The Fish Seed

Dr Shivakumar
MAGADA

"**The Fish Seed**" written by Dr Shivakumar Magada, Director General, Sea=MC^2 and published by Arabian Sea Fisheries Management Coordination Committee (Sea=MC^2), India in the year 2025 on the occasion of "National Fish Farmers' Day-2025"

Cover Page: Designed by Dr Magada.

Copies: 500

Price: Rs. 300

Published by:
Secretary General
SeaMC2, College of Fisheries
Mangalore 575 002, India
http://seamc2.com

Preface...

Fish seed production stands as the cornerstone of sustainable aquaculture. Without quality seed, all downstream efforts—whether in nursery, grow-out, or marketing—are bound to face challenges. This manual on **Fish Seed** is born out of the realization that there exists a wide knowledge gap between scientific practices and field-level operations. While India has made significant strides in fish production, inconsistencies in seed quality, survivability, and hatchery practices continue to impede progress.

This manual is designed as a **self-learning resource** for students, progressive farmers, hatchery operators, and young entrepreneurs venturing into the aquaculture sector. It brings together essential theoretical knowledge, best management practices in the field, troubleshooting tips, and simplified technical guidelines. Emphasis is given to practical insights gathered from various hatcheries across India, especially from ground-level experiences in carp, catfish, and other freshwater seed production units.

I hope this manual serves not just as a guidebook, but also as a motivator—to foster scientific thinking, to encourage better management decisions, and to raise the overall standard of fish seed production in the country.

Constructive feedback and suggestions from readers, practitioners, and academicians are most welcome for improving future editions.

Dr Shivakumar MAGADA
Professor of Aquatic Biology
shivakumarmagada@gmail.com
+91-99457 83906/http://seamc2.com

Fish Seed Production

India is endowed with remarkable aquatic biodiversity, accounting for nearly **9–10% of the global fish diversity**. With approximately **3,250 species of fish** found across its vast and varied aquatic ecosystems — ranging from rivers, lakes, and reservoirs to estuaries, backwaters, and coastal waters — India is one of the richest countries in terms of ichthyofaunal wealth.

Out of this immense diversity, **only 20 to 30 fish species are currently being cultured on a commercial scale**, including carps, catfishes, murrels, tilapia, and a few high-value marine finfish like seabass and pompano. In addition to aquaculture, around **200 or more edible fish species** are regularly harvested from the wild, contributing significantly to the country's capture fisheries and the livelihoods of millions.

India is also a significant player in the **ornamental fish trade**, with **200 to 300 varieties** of colorful and exotic freshwater and marine ornamental fishes being collected, bred, and traded domestically and internationally. This segment offers promising opportunities for income generation, particularly for small-scale farmers, hobbyists, and entrepreneurs. Altogether, India's fish biodiversity not only supports nutritional security and economic development but also offers immense scope for research, conservation, and expansion of sustainable aquaculture practices.

Monsoon and Fish Breeding: A Natural Synchrony

Most of the fish species naturally breed during the monsoon season. This timing is not coincidental but a result of long-term ecological adaptation and environmental synchronization. The monsoon rains bring about a cascade of favorable changes in the aquatic ecosystem—such as increased water levels, reduced salinity in some regions, and the inflow of nutrient-rich runoff from surrounding lands. This runoff acts as a natural fertilizer, boosting the productivity of plankton, which forms the primary food source for fish larvae and juvenile fish.

The spawning behavior of fishes is closely linked with key environmental cues like **water pH, temperature, turbidity, dissolved oxygen levels, and even the tactile sensation of flowing water and raindrops.** Many species possess highly sensitive chemoreceptors and thermoreceptors that enable them to detect these subtle changes in their surroundings, prompting them to migrate, spawn, or prepare for reproduction.

In controlled or captive conditions such as hatcheries, these natural stimuli can be **mimicked or simulated** to trigger breeding. While certain environmental factors such as temperature and water quality can be manipulated artificially, most cultured fish species require **induced breeding techniques** for successful spawning. This involves administering **synthetic hormones**, such as Ovaprim, Ovatide, or HCG (Human Chorionic Gonadotropin), to mature broodstock to stimulate gonadal maturation, ovulation, and sperm release. This practice, known as hypophysation, allows aquaculturists to breed fishes **outside their natural season** or **on demand**, ensuring continuous seed supply for farming.

