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Pawan Kumar Sharma
PhD. Research Scholar, Dept. of Aquaculture, Fisheries college & Research Institute Ponneri, TNJFU, Tamil Nadu, India

J Stephan Sampath Kumar
Director, Directorate for Sustainable Aquaculture, Thanjavur, TNJFU, Tamil Nadu India

A Priyatharshni
Teaching Assistant, Department of Aquaculture, TCeSA, Thanjavur, TNJFU, Tamil Nadu, India

Ekta Singh
Assistant Professor& Head I/C TCeSA, Thanjavur, TNJFU, Tamil Nadu, India

V Senthil Kumar
Assistant Professor& Head I/C TCeSA, Thanjavur, TNJFU, Tamil Nadu, India

Correspondence
Pawan Kumar Sharma
PhD. Research Scholar, Dept. of Aquaculture, Fisheries college & Research Institute Ponneri, TNJFU, Tamil Nadu, India

Analysis of potential background for the establishment of seed production units (Fish hatcheries) towards the livelihood development in rural sector

Pawan Kumar Sharma, J Stephan Sampath Kumar, A Priyatharshni, Ekta Singh and V Senthil Kumar

Abstract
India is the seventh largest country in the world with 72.2 % population living in villages. In India, there are 19,370 reservoirs (Small + medium + large = 19,134 + 180 + 56) and the total area of these reservoirs is estimated at 31,53,366 (14,85,557 + 5,27,541 + 11,40,268) hectare. In the present scenario it is very clear that we are not having sufficient seeds, Due to shortage of seeds, our water bodies are always under stocked. The fish hatchery has some essential components like- Overhead tank, Brooders tank, Spawning tank, Hatching tank, Nursery tank, Rearing tank. The amount of milt ejaculated (ml/kg body weight) is observed 1- 2 ml in natural condition while 6-10 ml in hatchery during induced breeding. The rate of breeding success is much higher during induced breeding that is 88% followed by 90% success of hatching that is also much higher than natural breeding. The survivalist of spawn is also 50-90% in hatchery condition while it is 10-20% in natural condition. There are 6, 49,481 villages in India, concept of one hatchery in every village will provide employment at least 4 person so 25, 97,924 people will get job directly. The department of animal husbandry dairying and fisheries (DADF) provides an assistance of Rs 8 lakh for a fish seed hatchery with 10 million (fry) capacity for the plain areas and Rs 12 lakh for same capacity in the hill States/Districts. The percentage of survival, milt amount, rate of fertilization and possibility of selective breeding is also not satisfactory in the breeding in natural condition. Thus the need for local carp seed hatcheries in villages can be found as a best alternative for meeting the higher fish seed demand, while also promoting regional socio-economic upliftment.

Keywords: production potential, fish seed hatcheries, employment, socio-economic upliftment

1. Introduction
India is the seventh largest country in the world with 72.2 % population living in villages (Census India, 2011) [11]. Job opportunities if provided to the villagers then the problem of unemployment would be almost solved. To achieve this target, there is a need to find out a technology which is easier to understand, easy to operate, productive in a short period, which can be implemented with the available resources and should be highly sustainable. Fish seed production units or fish hatcheries possess the above qualities for adoption in rural areas of country.

1.1 Why fish hatchery?
In India, there are 19,370 reservoirs (Small + medium + large = 19,134 + 180 + 56) and the total area of these reservoirs is estimated at 31,53,366 (14,85,557 + 5,27,541 + 11,40,268) hectare (Reservoir fisheries resources of India, FAO). The production level from these water bodies is very low standing at49.9kg / hectare from the small reservoir, followed by the medium reservoir (12.3 kg ha^{-1}) and larger reservoir (11.43 kg ha^{-1}). The average reservoir production of the nation is 20 kg ha^{-1} (Annual report CIFRI- ICAR, 2016-17). The poor productivity is primarily due to lack of the management of these water bodies. However, management of such a large water body is not easy job, due to higher costs and higher time requirement. The best preferred way to increase the productivity of such water bodies is by stocking of the fingerling size fishes by such stocking, productivity can be easily increased, since in a developing country like India, people continuously harvest fishes even during

breeding season leading fish species loss. In a study it was projected that Tripura is expected to produce 63,616 tonnes fish, 6043 lakh fish seed, to 25,731 ha and availing 24,513 tonnes of ISF by the year 2015 (Biswajit Debnath *et al*. 2009) [5]. In the present scenario it is very clear that we are not having sufficient seeds, sometimes the culturist are bringing seeds from other states so that it is affecting the production cost. Due to shortage of seeds, our water bodies are always under stocked.

