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Carp Spawn to Fry Rearing in Specially Designed Floating Cage Nursery

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ABSTRACT: The present study focuses on survivability and growth assessment of spawn to fry rearing of rohu, *Labeo rohita* in a floating cage nursery system, specifically designed and fabricated under ICAR-AICRP on PEASEM (All India Coordinated Research Project on Plastic Engineering in Agriculture Structures and Environment Management) scheme, centre at ICAR-CIFA (Central Institute of Freshwater Aquaculture), Bhubaneswar. The cage system is comprised of a platform of 6 × 6 m size with four net cages synthesized using nylon hapa of 1/40" (635 µm) mesh size. The hapa inside the cages is braced with MS (mild steel) frames of 2 × 2 × 1.5 m. The buoyancy of the floating cage nursery structure is calculated to be 77.37%, which is found suitable for safe operation. The rohu spawn were stocked@ 1000, 2000, 3000 & 4000 numbers per m^3 in the four floating cage nurseries (C1-C4) in a 2-hectare reservoir of ICAR-CIFA Farm. The experiment was conducted in duplicate treatments (T1 & T2). The T-1 was conducted from 16 July 2019 - 6 August 2019 and T-2 during 12 August 2019 - 3 September 2019. Standard spawn to fry rearing practices were followed for 21 days for each treatment. The survivability of spawn to fry ranged between 26.2-42.5% and was seen inversely proportional to the stocking density. The harvested sizes of fry ranged between 48.5-61.8 mg and 12-19 mm. Spawn stocking density upto 3000 numbers per m^3 was found suitable for fry production in cage nurseries. The physicochemical parameters of the water were found within the safe limits of aquaculture.

Keywords: Floating nursery; Cage culture; Fish seed; Spawn; Fish fry; IMC

INTRODUCTION

The common practices of commercial fish rearing are done in various culture settings, such as open ponds, raceways, tanks or cages. Cage culture of fish utilizes existing water resources, but encloses the fish in a cage or basket which allows water to pass freely between the fish and the pond or reservoir. The origins of cage culture are a little vague. The first cages were used by the fishermen as holding structures until fish could be accumulated for the market. The first true cages for producing fish were seemingly developed in Southeast Asia around the end of the 20th century (Masser, 2008; Masser, 2012). Early cages were constructed of wood or bamboo, and the fish were fed trash fish and food scraps. Modern cage culture began in the 1950s with the arrival of synthetic materials for cage construction (Vikas *et al.*, 2010).

Cage culture is now-a-days receiving more attention from both researchers and commercial producers. Factors such as increasing consumption of fish, declining of wild fish stocks and a poor farm economy have produced a strong interest in fish production in cages. Cage culture also offers the farmer a chance to utilize existing water resources which in most cases have only limited use for other purposes (Shivkumar *et al.*, 2019). It should be emphasized that the cage culture of fish is not fool proof or simple. On the contrary, cage production can be more intensive in many ways than pond culture and should probably be considered, as a commercial alternative only where open pond culture is not practical.

When promoted in a manner appropriate to local needs and resources, cage aquaculture can be successfully used to alleviate poverty among the rural poor (Huchette & Beveridge, 2003). Since 1995, the Cage Aquaculture for Greater Economic Security (CAGES) development project in Bangladesh has successfully assisted more than 2500 families to successfully adopt cage farming (Hambrey *et al.*, 2001; Mc Andrew *et al.*, 2002).

Nevertheless, one of the main factors limiting the access to aquaculture by the poorer sectors of society in the country remains to be the requirement for inputs of seed and feed (Hambrey *et al.*, 2001). Thus, a cage system not only for the rearing of food fish, but also a specifically designed cage culture system for fish seed rearing can effectively mitigate such problems across the world. In India, there are available 3.15 million ha of reservoirs and to get enhanced biomass production from these water bodies, carp fingerlings are to be stocked at the right time and in the right numbers (Mohapatra *et al.*, 2018). Many schemes are there to encourage the owners of these reservoirs to stock them with carp fingerlings, but availability and transport are the major constraints. Floating nurseries may be the suitable alternatives for the rearing of carp spawn to fry and then to the fingerling stage in the reservoir itself. The primary objective of this study is being to design and fabricate the floating nurseries (cage) suitable for reservoirs and large water bodies for carp seed rearing with convenience.

MATERIAL AND METHODS

The cage structure for seed rearing experiment is assembled of a rigid platform, 4 net cages and 12 numbers of plastic floats for buoyancy (Fig. 1).