By understanding and simulating nature's signals, fish seed production has evolved into a reliable and scalable enterprise, bridging the gap between ecological rhythm and commercial necessity.

Fig 1. A. Male fish with project papila (Milt oozing) **B.** Female fish

In the process of induced breeding, careful selection of brooders (mature male and female fish) is critical for successful seed production. Brooders are chosen based on their age, body size, and prominent **secondary sexual characteristics—**such as roughness on the pectoral fins of males and softness and roundness of the belly in females. Once the right brooders are identified, they are **induced with synthetic hormones** at prescribed dosages to stimulate ovulation and spermiation.

After hormone administration, the selected males and females are **released into spawning hapas**—fine mesh enclosures placed in breeding ponds or tanks. The ratio of males to females varies by species. In carps (such as Rohu, Catla, and Mrigal), the typical ratio is **1 female to 4 males**. However, in species like **Channa (snakeheads)**, a **1:1 male to female** ratio is maintained due to their different reproductive behavior.

For fish species like **Common carp** and **Koi carp**, which release **adhesive eggs**, special **egg-laying substrates** are provided inside the hapas. These substrates may include **hydrilla plants, casuarina branches**, or **bundles of fibrous synthetic yarns** that mimic natural spawning beds. The eggs released by the females get attached to these materials.

Spawning typically occurs within **18–24 hours** after hormone administration, depending on species and environmental conditions. Once spawning is complete, the brooders are gently removed and transferred back to holding tanks.

The eggs, especially those of carps, are then transferred to a **Chinese hatchery system**, which consists of **two concentric circular tanks—**an inner chamber where eggs are placed and an outer chamber for water flow. Water is made to circulate gently using a **water jet or inlet pipe**, ensuring that the eggs remain **in suspension and are well oxygenated.** This mimics riverine conditions and prevents fungal infection or suffocation due to settling. Depending on the water **temperature**, the **incubation period** lasts around **18–26 hours**, after which the eggs hatch into free-swimming larvae ready for nursery rearing.


Chinese Hatchery

In species such as **Pangasius and other catfishes**, fertilization is typically carried out through **stripping and artificial insemination.** Mature males and females are selected, and when gently pressed along the abdomen, **females release eggs** and **males release milt**. However, in the case of male catfishes, **milt is not expelled naturally through the genital opening** due to the **internal positioning of the testes**. As a result, the males are **sacrificed**, and the **testes are carefully removed.** The extracted testes are then **macerated (crushed)** in a clean basin to release the milt, which is then **mixed with the collected eggs** to achieve **external fertilization**.

The fertilised eggs of tilapia, catfish and other fish species are incubated in glass jar hatcheries. For tilapia there are different incubators are there while for trouts and mahseers, there are unique trouhgs are used. Tilapias do not spawn the eggs to the media, they keep the eggs in their mouth and they are collected manually and transferred to glass jar hatcheries.

Egg collection in Tilapia

Glass Jar Hatchery

Mahseer/Trout hatching troughs

Hatching Troughs

Trout eggs

After hatching, the fish larvae are carefully transferred to nursery tanks, where they are initially fed with **microencapsulated diets**, **nutritious plankton**, and **egg custard** to support their early development. Once they reach a more resilient stage, they are moved to **pre-manured earthen or cement nursery ponds**, where they are reared until they grow to a size of about **5–6 cm**, at which point they are sold to fish farmers as fingerlings.

Traditionally, **rice bran and oil cake** are used for feeding; however, these are not easily digestible due to their **high cellulose content**, which larvae cannot process in the early days. To improve **survival and growth rates**, farmers are advised to use **pre-digested mash feeds** or **fermented groundnut cake paste** enriched with **probiotics** and **digestive enhancers**. During the first **8–12 days post-hatch**, the digestive system of larvae is still developing and cannot efficiently break down complex carbohydrates. Hence, **easily digestible, nutrient-rich, semi-digested feeds** are essential for ensuring better larval health and reducing mortality.