According to the CIFRI annual report 2016-17, for assessing the impact of fish seed stocking in reservoirs, secondary data on fish seed stocking and production were collected from state fisheries departments of Chhattisgarh, Karnataka, Kerala and Tamil Nadu. The analysis of data indicated that average productivity of selected reservoirs (34 nos.) of Chhattisgarh has increased 3.3 folds from 48 kg/ha/yr to 159 kg/ha/yr during 2010-2016 because of Bisser fish seed stocking. It means the production of reservoirs may be increased 3 times (280950) from the present production of 93650 if these are sufficiently stocked with higher size seeds.

2. Success stories

Ms. Bina Majhi, from Hajipur village, Patuakhali District, Bangladesh worked in a hatchery since 1992-96, started her business with fingerlings selling and finally started a proper hatchery business in 2013 with the help of USAID Funded and world fish led AIN Project. In the starting phase of business she faced the opposition of the society as they were against a women entrepreneur. Ms. Bina sold 586 kg spawn for 16,119 USD and 12, 00,000 fingerling for 3590 USD in 2016 which were grown in her hatchery (Bina's success story, 2016) [4].

In India among the inland states, Haryana is at second position in fish production and the productivity was 7,200 kilograms per hectare per year in 2016-17 (Jaideep Sarin, 2017) [15]. Farmer Mr. Sultan Singh from Haryana set up north India's first fish farm in 1983 with Rs. 28000 and within 10 months he earned Rs. 1, 68, 000. Now he is having well settled fish seed production unit and sells 4 days old spawn at the rate of Rs. 1200 per lakh, 11 to 12 days old @ Rs. 200 per thousand and the fingerlings which is 8-10 cm @ Rs. 1 for each during the breeding season, while during off season he charges at double rate. Mr. Sultan succeeded in breeding of hingara fish for the first time, in stagnant water body and received national and international awards for this success (Editorial team, Sultan Fish Seed Farm – entrepreneur success story, 2015) [9].

A retired primary school teacher, Mr. Paresh Chandra Sarker (2017) [25] of Bangladesh started aquaculture with two ponds and got a net benefit of 445827 BDT after a three year period (Sarker S, Basak SC, Hasan J, Hossain MS, Rahman MM, 2017) [25]. In 1961 the Pennsylvania fish and brood commission (PFBC) introduced 15000 steelhead (*Oncorhynchus mykiss*) fingerlings into lake Erie up to 1974 the stocking was sporadic, after 1979 stocking was increased the, in 1990 they developed a feral brood stock with a target of 5,00,000 steelhead Smolts (Juvenile steel head) production annually. Presently, PFBC collects about2000adults annually and produces about 2.3 million eggs of steelhead each year. They stock about 1 million steelhead per year and cooperative nursery stock another 1 lakh per year into Lake Erie and its tributaries, now it is counted as a world class steelhead fishery in Pennsylvania (Craig vargason, 2013) [6].

During 2015-16 under RKVY Project, fingerlings of Indian Major Carp of 8-10 cm size were stocked in tanks and reservoirs of Hasthavaram village, Kadappa district. It was a seasonal tank with effective water spread area of 60 hectare. Prior to seed stocking by RKVY the lease used to stock 1.2 lakh seedlings of 2.5 cm size and the production was 1.5 to 2.0 ton per annum with a 200-300 gm growth per 5-6 month. The survival rate was approx. 20%. On 03/01/2016 in the presence of fish seed stocking committee, 52,897 advance size fingerlings (8-10 cm) were stocked in Hasthavaram tank and netted on 08/06/2016, the growth was observed to be 750-1000 gm in 5-6 months and the survival rate was approx 70 %, with a recorded total production of 5.0 ton (Fisheries Success Story, Success story in implementation of RKVY scheme, 2016) [8].

Phan van Chung and his wife started a job as laborers as well as fishing and achieved a goal to have their own fish farm of sharp tooth snakehead before 20 years. Now he has been awarded with a title of prominent farmer in his home province of Vietnam and presently supplying hundreds of snakehead in the market and fish seed to the fish farmers. He has become a good entrepreneur, providing jobs to the many people (Vietnamese success story, 2013) [28].

