertilized eggs to fingerlings i.e., till taggable size for individual tagging. The specialized hatchery was developed for individual fullsib family spawn production i.e., fertilized eggs to spawn. Water requirement study was performed for full sib family production as well as for mass scale spawn production and, it was worked out to be 10.54 and 81.07 m³ for one fullsib family and a million of spawn production, respectively. The specialized hatchery improved the production of fullsib families and spawn recovery percentage to a greater extent. Recovery of fullsib families increased from 70-82% to 94-100% in different year classes. In the present paper, efficacy of the hatchery for fullsib family and mass scale spawn production in selective breeding programme of rohu for last 19 years is discussed. The same model of hatchery can also be utilized for selective breeding programme for any other carp species.

INTRODUCTION

Indian Major Carps (IMC) i.e., catla (*Catla catla*), rohu (*Labeo rohita*) and mrigal (*Cirrhinus mrigala*) spawn naturally only in flooded rivers and also in tanks, where riverine conditions are simulated during the monsoon months. Till 1964-1965, 92-95% of the country's carp seed were obtained from rivers, which were the traditional sources of fish seed for aquaculture. Presently carp seed required for aquaculture in India is being obtained mainly from two sources: (i) bundh breeding and (ii) hatcheries (through induced breeding). At present, hatcheries account for more than 95% of seed source. A steady increase in carp seed production from 1980's can be attributed to the use of Chinese type eco carp hatchery technology and the application of synthetic inducing agent. The Chinese type carp hatchery is most widely used followed by the jar hatchery. Carp seeds are also produced in bundhs by simulating riverine conditions during monsoon in state like West Bengal (Basavaraja, 2007).

Fish hatchery was earlier used in India as a facility for hatching of carp eggs collected from rivers and bundhs. At that time, rivers and bundhs were the main sources of carp seeds. Over the years, the development and refinement of the technique of induced breeding of carps have taken place. Hence, more emphasis is being given to hatcheries for large scale production of fish seed. Now the hatchery component is perhaps the most vital component of a modern fish farm (Jhingran and Pullin, 1985; Gupta and Rath, 2011).

The modern eco-carp hatchery proved to be very efficient to produce seed from Indian major carps as well as other exotic carps such as grass carp and silver carp etc. However, very little attention has been paid towards the qualitative improvement of carp seed in India. As a result some of the carp hatcheries are suffering from the negative effects of inbreeding (Eknath and Doyle, 1990). So it was felt that genetic improvement of carp is highly essential in the Indian subcontinent. Under an Indo-Norwegian collaborative project on selective breeding of rohu, combined selection method was followed where fullsib families had to be produced and reared separately from fertilized eggs to fingerlings (10-15g) i.e., till taggable size for individual tagging with Passive Integrated Transponder (PIT) tag (Das Mahapatra *et al.*, 2001)

Initially, cloth outer and inner hatching hapas were used in the ponds for separate hatching and incubation purpose of fertilized eggs. But these hapas were exposed to high ambient temperature and, natural calamities like flood, cyclone and predation by trash fishes, which enter the hapas inadvertently from the pond. There were also hapa cutting by crabs and other unmanageable ecological parameters that affected the spawn recovery. Thus recovery of fullsib families was low in the outdoor hatching systems and hence, a prototype hatchery was established to improve the situation.

MATERIALS AND METHODS

The prototype carp hatchery, which was developed for breeding of rohu at CIFA consists of components such as 1. Overhead tanks, 2. Spawning pool, 3. Male broodfish cistern, 4. Acrylic jars for incubation of fertilized eggs, 5. Hatchling collection cisterns and 6. Circular hatching pool for mass scale incubation of fertilized eggs (Fig. 1a).

Overhead tanks

Two overhead tanks of 10,000 liter capacity each were constructed 5 feet above the ground level. Both the overhead tanks were joined together at the bottom by galvanized iron (GI) pipe. Water is supplied to the hatchery from a pond. The pond water is pumped to the overhead tank after filtering through bolting silk cloth to avoid plankton in the hatchery water. From the overhead tanks, water is supplied to different units through GI pipes.

