specialise in their area of operation, but if necessity demands, each can carry out all the activities. However, it was identified that both men and women should be trained to enable them to carry out the activity in the family as a team.

Following the training, based on the expressed desire of farmers, a field trip for the selected group of farmers was organised top see the shrimp farming activity in Ham Ninh commune in Quang Binh province. The farmers could see themselves on how the shrimp farming can be carried out successfully by getting themselves organised into a group. Each farmer in the group is successfully harvesting two crops of shrimp with tiger shrimp cultivation being taken up high saline season followed by the white leg shrimp in the monsoon season. Farmers could learn about the type of coordination needed in shrimp farming to prevent disease and how quality inputs can be obtained by organising in to groups.

Farmers have planned to form group in Ninh Binh province and undertake shrimp farming following the good practice of Ham Ninh commune. Farmers from Ham Ninh Commune have promised to help the farmers in Ninh Binh to establish the farmer groups and initiate the activity. All this would depend largely based on the leadership and it is hoped that, having seen the success with the follow up support, they would initiate the activity on the similar lines.

The Vietnam team has also developed a good pictorial guide on the benefits of forming farmer organisation. This manual would be useful to all countries in educating people on establishing farmer groups.

Conclusion

The project has been able to accomplish most of the anticipated outcomes owing to the active interest and support extended by the participating countries. As all the commodities identified by different countries are significantly important from the trade, the project has focused on building the capacity of people in meeting the market requirements both domestically and internationally. Access to information is key not only for the successful culture of the aquatic products, but also for profitable marketing. Since buyers require the product in bulk, if farmers become organised, they can have better bargaining power.

In the coming months, project is expected to provide support for the formation of groups and help them begin best aquaculture practices. All these experiences will be shared among all the ASEAN countries in the workshop scheduled to be held in August in Vietnam.

Carp seed production at rural front in Orissa, India

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The availability of quality seed is prerequisite for rapid expansion and growth of aquaculture. However, uncertainty in timely seed supply is one of the major constraints. Considering its significance constant efforts have been made to produce large quantity of carp seed every year in increasing trends. For instance, the total fry production in India was estimated at 632 million in 1986-87 which had increased to 18.5 billion in 2002-2003 and in 2005-06 it was over 22.6 billion. Quantified data on larger size fingerlings and/or yearlings are not available, although it is much needed for grow out culture.

Fish seed production includes egg to spawn production for 3 days, spawn to fry nursing for 15-20 days, fry to fingerling rearing for 60-90 days and fingerling to yearling rearing for 8-9 months. Thus the carp seed may be categorised at its final size into spawn (6-8 mm size), fry (20-25 mm size), fingerlings (100-150 mm size) and yearlings (100-200 g weight).

Mass production of carp eggs in a spawning pool.

The distribution system of carp seed is complex and dynamic. Though some of the entrepreneurs produce and supply the fish seed to end users often as a part of complex networks, their supply remains erratic in other part, particularly in rural sectors[1]. The gap between demand and supply of quality seeds, by and large, remains a daunting task in rural aquaculture development. This can be mitigated, if village farmers produce quality carp seed in their ponds to not only make the access of locally produced and nursed quality seed to the fish farmers but also stimulate and support neighbouring farmers to adopt fish culture within their situation. Earlier studies indicate that paucity of carp spawn compelled village farmers to stock their ponds with riverine fish seed[2] and due to lack of technical support and basic infrastructure facilities; carp breeding was rarely adopted by farmers[3]. In view of this various attempts have been made to demonstrate carp breeding[4-8], spawn to fry rearing and fry to fingerling rearing[6, 9-22] and fingerling to yearling rearing[21]

in rural area. Despite pointed extension focus in this regard, the sustainability aspect of the production of carp seed by the farmers still remains a missing link. Present communication summarises the carp spawn production and seed rearing management by the fish farmers of Orissa by citing examples of some selected cases.

What is rural carp seed production?

Rural carp seed production may be defined as “carp seed production by small-scale households or communities using mainly extensive and semi-intensive management appropriate to existing resource base for their own use and/ or improving their family income” or “carp seed production using technologies adapted to locally available and limited resources of households”. Rural carp seed production is not very capital intensive or input intensive and contributes to rural livelihoods. It is different from more commercially carp seed production systems or entrepreneurial carp seed production.

Evolving rural to entrepreneurial carp seed producers

The system of carp seed production process is a continuum and it is very difficult to strictly divide rural from entrepreneurial fish seed producers. In fact, many farmers who have been involved in subsistence level carp seed production increased their production over the years, with the more inputs and better management skill, resulting in enlarging their resource base and gradually becoming entrepreneurial. For example, a farmer who used to stock spawn in unprepared pond because of not knowing the technique of pond preparation, when came to know, followed the technique strictly and got better recovery and more income. Thus over a period of few years he could afford more inputs and intensifies his management and becomes entrepreneurial seed producer. It is more desirable to make the resource poor farmers entrepreneurial farmers in rural area. Such evolution is already taking place with the time. For instances, farmers of Sarakana village evolved as carp seed entrepreneurs from traditional carp seed producer.