Mash Feed

Dried Artemia

Microencapsulated mash feed

Fish Seed Requirement of India

Dr Shivakumar Magada
Professor of Aquatic Biology, College of Fisheries
Mangalore, India/shivakumarmagada@gmail.com

Mr Vishwanath, T S.
Deputy Director of Fisheries, Department of Fisheries
Government of Karnataka

India, the seventh-largest country in the world, covers a vast area of 3.28 million square kilometers and is endowed with extensive aquatic resources, including rivers, lakes, reservoirs, and coastal regions. While fishing has been a traditional method of securing food for centuries, the practice of collecting fish spawn and hatchlings from natural waterbodies and raising them in captivity (such as in fish farms) is relatively new. This method involves gathering young fish seeds from rivers and other waterbodies and transporting them to fish farms for further growth. However, the sector faced several challenges. One significant issue is the poor quality of the fish seeds collected from natural sources. Environmental degradation, particularly in river ecosystems, has contributed to a decline in both the quality and quantity of fish spawn. Additionally, transporting fish seeds from collection areas to fish farms incurs high costs due to the need for specialized handling and equipment to ensure the viability of the young fish during transit. Furthermore, the period during which fish spawn can be collected is limited, often dependent on specific seasons and weather conditions, making it unpredictable and unreliable. Climate fluctuations exacerbate this, causing further inconsistencies in the annual yield of fish seeds.

Fish seed transportation on bicycles during 1960s and 2024 at Kolkata, India

The deterioration of river environments, caused by pollution, habitat destruction, and changes in water flow, has worsened the situation. As rivers become more polluted and degraded, the natural breeding grounds for fish are compromised, leading to a rapid decline in both the quantity of fish spawn collected and the quality of the product. This poses a major challenge for the sustainable development of aquaculture in India, as the availability of healthy fish seeds is essential for the growth of the industry.

Table 1. Aquatic Resources of India

Exclusive Economic Zone	2.02 m km^2
Continental Shelf	0.52 m km^2
Reservoirs	3.15 mh
Ponds and Lakes	2.35 mh
Oxbow lakes	1.3 mh
Rivers	1.97 lakh km
Coastline	11098 km
Brackishwater	1.2 mh
Estuaries	0.29 mh

In the year 1957, Indian scientists Dr Hiralal Chaudhury and Dr K H Alikunhi have successfully achieved artificial breeding of Asiatic carps (including major Indian and Chinese carps) by application of the hypophysation technique. This achievement has significantly contributed to the methodology of fish seed production, particularly of warm-water fishes. After the advent of synthetic Gonadotrophin-releasing hormone (GNRH) hormones, the carp fish seed production has been increased significantly.

Over the past 65 years, India has witnessed a remarkable 15-fold increase in fish production, reflecting the growing importance of the fisheries and aquaculture sectors in the country's economy. Currently, India produces an impressive 18.4 million tons (mt) of fish annually, with 14.8 mt coming from freshwater resources and 3.6 mt from the marine sector. This substantial growth in freshwater fish production is largely attributed to the widespread adoption of carp culture, which has become the dominant form of aquaculture in India. Carps, including species such as rohu, catla, and mrigal, are well-suited to Indian freshwater environments, and their cultivation has been expanding steadily.

Several factors have contributed to this steady rise in freshwater fish production. One of the key drivers has been the expansion of aquaculture areas, particularly earthen ponds, where farmers practice semi-intensive fish farming. This expansion has been facilitated by concerted efforts from both central and state governments to support the fisheries sector. Government policies, including financial incentives, subsidies, and technical guidance, have played a crucial role in promoting sustainable aquaculture practices. Additionally, the establishment of research and development centres, as well as training programs for fish farmers, has enhanced the capacity of farmers to adopt modern technologies and improve yields.

The freshwater sector has also benefitted from innovations in breeding, seed production, and feed management, leading to higher survival rates and faster growth of farmed fish. Furthermore, initiatives aimed at improving water quality and disease management in aquaculture systems have contributed to the increase in production. The combination of these efforts has not only improved the availability of fish for domestic consumption but has also boosted India's fish exports, positioning the country as one of the leading fish producers globally.

This growth in fish production has had significant socioeconomic benefits, providing livelihoods to millions of people, particularly in rural areas, and ensuring a more stable supply of affordable protein for India's growing population. However, challenges remain, including environmental sustainability, the need for continued investment in infrastructure, and the protection of marine ecosystems from overfishing and pollution. Nonetheless, the steady rise in freshwater fish production reflects India's ongoing commitment to developing its fisheries sector while addressing these challenges.

There is currently no precise data available on the fish seed requirements of the country. Different departments provide varying data, leading to ambiguities. This paper aims to establish a unified understanding and calculation of the country's fish seed needs. Aquatic resource data from the Department of Animal Husbandry and Fisheries, Government of India, has been utilized to calculate fish seed requirements based on recommended stocking densities.