Spawning pool

The Circular Chinese type of spawning pool was constructed for breeding/spawning purpose. During selective breeding work, only female broodfishes were released in the spawning pool for full sib family production. However, for mass scale spawn production, both male and female broodfishes were released. The diameter of the spawning pool is 3.0 m. Water depth is maintained at 0.6-0.7 m. Showering system was also provided in the wall of the pool with plastic sieve tubes. Single water inlet with 60° tangent was fitted at the bottom of the sidewall. The water depth is controlled by outlet on the sidewall of the pool. Water current is produced in the spawning pool before two hours of calculated spawning time through the inlet pipe. The speed of the water is maintained at 3-4 m/ second. The volume of the spawning pool is 5 m³.

Broodfish @ 6 kg/m³ is used on an average in the spawning pool for breeding purpose. For fullsib family production, 25-30 kg of female broodfishes are utilized; whereas for mass scale spawn production, average 16 kg female and 14 kg males (1:1 by number) are used for breeding in a single operation.

Male broodfish cistern

For the production of fullsib families in selective breeding study, male and female broodfishes are to be stripped separately to obtain gametes. So after hormone injection they have to be kept separately. One rectangular (3.5 m x 1.8 m x 1.0 m) male broodfish cistern was constructed for holding male broodfish. The water outlet was fitted at a height of 0.9 m in order to maintain the water depth at 0.9 m. The cistern was fitted with two showers from both the sides to supply oxygenated water. After hormone injection, male broodfishes are released to the breeding hapa fixed in the cistern.

Acrylic jar hatching unit

The transparent acrylic jars in which fertilized eggs are incubated get water supply from bottom through a flexible connecting pipe. There are seven acrylic jars in each unit. The hatchery complex consists of three such units; so 21 acrylic jars are there in the hatchery that can incubate 21-fullsib families in a single operation. Each acrylic jar has the specifications as shown in Fig. 1b. The capacity of each jar is 15 l. At the bottom of the jar a sieved guard of 18 mm diameter and 5 mm thickness was fixed. A total 17 holes of 2 mm diameter were fitted in each jar to block the flow of eggs into the pipe. Only swollen eggs are loaded in the jars. In each jar 60,000-75000 numbers of fertilized eggs can be loaded @ 4000-5000 numbers/l. The outlet of the jar is connected to fibreglass channel, which opens to hatching hapa separately. After 14-16 hours of incubation, the eggs hatch and hatchlings start migrating with the water flow to the hatchling collection hapa. The migration normally gets completed by 20-24 hours.