In Greece, the supply of fish fingerlings from hatcheries in on growing marine cages was started in early 1980’s and cage farming is mostly related with salmon culture. The cage farming technology was known as salmon industry. Butthat time the European Union was importing sea food much higher than export, So EU released lot of funds and few entrepreneurial activities started there to promote the fishery. Due to these initiatives now the Greece has become a largest producer of Sea bass (*Dicentrarchus labrax*) and sea bream (*Sparus aurata*) in the world. It gained 1000 % increment in the production and the farms were increased from 12 to 320 (George Triantaphyllidis, 2013) [12].

Shri salam Shyam Kumar Singh of Uchiwa Wangma adopted a technology which was developed by KVK Thoubal in 2009 through on farm trial and demonstrated in 2010. In this technology one crop of rice in pre-kharif (February – July) and one crop of fish during kharif (July – December) is being cultivated. Shyam Kumarearns an annual income of about Rs.170000/- both from fishes and paddy, with cost benefit ratio of 1: 1.83 in his farming system (Krishi Vigyan Kendra Thoubal, 2010) [16].

3. Construction of a fish hatchery or fish seed production unit

The hatchery is a place where fishes are bred by induced breeding methods and these induced methods may be done with the help of natural hormones (Like pituitary gland extract, Human Chorionic Gonadotropin), artificial or synthesized hormones (Like ovaprim, ovatide, ovapel, ova-h). The fish hatchery has some essential components like-

1. Overhead tank
2. Brooders tank
3. Spawning tank
4. Hatching tank
5. Nursery tank
6. Rearing tank

The above hatchery components have to be made at the same place and in a particular design that has a great scientific meaning. The importance of the components and construction method is as follows

3.1 Overhead tank

The overhead tank must be constructed at the terrace of the building so as to facilitate gravitational flow of water. The height of water tank should be minimum 3 meter from the ground so that the pressure will be sufficient for the operation of other sub units in the hatchery. Different dimensions of the overhead tank may be used according to the requirement, these may be 6.0 x 3.0 x 3.0 m or 3.0 x 2.0 x 1.5 m. The source of water of overhead tank should be clean and pathogen free, it may be a open source or tube well. Proper cleaning is suggested in a particular time interval.

Fig 1: Overhead tank

3.2 Brooder tank
This is a tank where the mature fishes are kept on special diets with high protein content. Generally these tanks are circular. When brooders are completely mature they are selected for spawning.

3.3 Spawning tank
Here spawning takes place, so the selected mature brooders use to place here. It is a circular tank made by the cement and concrete or FRP. The inner diameter may vary from 4 meter to 8 m. The outlet pipe is located at center in this tank so the slope should be towards the center. A water supply line is laid along the outside of the wall and the inlet to the pond is provided at 14-16 places equally spaced and fixed at an angle of 45° to the radius of the tank using a 20 mm diameter pipe with a nozzle mouth, all arranged in one direction. These are fixed to the vertical wall and the nozzle mouth is flushed with cement plaster face, fertilized eggs along with water are transferred into incubation pond for hatching. The water flow in the spawning pool creates an artificial riverine condition for the fish to breed. The shower and a perforated galvanized iron pipe are useful to increase the dissolved oxygen and reduction of the temperature of the water. About 70 kg of males and 70 kg of females can be kept in the spanning tank which can yield 10 millions of eggs in one breeding operation.

Fig 2: Breeding tank

3.4 Hatching tanks
The hatching tanks have two circular incubation units. There are 2 chambers in each pond. The dimension of the outer chamber is 4 m having an outer masonry / concrete wall. The inner chamber is provided with 10 cm diameter vertical outlets with holes at different heights for taking out excess of water of the incubation pond. The spawn along with water flows from these ponds to spawn collection pond. 8 numbers of outlets are fitted in the floor of the incubation pond with each outlet having duck mouth opening fixed at an angle of 45° towards inner wall. All the outlets are fixed in one direction only. There is an outlet, through which the hatchlings pass into the hatchling receiving pond. This opening is also used for complete dewatering of the outer chamber of the incubation pool.