Spawn production in rural area

Common spawn production

In rural areas generally carp spawn are generally produced twice during June-August and January-March of the year, following the adaptive breeding methods.

Pond breeding: Common carp brood fish are reared in composite fish culture ponds. In season, clean aquatic weeds such as *Hydrilla* / *Najaj* or water hyacinth are placed in pond’s corners or inside floating bamboo frames in the evening hours. During late night to early morning fish breed naturally and eggs are attached to aquatic weeds. Since water hyacinth is floating, the eggs get attached on the roots only. The egg loaded aquatic weeds are collected in morning hours and kept for incubation in hatching hapas or directly spread in well prepared nursery ponds. However, in nursery spread eggs the spawn survival is very poor than hapa hatching. This

Release of carp spawns in incubation pool.

method has certain disadvantages like: difficult to estimate eggs, egg predation by pond animals, poor egg fertilisation etc.

Hapa breeding: Brood fish are reared either in separate ponds or in composite fish culture ponds. Brood fish are netted out to segregate mature males and females. They are weighed and kept in breeding hapa containing suitable egg collectors in evening hours. Generally 3-4 kg *Hydrilla*/ kg female fish is used as egg collector. Males and females are kept in ratio of 1:1 by weight. They breed naturally in hapa after 6-8 hrs. In less suitable condition fishes are injected with inducing hormones to ensure breeding. After spawning, the females are weighed to estimate the egg release. About 12-15% of the weight difference goes towards faecal matter of fish and rest weight difference is due to egg release in ovary. One gram weight difference in ovary provides an estimate of 700 egg release. Egg attached 2-4 kg *Hydrilla* is spread per inner hatching hapa. Depending on water temperature, hatching takes place in 2 days and inner hatching hapas are removed in 3 days. After 4-5 days, spawn are collected for stocking in nursery ponds[23].

Hatchery breeding: Some of the village hatchery owners use breeding pools for common carp spawning. They use nylon threads or plastic threads or plastic nets or *Hydrilla* or water hyacinth as egg collectors. Egg incubation is carried out in hatching pools.

Indian and exotic major carp spawn production

Hapa breeding: In remote villages brood fish are grown in composite fish culture ponds. During monsoon season they are netted out and fully mature males and females are selected. Breeding hapas are fixed in composite fish culture ponds having common carps. Presence of common carp, prawns and crabs cause severe damage to carp eggs in breeding hapas. Hence, to avoid hazards of loss of viable eggs, the breeding hapas are fixed inside the net enclosure[5,7]. Generally for one female two males are used. Intra-muscular and/or intra-peritorial injection is administered to brood fish during June-October. Females are injected with PG extract or glycerine extract of PG twice but males are injected only once. First dose is given in the evening hours to female @ 5-6mg/kg and second dose after 4-6 hours of first injection @ 8-16 mg/kg. Males are injected at the time of second dose of female @ 4-5mg/kg male. Presently synthetic hormones (ovaprim or ovatide) are used as inducing agents in rural areas[7]. Both the males and females are injected only once.

These synthetic hormones are administered @ 0.2-0.5 ml/kg female and 0.1-0.2 ml/kg male. After 4-6 hours of injection fish spawn. Fertilised eggs are identified and quantified at comma stage of embryos and hatching are done using hapa hatching device. Spawn are collected after 72-80 hours of hatching by filtering with inner hatching hapa with the spawn recovery of only 24-44% of the fertilised eggs[7,8]. The low recovery of spawn from hapa hatching device could be due to a combination of factors such as cutting of hapas by crabs and/or large freshwater prawns, entry of unwanted fishes in hatching hapas[8], presence of predatory cyclopoid copepods in hatching hapas[4,24] and sudden change in water temperature, depletion of DO content, water bloom and cyclonic weather[7,8,25].