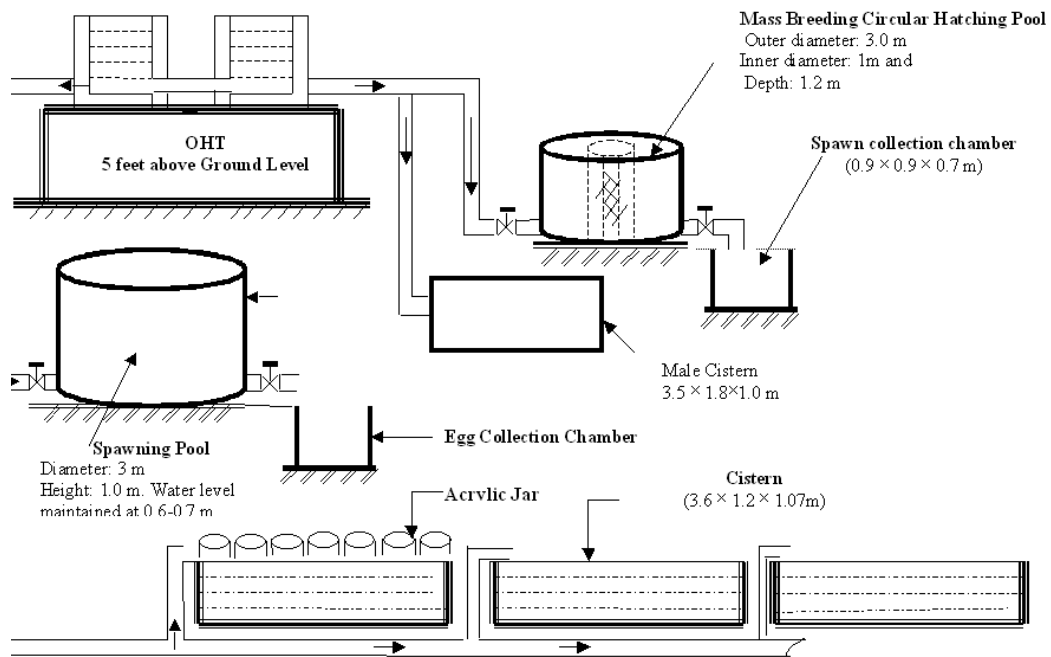


Fig.1a Layout Diagram of the Specialized Selective Breeding Hatchery

Hatchling rearing unit

Each acrylic jar independently opens to hatchling collection hapa. The hatchling collection hapas are made up of bolting silk cloth having 1.2 m length, 0.5 m width and 1.0 m height. The hapas have tapes to join the four corners with the cistern. At the bottom side of the hapa small weights are tied to prevent floating. Each cistern receives spawn from seven acrylic jars separately into seven hatchling collection hapas. There are three cisterns in the hatchery and each cistern has the dimension of $3.6 \times 1.2 \times 1.07$ m. Showers are provided from the top to each hatchling collection hapa. The water depth of the cistern is maintained at 0.85 m. Hatchlings are kept in those hapas for 60-72 hours (till complete absorption of yolk sac).

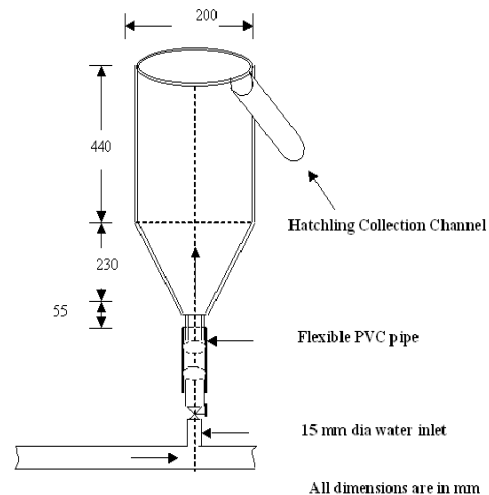


Fig.1b: View of Single Unit Acrylic Jar

Circular hatching pool

One circular hatching pool was also constructed for mass scale incubation of fertilized eggs to spawn. The diameter of the pool is 3.0 m. It is a double circular smooth cistern made of brick and RCC material. The hatching pool has two chambers and water enters into the cistern by ten numbers of duck mouth inlets and expel out through a screen encircling the inner chamber. A delivery pipe was erected on the central outlet hole to maintain the water depth of the incubation chamber. The pool was also provided with spawn delivery outlet fixed at the bottom of the outer wall. The duck mouths were arranged in holes equidistant from each other and from both inner and outer walls of the chamber. The equidistant principle with unidirectional water flow allows the eggs to circulate without low oxygen and without touching the screen of the cistern. The depth of the pool is maintained at 1.0 m. The mesh size of the inner screen is 0.32 mm in order to prevent the escape of hatchlings. The eggs are loaded @ 7 lakhs/ m³. The regulated water flow in the hatching pool is maintained at 0.4-0.5 m/second for first 12 hours and then reduced to 0.1-0.2 m/second to avoid premature hatching. For rest of the period, it is maintained at 0.3-0.4 m/second.