Fig 3: Hatching tank

3.5 Nursery tank
This is a rectangular masonry concrete tank of 4 x 2.5 x 1.2 m size. This is located at a lower elevation than the incubation pond, so as to drain out the water from it by gravity. Fresh water supply from the overhead tank is provided by a 7.5 cm diameter pipe line, bifurcated into 3 numbers of 3cm diameter pipelines. These pipelines are arranged to provide the spray for aeration. From each of the incubation ponds 7.5 cm diameter pipes are provided for transferring and regulating spawn intake into the spawn receiving pond. Hooks are fixed in two opposite side walls of the pond for fixing the net for the collection of spawn. Steps are also provided for getting into the pond for the collection of spawn. The overflow from this pond is discharged into an open drain and suitably utilized in the earthen ponds, if possible.

Fig 4: Nursery ponds

3.6 Rearing tank
In rearing tanks fry (1.5-2.5 cm) are transferred to grow up to a fingerling size (8-10 cm) fish. These tanks are larger than nursery tanks, and the size of these tanks may vary from 0.1 hectare to 0.5 hectare.

Fig 5: Rearing pond

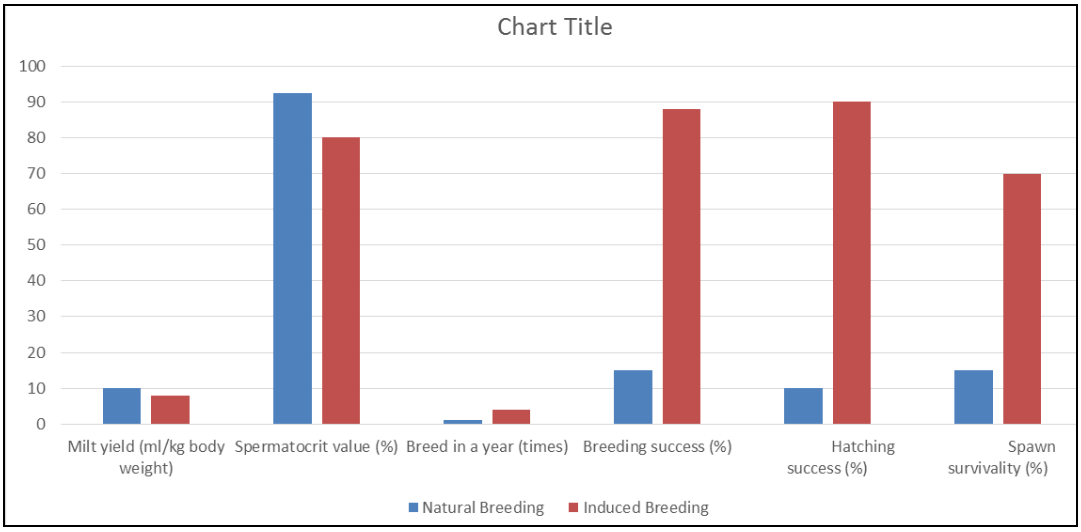
4. The Possible Outcomes

4.1 utilization of breeding potential of fishes

In the natural condition the breeding success is very poor in compare to hatchery as the amount of milt ejaculated (ml/kg body weight) is observed 1- 2 ml in natural condition while 6-10 ml in hatchery during induced breeding but the Spermatocrit value is higher in natural breeding that is 90-95% while in induced breeding it is 70-90 %. The rate of breeding success is much higher during induced breeding that is 88% followed by 90% success of hatching that is also much higher than natural breeding. The survivalist of spawn is also 50-90% in hatchery condition while it is 10-20% in natural condition (Table-1& Graph-1).

Table 1: Comparison of breeding potential of IMC in natural condition and hatchery (Source of data: Handbook of Aquaculture, 2011)

Parameters	Natural Breeding	Induced Breeding
Milt yield (ml/kg body weight)	1-2	6-10
Spermatocrit value (%)	90-95	70-90
Breed in a year (times)	1	3-4
Breeding success (%)	10-20	88
Hatching success (%)	10	90
Spawn survivality (%)	10-20	50-90



Graph 1: Graphical representation of table 1 (Source of data: Handbook of Aquaculture, 2011) [1].

5. Discussion

As the result indicated that the spermatocrit value is higher in natural or wild fish breeding and the survival rate is higher in hatchery so to utilize both potential use of naturally developed fishes may be beneficial. It is well supported by the findings of Ford MJ *et al***.** 2016 [11], which concluded that the incorporating natural fish into hatchery Broodstock is clearly beneficial for improving subsequent natural spawning success, even in a population that has a decades-long history of hatchery releases, as is the case in the Wenatchee River.