Hatchery breeding: For hatchery breeding, brood stocks are maintained in separate ponds by stoking 1-3t/ha brood fish under scientific management. Brood fishes are injected with inducing hormones as mentioned in hapa breeding. In rural area the spawning is done in breeding hapa and/or spawning pool but hatching is done in incubation pools. Two-three year old carps weighing 2-5 kg are the best for hypophysation. "Eco-hatchery" is used by the village entrepreneurs. It includes overhead tank, spawning pools, egg collection chamber, incubation pools and spawn collection chamber. An overhead tank is generally made on the roof of single or double storied building and a water holding capacity of 5000 litre can supply water to spawning and incubation pools. Depending upon the requirements, the sizes of spawning pools vary. Spawning pool is 8-9 m diameter and 1.0-1.5 m deep with the provision of water circulatory system and shower. Farmers use 20-30 kg female per spawning pool and produce 250-400 litres of carp eggs in one operation. These eggs are incubated in 3-5 hatching pools. Incubation pools are 3-4m inside diameter and 1 m deep. Generally 1 egg is incubated in one ml water. During egg incubation, farmers maintain water flow @ 2.5 l/sec. initially, @ 2.0 l / sec at twisting movements of embryos and @ 3.5 l/sec after hatching to get better spawn recovery. Farmers harvest 800,000 to 1,000,000 spawn/pool/operation. KVK/TTC, CIFA designed and fabricated portable FRP carp hatchery in 1989 with the maximum spawn recovery of 3,000,000 lakh / operation/pool[26], now modified and commercialised by CIFA and it is used by the village entrepreneurs to produce carp spawn. From hatchery breeding farmers get 80-95% recovery from the viable eggs. By adopting circular carp hatchery some of the rural fish farmers changed into entrepreneurial seed producers.

Success cases of carp spawn production

Carp spawn production at Sarakana: Farmers from the Sarakana village started carp spawn production in 1987 with common carp and produced 3.5 lakh spawn in hapa - breeding. Gradually they learnt the induced breeding techniques of Indian major carps and exotic carps in hapa17. Carp spawn production increased to 1,440,000-8,555,000 up to 1995. The spawn recovery was poor and ranged between 24-44%[8]. To mitigate the problems of poor recovery of spawn in hapa, they have been motivated by KVK/TTC, CIFA to construct a cemented circular hatchery in 1995 which resulted higher spawn recovery of 74-85% from 1996 onwards. This resulted in producing 15,750,000-31,950,000 spawn of *Catla catla*, *Labeo rohita*, *Cirrhinus mrigala*, *Cyprinus carpio*, *Ctenopharyngodon idella* and *Hypophthalmychthys molitrix* annually[8]. To meet the market demand of carp spawn in

Carp fry production in rural area.

the region, they ploughed back their hard earned money to construct another carp hatchery with higher production efficiency. As a result of which they are able to produce 100-150 million carp spawn annually. This suggests that traditional seed production in rural area transformed into entrepreneurial seed production by utilising the improved technology. They produce carp seed not only to meet the market demands but also earn handsome income and employment.

Carp spawn production at Kantapada: Farmers from Kantapada village initiated carp spawn production in 1996 using hapa breeding device. With spawn recovery of 25-40% of viable eggs, they produced 40, 50, 67and 42 lakh spawn during 1996, 1997, 1998 and 199925. After realising the poor spawn recovery, farmers constructed one circular carp hatchery and now they are producing 40-60 million carp spawn annually.

Carp spawn production at Bhatapadgarh: Carp breeding was started with hapa breeding with the technical guidance of CIFA, Kausalyagang in stored rain water in ponds constructed at hilly terrains during 2002[27]. Farmers have been trained through participatory approach in carp breeding skills. During skill learning farmers could produce 1,100,000 carp spawn with 20-40% recovery in hapa breeding. Meanwhile, they constructed one commercial carp hatchery during 2003 and made it operational through the technical guidance of the author in 2004. Now farmers are producing 50-110 million spawn of *C. catla*, *L. rohita*, *C. mrigala*, *C. carpio*, *L. calbasu*, *C. idella* and *H. molitrix* every year at the hilly terrains to meet the regional demand.

By seeing the economic profitability in carp spawn production, many of the neighbouring farmers and entrepreneurs have constructed carp hatchery to produce carp spawn to meet the local carp seed demand.

Carp fry and fingerling rearing in rural areas

In rural area, spawn to fry nursing is carried out in smaller ponds of 0.02-0.05 ha (0.5-1.0m depth). In same perennial ponds fry, fingerling and/or yearlings are reared in succession during June-July, August-November and December-June respectively. Alternatively the ponds are stocked with carp

fry and rearing of fingerlings and yearlings are continued in succession. For rearing larger size carp fingerlings 0.05-0.1 ha with an average depth of 1.0-2.0m are preferred. Ponds shaded by trees are rendered unproductive by reduced sunlight. Accumulation of leaf litter and an excessive organic load in the pond further deteriorates water quality, adversely affecting carp and carp food organisms[28]. At times, masses of foamy brown/white frog eggs, which tend to fall into ponds during rains, caused a proliferation of tadpoles[8]. Therefore, marginal trees and bushes are cleared before launching the seed raising programme. Pond embankments are renovated with the provision of secured inlet and outlet. Since backyard ponds are shallow and small, aquatic weed clearance is completed manually by rural farmers. Predatory animals/ fishes and weed fishes are eradicated by de-watering and drying the ponds or application of suitable piscicides. Raw cattle dung is applied as basal manure in ponds. To enhance the fertilisation effect liming is done. For sustained production of natural fish food organisms a mixture of de-oiled cake, cattle dung/ bio-gas slurry and single super phosphate or a multiplex pre mineral mixture and vitamins are used in liquid forms before 4-5 days of spawn stocking[29].