Water requirement assessment

Water requirement study was conducted for fullsib family spawn production involving water used in spawning pool, male cistern, hatching acrylic jars and incubation in the cistern in one cycle i.e., from spawning to spawn. Whereas in mass scale improved rohu spawn production, water utilization in spawning pool and circular hatching pool were taken into account. Water requirement in each case was studied till complete absorption of yolk sac in the hatchlings. Water output was measured on hourly basis. Each hour was again divided into three observations of one-minute duration at every 20 minute interval. Finally, total water requirement for each fullsib family and per million spawn production was estimated.

RESULTS AND DISCUSSION

Spawning pool in the hatchery unit is Chinese eco type hatchery where it serves two purposes. First, it is utilized for holding female broodfish for different fullsib family production and second, it is also utilized for mass production of improved rohu, wherein both the male and female broodfishes are released together in the same pool after hormone injection. Due to single water inlet facility the water current and a centrifugal force sweep out eggs soon after the spawning. The spawning pool opened to the egg collection tank (0.9 x 0.9 x 0.7 m). The outlet is 'L' shaped and eggs are collected on a water cushion and hence, ruptures of egg cell walls are minimized. The spawning success in the pool was observed to be 95-100% for last 13 years.

Several authors have reported earlier that broodfish utilization @ 3.5 kg/m³ of water is optimum (Rath and Gupta, 1997; Gupta *et al.*, 2000; Sahoo *et al.*, 2001; Thomas *et al.*, 2003). However, in this hatchery average 6 kg broodfish/ m³ water was utilized with high rate of spawning success. Considering the volume of spawning pool (5 m³), approximately 30 kg of broodfishes could be utilized in each operation.

The recovery of fullsib families increased to a greater extent in different year classes due to this hatchery. Before construction of the hatchery (up to 1999), fertilized eggs were incubated separately in hapas (outdoor). Though large numbers of fullsib families were produced, the recovery was poor. The hatchery was fully operational from the year 2000 and the recovery of fullsib families increased thereafter (Table 1). The percentage of spawn recovery was also higher i.e., 85-90% in the hatching unit in comparison to earlier hapa rearing at 45-50%.

Table 1. Production and recovery of fullsib families of rohu in different year classes

| Sl. No. | Year class | Fullsib families produced | Fullsib families actually recovered | % of recovery |
|---------|----------------------------------|---------------------------|-------------------------------------|---------------|
| 1 | 1993 | 80 | 60 | 75 |
| 2 | 1994 | 84 | 66 | 79 |
| 3 | 1995 | 89 | 73 | 82 |
| 4 | 1996 | 89 | 68 | 77 |
| 5 | 1997 | 84 | 61 | 73 |
| 6 | 1999 | 77 | 54 | 70 |
| 7 | 2000 | 59 | 56 | 95 |
| | (year of hatchery establishment) | | | |
| 8 | 2001 | 58 | 58 | 100 |
| 9 | 2002 | 61 | 60 | 98 |
| 10 | 2003 | 58 | 57 | 98 |
| 11 | 2004 | 56 | 56 | 100 |
| 12 | 2005 | 61 | 60 | 98 |
| 13 | 2006 | 69 | 69 | 100 |
| 14 | 2007 | 62 | 62 | 100 |
| 15 | 2008 | 62 | 62 | 100 |
| 16 | 2009 | 57 | 56 | 98 |
| 17 | 2010 | 59 | 58 | 98 |
| 18 | 2011 | 66 | 65 | 98 |
| 19 | 2012 | 66 | 66 | 100 |

A number of modifications were made in the hatching unit in comparison to other acrylic jar hatcheries in order to suit the requirements of selective breeding and

separate rearing of fullsib families. Acrylic jars were connected separately to the collection hapas so that from individual jars hatchlings could be collected separately. Individual hapa was provided with shower for receiving fresh water continuously (Fig. 1a) and this has improved the recovery percentage of spawn.