From now on, stakeholders can use this report as a foundation for systematic planning and reporting. This will help streamline processes and ensure better organization. Ultimately, it will contribute to improving science-based, evidence-driven management systems.

Table 2. Fish seed requirement of India

#	Aquatic Resource Type	Area	Proposed stocking density/ha	Total fish seed Requirement (Crores)
1.	Reservoirs	3.15 mh	200	63
2.	Tanks and ponds	2.35 mh	2000	470
3.	Traditional Aquaculture ponds	50000 ha	10000	50
4.	Semi-intensive ponds (Brackishwater ponds)	153000 ha	6 lakh	5400 Vannamei and monodon (54 billion)
5.	Rivers	1.97 lakh km	1000/km	19.7
6.	Oxbow lakes and derelict waterbodies	1.3 mh	500	65
7.	Brackish water	1.2 mh	-	-
	Total requirement			**667.77 fish seed (6.67 billion) 5400 cr. shrimp seed (54 billion)**

Over time, the number, area, and characteristics of aquatic resources have changed. For more accurate micro-level planning, it is recommended to assess the effective water spread area (EWA) and determine the seed requirement.

To produce 6.67 billion fingerlings, it is necessary to stock 23.92 billion spawns, considering a survival rate of 27.88% (rounded to 28%) from spawn to fingerling stage. However, a common practice is to stock waterbodies with fry due to their lower cost, which unfortunately results in a high mortality rate, with a significant portion of the fry dying within the first 15 days. This practice leads to suboptimal outcomes for fish production. In fact, stocking fewer but healthier and larger fingerlings is a more effective management strategy to enhance fish production in natural waterbodies. By stocking at an optimal density, fish populations have a higher survival rate and can grow more efficiently, ultimately leading to better yields.

The above size classification applies for only carps and pangasius and doesn't applicable for tilapia, catfishes, shrimp, crab and other indigenous species. In many South-East Asian countries, farmers typically stock either stunted fish or yearlings and harvest them within 4 to 6 months. This method is also common in India, particularly in the North Eastern states and West Bengal. By using this approach, the cultivation period can be shortened by 4 to 6 months.

There is a pressing need to develop a comprehensive assessment of the current status of waterbodies across each state and their specific fish seed requirements. This data should be updated every five years to account for changes in the aquatic environment and ensure accurate planning for fish seed stocking. For reference, the fish seed requirement for the state of Karnataka is provided below, illustrating the process of determining the average stocking densities and expected production per hectare.

Table 3. Fish seed requirement and Production status of Karnataka state

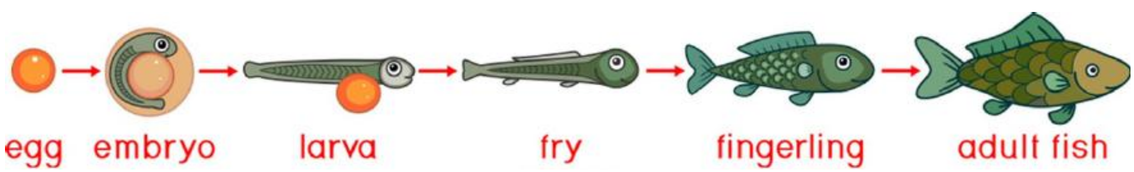
#	Aquatic Resource Type	Numb-er	Area (lakh ha) /Length (km)	Proposed stocking density/ha	Total fish seed requirement in crores	Average Fish production Kg/ha/yr	Total production/ Anum (Ton)
1.	Department Tanks (>40 ha. Achcut)	3946	1.78	2000	35.60	940	167320
2.	Gram Panchayat Tanks (<40 ha. Achcut)	24319	1.25	2500	31.25	1200	96875
3.	Reservoirs Medium + Large (49)	49	2.65	500	13.25	250	54600
4.	Reservoir (Small)	34	0.076	1000	0.76	380	2888
5.	Aquaculture ponds	-	9910	12000	11.89	6500	64415
6.	Rivers (Length)	17	5813	2000/km	00.58	250 kg/km	1453
7.	Non-conventional waterbodies[1]	50000	500	3000	00.15	1000	500
8.	Cages	1500	150000 m^3	50/m^3	00.75	10-20 kg/m^3	2250
9.	Biofloc and RAS	400	-	10-50/m^3	-	10000/unit	4000
	Fish Seed Requirement				**82.34**		**394301**
10.	Shrimp farming (Brackishwater)	-	450	6 lakh Larvae/ha	27.0	6 t/ha X 2 crops	5400
11.	Shrimp farming (Inland)	-	500	6 lakh Post Larvae/ha	30.0	4 t/ha X 2 crops	4000
	Shrimp Seed Requirement				**57.0**		**9400**
	Total Production						**403701**