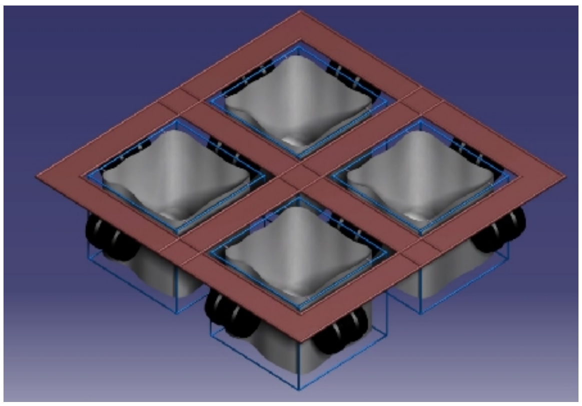

Fig. 1. 3D model of the floating cage nursery.

Platform: The platform for the cage nursery has been constructed from Mild Steel (MS) hollow pipes of 25.4 mm diameter and density of 7850 kg/m^3. The platform is rectangular of size 6 × 6 m with cross walkways as per the design shown in Fig. 2. The walkways are made from 12 mm thick plywood boards of 500 kg/m^3 density. The floating structure along with the walkways help in monitoring the livestock.

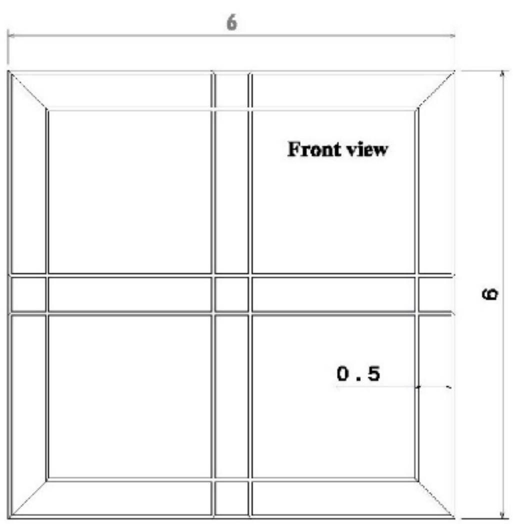

Fig. 2. Draft of platform structure.

Cage: Four outer skeleton of size 2 × 2 × 1.5 m have been fabricated from 20 × 20 × 3 mm MS angles. The outer rectangular parallel epiped frames are designed to maintain the net cages intact and prevent them from flopping around (Fig. 3). The net cages are made with nylon hapa of 635 μm mesh size.

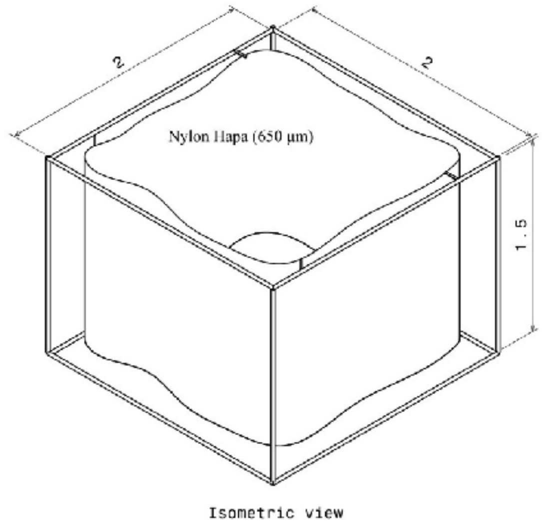

Fig. 3. Draft of individual cage with dimesions.

Bouy/float: The floats are HDPE (High Density Poly-Ethylene) cylindrical barrels of ⌀0.7 × 0.6 m with density of 970 kg/m^3. A total of 12 numbers of floats are used for sufficient buoyancy for the platform of cage nursery system.

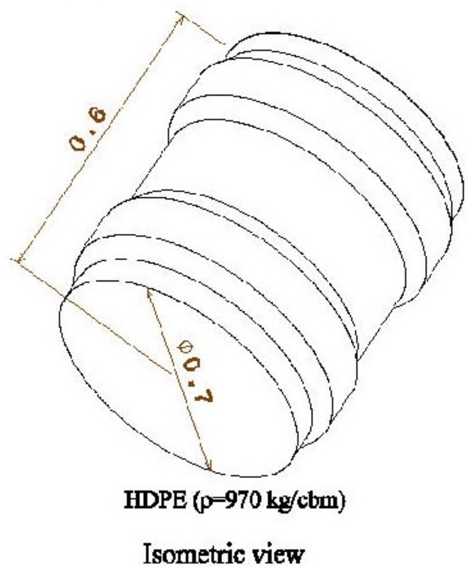

Fig. 4. Draft and dimensions of the float.