Water requirement for fullsib family spawn production was calculated taking into account the water consumption in spawning pool (Table 2a), male cistern (Table 2b), hatching acrylic jars and incubation in the cistern (Table 2c) in one cycle i.e., from spawning to spawn. Total water requirement was found to be 2,21,325 l in one operation. In a single operation, 21 fullsib families can be produced and so, for each fullsib family production 10.54 m³ water is required. In mass scale improved rohu spawn production, water utilization in spawning pool (Table 2a) and circular hatching pool (Table 2d) were taken into account. Total water requirement was worked out to be 2,83,743 l per operation. In a single operation, average 3.5 million spawn can be produced. Thus water requirement per million of spawn production was calculated to be 81.07 m³. Rath *et al.* (2006) however, reported water requirement at 87 m³/ million of spawn production in eco carp hatchery.

Table 2. Water requirement in the hatchery

a) Water requirement in spawning pool

| Operational activity | Duration (hrs) | Avg. flow (l/min) | Total water consumption (l) |
|--|----------------|-------------------|-----------------------------|
| Initial loading of water (Diameter: 3.0 m and depth: 1.0 m; Water depth maintained at 0.7 m) | - | - | 4950.0 |
| Showering of water into pool | 5.0 | 5.65 | 1695.00 |
| Water flow through inlet into spawning pool | 5.0 | 72.69 | 21807.0 |
| Total: | | | 28452.0 |

b) Water requirement in male rectangular cistern

| Operational activity | Duration (hrs) | Avg. flow (l/min) | Total water consumption (l) |
|---|----------------|-------------------|-----------------------------|
| Initial loading of water (Size: 3.5 × 1.8 × 1.0 m; Water depth maintained at 0.9 m) | - | - | 5670.00 |
| Showering of water into cistern | 10.0 | 5.00 | 3000.00 |
| Total: | | | 8,670.00 |

c) Water requirement in jars for incubation

| Operational activity | Duration (hrs) | Avg. flow (l/min) | Total water consumption (l) |
|---|----------------|-------------------|-----------------------------|
| Initial loading of water in three rectangular cisterns (Size: 3.6 × 1.2 × 1.07 m each); Water depth maintained at 0.85 m. | - | - | 11016.0 |
| Initial loading of water in jars (Capacity:15 l; Total nos. : 21) | - | - | 315.00 |
| Water flow into jar at low velocity (0-16 hrs) | 16.0 | 1.85 | 37296.00 |
| Water flow into jar at moderate velocity (17-20 hrs) | 4.0 | 5.30 | 26712.00 |
| Showering of water into hapa, fitted inside the cistern (Total number of showers: 21) | 72.0 | 1.20 | 108864.00 |
| Total: | | | 1,84,203.00 |

d) Water requirement in circular hatching pool for mass scale seed production

| Operational activity | Duration (hrs) | Avg. flow (l/min) | Total water consumption (l) |
|---|----------------|-------------------|-----------------------------|
| Initial loading of water (Outer and inner chamber diameter: 3.0 and 1.0 m and depth: 1.0 m) | - | - | 7071.0 |
| Water flow through duck-mouth {18 (Egg to hatchling) + 72 (Hatchling to spawn)} | 90 | 45.50 | 2,45,700.00 |
| Showering of water into cistern | 12.0 | 3.50 | 2520.00 |
| Total: | | | 2,55,291.00 |

CONCLUSION

The developed prototype hatchery was found to be suitable and effective for breeding of rohu for family based or combined method of selective breeding. The same hatchery also could be used successfully for mass breeding for spawn production. Efficiency of this hatchery has improved the fullsib family production as well as spawn recovery to a greater extent in the selective breeding programme of rohu in the Institute. Water requirement studies indicated less water consumption per million spawn productions in comparison to other commercial carp hatcheries. Thus considering its efficacy and low water requirement, this hatchery can be a model hatchery for selective breeding programme of any other carp species.

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