In many instances, most of the waterbodies will not receive the water to their potential. In this context, in order to utilize the resources by 50%, the state requires **47.44 crores of fish fingerlings (5-8 cm).** To produce the same, by taking 30% survival from the

[1] Krishi Honda, Nala Bunds, Farm Ponds and other non-conventional waterbodies

spawn to fingerlings, we need **158.11** crore spawn. By leaving cages and 10% of fish farms, predominantly farmers stock only carps. So, we require about **42.69 crores of carp seeds**. In the classic ratio of 2.5:3:3:1:0.5 (Catla: Rohu:CC: Silver Carp: Grass Carp), the state requires **10.67 crore of Catla, 12.8 of Rohu, 12.8 crores of CC, 4.26 crore Grass Carp, 2 crores Silver Carp. Pangasius about 60 lakhs and tilapia is 40 lakhs.** The recommended shrimp stocking density of shrimp *L. vannamei* is 60/m^2, but farmers are stocking up to 200-500/m^2. Based on the shrimp farm area, seed requirement can be estimated. The misconception that stocking a higher number of smaller, cheaper seeds is beneficial is one of the major issues in the seed industry. While this approach results in producing more seeds, it does not translate into increased production, as many of the smaller seeds die in large numbers before, they can properly acclimatize.

Table 4. Classification of fish seed	
Stage	**Size in cm**
Spawn	0.6-1.5
Fry	1.5 -3.0
Advanced fry	3.0-5.0
Fingerlings	5.0-8.0
Advanced fingerlings	8.0-12.0
Stunted fingerlings	15-20 g
Yearlings	100-200 g



The above size classification applies for only carps and pangasius and doesn't applicable for tilapia, catfishes, shrimp, crab and other indigenous species. In many South-East Asian countries, farmers typically stock either stunted fish or yearlings and harvest them within 4 to 6 months. This method is also common in India, particularly in the North Eastern states and West Bengal. By using this approach, the cultivation period can be shortened by 4 to 6 months.

Cost of production of fish seed

The cost of producing fish seeds has risen significantly over the past few decades, with production expenses increasing many times over. However, the price of fish seeds has not been revised in nearly 65 years, which has put financial pressure on the fish seed production industry. For instance, in the year 1980, the cost of rice bran, a commonly used feed, was only ₹1.60 per kilogram, and groundnut cake, another essential feed ingredient, cost ₹3.60 per kilogram. At that time, the price of fish seeds ranged from ₹230 to ₹280 per 1,000 seeds, which was reasonable given the lower production costs of that period.

Despite the drastic increase in feed and other production costs, the price of fish seeds remained stagnant for decades. This has resulted in reduced profitability for fish seed producers and impacted the sustainability of seed production. Recognizing the need for change, after 65 years, the State Fisheries Department of the Government of Karnataka finally revised the fish seed prices. However, the price increase has been minimal, and it still remains lower than what is necessary to cover the current production costs.

The low prices have unintended consequences for fish farmers. Since the cost of fish seeds is relatively low, many farmers tend to overstock their ponds and other waterbodies, believing it will lead to higher yields. However, this practice often leads to negative results. Apart from huge mortality rates during initial days, overstocking creates competition for food and space, which can result in stunted growth, lower fish survival rates, and poor overall harvest quality. To improve both the economic viability of fish seed production and the productivity of fish farming, it is essential to revise seed prices in a way that reflects the true cost of production while encouraging sustainable stocking practices. This would not only increase revenue for the Department of Fisheries but also promote more responsible aquaculture practices.

The fisheries and aquaculture sector in the country is poised to play a major role in the lives of people in the coming decades, with increasing population pressure on land and alternate food production system being increasingly projected from the aquatic resources. The research and development activities as indicated above in the frontier areas of fisheries sector are urgently required on priority basis to meet the new challenges in fisheries sector and to make the whole system sustainable and eco-friendly (Ayyappan et al., 2006). Because of the changing trends in food habits of younger generations and the increased purchasing power of middle-class population, in India, the fish-eating population is increased significantly. One need not focus only on export market; there lies huge demand in the domestic market.