Mass balance calculation of cage nursery: Total mass of the platform calculated considering the densities of the raw material is 527 kg. Individual cage structure weighing at 21 kg, the total weight of four cages in the platform is calculated to be 84 kg. Hence, the total downward force created by the platform fitted with 4 cages becomes 611kgf.

The buoyancy force created by the HDPE floats is calculate using Equation-1 by following the Archimedes' principle of water displacement. The mass of one HDPE cylinder is calculated to be 5.8 kg. Thus, the buoyancy force created from one cylindrical float is calculated to be 225kgf and the total upward force created from 12 floats is 2699.88 kgf.

$$F_{buoyant} = \rho_{water} V_{float} - M_{float} \quad \text{... (1)}$$

Here, the mass of the fish and the net have been neglected for obvious reasons. The total downward and upward forces are compared for calculating the floating feasibility of the cage nursery system in laden and un-laden conditions, which in turn provides the operational safety diagnosis.

Carp seed rearing: In T-1, the rohu (*Labeo rohita*) spawn of average size 1.8 mg were stocked in 4 cage nurseries, each of 6.0 m^3 installed in a 2.0 ha reservoir of ICAR-CIFA Farm at Kausalyaganga, Bhubaneswar (Fig. 5). The spawn were stocked at densities (SD) of 1000, 2000, 3000 & 4000 numbers/m^3 in cages C1, C2, C3 & C4, respectively. Normal seed rearing practices were followed, which included standard feeding of powered feed (rice bran and groundnut oil cake:: 1:1) @ 6 kg per million spawn for the first week, 12 and 18 kg in second and third weeks, respectively. During the experimental period of 21 days, physicochemical parameters of water such as pH, total hardness (mg/l), total alkalinity (mg/l) and dissolved oxygen (mg/l) from the cages and reservoir were estimated every week as per standard laboratory procedures (APHA-AWWA-WPCF, 1989). The experiment was repeated as T-2 with exact parameters as in the case of T-1.

Fig. 5. Cage installation and spawn stocking.

RESULTS AND DISCUSSION

Four cage nurseries were stocked with rohu (*Labeo rohita*) spawn with an initial average weight of 1.8 (1.6-2.1) mg, and grew to the size range of 48.5-61.8 mg and 12-19 mm in21 days of rearing period in both treatments (Table 1). The average survivability percentage from spawn to fry rearing in cage nurseries during the rearing period was calculated to be 42.5, 38.1, 35.5 and 26.2 for the cages C1, C2, C3 and C4, respectively (Fig. 6). The survivability rates of the seed across the samples were seen indirectly proportional to the SD. The rate of survival and growth of the seed in C1 of T1 & T2 were found non-significantly different (P>0.05) to each other. It was also non-significant in C2 of T1 & T2, in C3 of T1 & T2 and in C4 of T1 & T2. Spawn stocking density upto 3000 nos/m^3 was found suitable for fry production in cage nurseries.

Table 1: Carp spawn to fry rearing.

		Average wt. of spawn stocked (mg)	Spawn stocked (nos/m^3)	Average wt. of fry harvested (mg)	Ave. of TI & T2 (mg)	Fry harvest (nos/m^3)	Survival from spawn to fry (%)	Average survival (%)
C1	T-1	1.7	1000	63.4	61.8	439	43.9	42.5
	T-2	1.9	1000	60.2		411	41.1	
C2	T-1	1.7	2000	54.3	57.1	798	39.9	38.1
	T-2	1.9	2000	59.9		726	36.3	
C3	T-1	1.7	3000	57.4	55.2	1011	33.7	35.5
	T-2	1.9	3000	53.0		1119	37.3	
C4	T-1	1.7	4000	52.8	48.5	1016	25.4	26.2
	T-2	1.9	4000	44.2		1080	27.0	

'C' and 'T' denote cage and treatment, respectively.