Fry are harvested and/or thinned in phases according to the local demand, allowing an extended period of rearing (14-44 days) in rural area. Prolonged retention of fry in nursery ponds adversely affects the fry survival. Fry recovery is 20-40%[3, 8,10,12,19]. Stocking spawn at shallow water depth (35-45 cm) followed by phased increase of water level at 3 - 4 days intervals, results higher fry recovery of 50-70 %[8,29]. Fortification of micro-nutrients in artificial feeds is also enhances the growth and survival of fry[16]. A commercially available multiplex pre-minerals mixture with vitamins accelerates plankton production and fry survival in nursery ponds[8]. In case ponds are used for fry rearing, fry are harvested by repeated netting on day 15-20 of stocking. At times, two crops of fry are taken. After fry harvesting, the ponds are fertilised with the mixture of above manure to produce adequate natural fish-food organisms. On day 2 or 3 of fertilisation, the fresh fry are stocked along with residual fry in such a way to maintain the density of 300,000-500,000/ ha. Later a mixture of above fertilisers is applied in liquid form at weekly or fortnightly intervals. Fingerlings are also fed traditionally and harvested by repeated netting after three months of rearing.

Success cases of fry and fingerling production

Fry and fingerling production at Sarakana village: Farmers from the Sarakana village started carp fry raising in one pond of 0.08ha and produced only 220,000 fry and 40,000 fingerlings[17]. High profitability in fry and fingerling rearing work encouraged the farmers to invest money for creating more facilities by constructing two other ponds in 1988 and produced 384,000 fry and over 100,000 fingerlings[8]. Since then every year the farmers expanded their activities by excavating new ponds and at preset 23 ponds of 0.02-0.1ha each are available for fry and fingerling production. Now they are producing 4,300,000-6,000,000 lakh fry and 440,000-570,000 fingerlings every year.

Fry and fingerling production at Kantapada village: In this village fish seed nursing was initiated in 1983 by using 12 nursery ponds. Ponds were prepared and stocked @ 30-50 lakh spawn/ha. The fry were harvested after 30-45 days with the recovery of 15-30%. With the time farmers acquired scientific management practices and expanded rearing area to 20 ponds (2.0 ha) gradually[25]. Farmers are harvesting carp fry within 12-20 days with the recovery of 35-60%. Multi cropping of fry production is also done. They are able to harvest 3,000,000-7,600,000 fry annually. The same ponds are used for fingerling rearing with the production of over 300,000-600,000 fingerlings every year.

Fry and fingerling production at Bhatapadagarh village: Terrace type a series of 17 nursery and rearing ponds (0.05-0.17ha) are constructed with a network of inlets and outlets systems during 2003 to store huge quantity of water flowing in from the hilly terrains[27].These ponds were prepared by manuring, liming and insect control and stocked with carp spawn @ 3,000,000-6,000,000/ha. Ponds were harvested after 20-30 days of rearing with the recovery of 20-60% yielding about 5,900,000 fry from July to September in 1 or 2 crops. After developing confidence in economic profitability, the farmers also started using even large size ponds of 0.5-0.7ha for stocking carp spawn at shallower depth followed by phased increase of water level[29] for commercial fry and fingerling production. They are producing 6,000,000-15,000,000 fry and 100,000-800,000 fingerlings of catla, rohu, mrigal, calbasu, common carp, silver carp, and grass carp every year for supply in the region.

Large sized fingerling and yearling production

Yearlings are produced traditionally in village ponds. When farmers fail to sale their fingerlings and they continue to rear them up to May-June. Before monsoon, when ponds are prepared for next fry rearing crops, farmers harvest stunted fish for consumption as they are grown with reduced nutrient uptake. But now a days with the increased awareness of yearlings significance as stocking materials, it is being sold at pond site for grow out fish culture. When stunted fingerlings are kept on a high quality diet they grow rapidly leading efficient body weight[21]. Some of the village fish farmers produce yearlings and/or stunted fingerlings with improved management on commercial scale. In this, the fingerlings stocked in well prepared ponds at high density July-August. Yearlings are also reared by stocking appropriate carp fingerlings along with residual stock of fingerlings. During culture period ponds are fertilised monthly once. Fingerlings are fed with the mixture of ground nut oil cake and rice bran in the ratio of 1:1 by weight @ 4-6% of the body weight. Complete harvesting of yearlings is done by repeated netting from May-June. Adopting this management the farmers of Kantapada and Bhatpadagarh are producing 3-5 tonnes of yearlings every year.

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