The higher breeding rate and spawning success in induced breeding presented in table no. 1 is well supported by the findings of Kuldeep Kumar *et al*. (2010) [16]. Where it was concluded that higher breeding response (80 - 100%), egg production (295.7- 374.2 g-1) and higher larvae production (186.0 - 233.8 g-1) could be obtained by the induced breeding of *Anabas testudineus*.

As the hatchery production is an innovative and productive idea, it can be considered as A Prime Minister Start up Yojana. The startup yojana is a scheme of central government in which a person can get a loan of 10 to 25 lakhs (Startup India, 2016), For initiating a freshwater carp hatchery, the department of animal husbandry dairying and fisheries (DADF) provides an assistance of Rs 8 lakh for a fish seed hatchery with 10 million (fry) capacity for the plain areas and Rs 12 lakh for same capacity in the hill States/Districts and NE Region under the Centrally Sponsored Scheme on Development of Inland Fisheries and Aquaculture. Subsidy @ 10% with a ceiling of Rs 80,000/- and Rs 1.20 lakh in the plain and hilly areas respectively to entrepreneurs only (dahd.nic.in).

There are 6, 49,481 villages in India (List of villages in India, Census, 2011) and if in every village one hatchery is started by a villager then 649, 481 persons will become entrepreneurs directly and at one hatchery at least 4 person are required to operate it so 25, 97,924 people will get job directly and more than one core families will be benefitted by adopting this business. However, this is hypothetical figures and if 10%

could be achieved, than itself will be of good use for reducing the unemployment.

According to Harjeet Singh Sehgal (1991) [14] *Anabas testudineu14s*, the fecundity range of *Labeo rohita* is 90415 to 323 209 in fish of 517 to 1474 g, respectively, while P.R. Moore, Department of Zoology, Kai Rasika Mahavidyalaya Deoni, Dist. Latur, India studied induced spawning, fecundity, fertilization rate and hatchling Rate of Indian Major Carp *Catla catla*, using synthetic Hormone and Carp Pituitary Extract and recorded that the fecundity rate for *Catla catla* with pituitary extract administration was from 69230 – 81666 eggs/Kg of body weight on average basis, While, ovaprim produced 94444 -140000 eggs/Kg of body weight.

A study was done on financial analysis of fish seed farms, in selected areas of Bangladesh and recorded that the average per annum cost of production of a fish seed hatchery was estimated at 1.5 lac TK in which the human labour costs the highest share (34%) followed by feed cost (31%) and lease cost (15%) of the total cost while the gross return from a typical fish seed hatchery was estimated 20.8- 24.3 lakh TK (1 BDT= 0.88 INR) (Islam *et al*., 2009) [19].

The proper cumulative efforts to promote the fish seed hatcheries by the government, academic institutions and societies can make a drastic change in economic condition of poor ones, as Sir Biland Khan *et al*., (2018) [27] proved it by their study on the economic analysis of per acre carp fish farm production in Khyber Pakhtunkhwa, Pakistan, concluded that, the carp fish farming is not only financially beneficial for the farmers, but it also improve the economic and socio-economic condition of the farmer.

6. Conclusion

In aquaculture production India stands second after China. China has been using their natural assets very efficiently on contrary poor management, improper policy implementation and the lack of awareness for hatchery technology can be attributed for such low productivity of reservoirs in India. India is having Area under Reservoirs -3.15 million ha, Area under Ponds & Tanks - 2.36 million ha, Area under Brackish water - 1.24 million ha, Length of Rivers & Canals - 0.19 million ha in inland region(Chapter 5, Overview of Indian Fisheries, Annual Report 2016-17, Department of Animal Husbandry, Dairying and Fisheries- ICAR). India needs to focus on enhancing the productivity of reservoirs by the proper seed stocking and cage culture practices, a production level of 50 kg /m^3. These reservoir management practices demand of seeds, which can be achieved only through promotion of hatchery technology in every village. The hatchery promotion will not only enhance the employment opportunity but also will solve a major problem of seed purchasing of the small and large farmers dependent on agents from the other state for their seed requirement. Such seeds are not only costly they also pose risk of higher mortality during long distance transportation. Thus the need for local carp seed hatcheries in villages can be found as a best alternative for meeting the higher fish seed demand, while also promoting regional socio-economic upliftment.

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