There are a rather small number of reports available in the area of fish seed rearing in cage nurseries. A study by Wagle *et al.*, (2012) with silver carp and bighead carp fry to fingerling in nursery cage culture system reported a heavy mortality rate of up to 70%. Whereas, in the present case, the rearing of *L. rohita* spawn to fry in stocking densities of 1000-3000 nos/m^3 in cage nurseries showed a better survivability rate, *i.e.*, 35.5-42.5%. The spawn to fry rearing of rohu experiment was conducted by Mohapatra *et al.*, 2018 in 1.0 × 1.0 × 1.0 m floating cages covered with different mesh sizes (1/40", 1/60" and 1/80") nylon nets. The stocking density was 3,000 nos rohu spawn per cage, *i.e.*, per m^3. The survivability achieved was 25.6% in 1/40" mesh cage in 20 days of rearing of spawn to fry, which is less than the present experiment. The present nursing cages are 6.0 m^3, thus produced better results than the cage size of 1.0 m^3. Rohu spawn to fry rearing was carried out at high density (2000 spawn/m^2) in large concrete nursery tanks of size 10 × 5 × 1.2 m (Das *et al.*, 2016). The fry survival was 45–59% at the density of 2000 spawn/m^2, indicating the efficacy of the concrete nursery system for high density seed rearing. In the present carp seed rearing experiment in cage nurseries, the survival percentage was 38.1 at the SD of 2000 spawn/m^3 which is a little below the reported value of Das *et al.*, (2016), but the results can be comparable. The fry were reared up to the fingerling stage in cages of 2 × 2 × 1.5 m size using nylon hapa supported with mild steel frames (Mohapatra *et al.*, 2018). The common carp (*Cyprinus carpio*) fry were stocked in different stocking densities. After 45 days of rearing, it was found that the survival and growth were indirectly proportional to the stocking densities of the seed. The survivability was ranged between 38-59.3%. The results of cage nursing of carp seed are in accordance with the present findings.

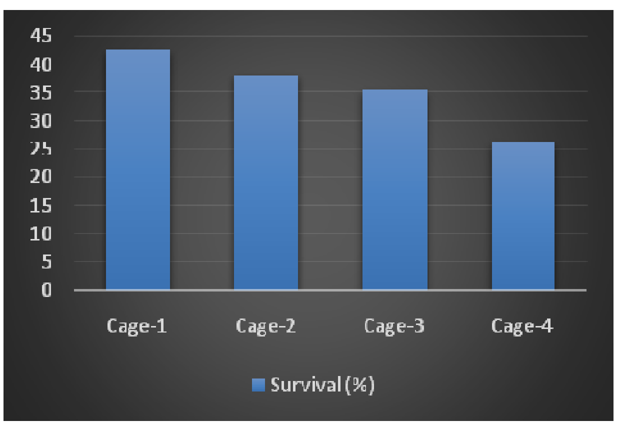

Fig. 6. Survivability of carp spawn to fry stage in a cage.

During the experimentation period, the physicochemical parameters such as pH ranged between 7.5-8.2, total alkalinity 68-82 mg/l, total hardness 62-76 mg/l, and DO 4.5-5.6 mg/l. The sampling data revealed that the water parameters were suitable for fish seed rearing purposes. The recorded parameters are in agreement with the values given in the book of Mohapatra and Saha, (2000).

The cage structure developed by Das *et al.*, (2009) also incorporated bamboo for platform and steel drums as floats. In their developed structure, the steel drum floats were coated with paint to prevent rusting and the overall structure showed 72.4% buoyancy. In comparison, the present study utilizing plastic floats reduces the structural un-laden load, easily recyclable, which in turn will reduce environmental pollution. In addition, the mass balance calculations in the present study showed 77.37% palatability of the floating cage design, which is adequate to keep the system safely floated with a maximum of 8 persons onboard at the same time of inspection or harvest. The estimated lifespan of the present designed floating cage nursery is 5-10 years. In addition, the traditional bamboo floating cages have a shorter lifespan, which is estimated by Wahab *et al.* (2009) as one year for untreated and 3-5 years for treated ones.

CONCLUSION

In India, there are available 3.15 million ha of reservoirs. To get enhanced biomass production from these water bodies, carp fingerlings or advanced fry are to be stocked at the right time and in the right numbers. Many schemes are there to encourage the owners of these reservoirs to stock them with carp fingerlings, but availability and transport are the major constraints. The current study on fish seed production in specially designed cage nurseries showed encouraging survival rates for Indian Major Carps. The scaled-up facilities of the present design can be fruitful to meet the demand of the fish seed requirement for stocking the large waterbodies of the country.

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