Government of India has understood the importance of this sector and spent Rs. 20500 crores during the last five years in the name of "Pradhan Mantri Mathsya Sampada Yojana (PMMSY)" to increase the fish production from 17.54 mt to 22.0 mt and to boost the fish fisheries products export earnings from 0.62 lakh crore to 1.0 lakh crores. Along with these schemes and initiatives, research and academic institutes must support the mission by taking up issue based and need based research programs. Such research and development support through various organizations will not only boost fish production and productivity but also ensure nutritional and food security, employment opportunities and socio-economic upliftment of the poorest of the poor.

Acknowledgement

We wish to acknowledge the support of Dr K C Veeranna, Hon'ble Vice Chancellor, KVAFSU, Bidar, Dr B V Shivaprakash, Director of Research, KVAFSU, Bidar, Sri Dinesh Kumar Kaller, Director of Fisheries, Dr H N Anjaneyappa, Dean (Fisheries), Mr Gireesh O, Joint Director of Fisheries, Department of Fisheries, GoK, Mr Kumaraswamy, DDF, and Mr Ramesh, M R, Aquaculture Consultant for their support in the data upgradation process for the fisheries and aquaculture development in the state and the country.

References:

Ayyappan, S. and A.D. Diwan, 2006. Fisheries Research and Development in India. Fishing Chimes, April 2006. PP. 19-21

FAO Report. 1977. Fish Seed Production and Distribution in India- Report of a Mission to Plan the Expansion of Fish Seed Production. 14 Nov- 6 Dec 1977. http://www.fao.org/3/L8791E/L8791E02.htm

Techniques for Enhancing Fish Seed Survival in Hatchery Systems

Karnataka accounts for approximately 9.3% of India's inland water resources. The estimated potential for inland fish production in the state is about 4.0 lakh tons, assuming optimal utilization of all available water bodies. To achieve this, the annual requirement of fish seed is around 85 crore fingerlings. However, the current production stands at only 55 crore fingerlings per year. There is considerable scope to enhance seed production within the existing system by improving operational efficiency and adopting better management practices.

Having visited several operational carp hatcheries across India, it is evident that many of them follow similar procedures and, consequently, make the same recurring mistakes. The nine most common issues are outlined below. These can be addressed through technical interventions, which would significantly improve seed survival rates while saving both time and effort.

Issue 1: Water quality

Fact: In a hatchery located in Karnataka, water is sourced from the nearby Bhadra Reservoir, whose catchment area is known for iron ore deposits. The water, drawn from the reservoir's bottom layer, travels less than 600 meters before being used in hatchery operations. This anaerobic water, high in iron content and suspended solids, is directly utilized for seed production. As the entire seed production process occurs during the monsoon season, the risk of pathogen contamination is significantly elevated. Similarly, in other regions across the country, water is often sourced from nearby rivers, which tend to carry heavy silt and organic matter loads.

Solution: The negative impact of suspended solids and heavy metals on spawning and hatching efficiency is well established. To address this, water should first be passed through slow sand filters to eliminate suspended particles, followed by rapid sand filtration. To remove heavy metals—particularly iron—treatment with 10 ppm EDTA is recommended. For pathogen reduction, the water should be disinfected using chlorine at a concentration of 10–12 ppm. To control fungal infections, a 0.025 ppm Treflan treatment can be applied. Subsequently, the water should pass through a series of cartridge filters (ranging from 5 to 1 micron) and finally through a UV sterilization system. Implementing such prophylactic water treatment measures can potentially resolve up to 90% of hatchery-related issues.

Issue 2: Hatching efficiency and spawn survival

Fact: Earlier circular tanks know as Chinese Hatchery are used. In some hatcheries, the inner walls are fixed with tiles. Still the surface rough and harbor algal film loaded with pathogen.

Solution: Inner walls can be rubbed with carborandom stone and coat the walls with epoxy paints. Smooth surface reduces the film thereby reducing the disease incidence

Issue 3: Spawn dying at the age of 70-80 h (Third day)

Fact: The broodstock currently used for seed production are quite aged, with their lineage tracing back to individuals introduced in the 1960s. Until recently, specialized broodstock feed was provided, but pedigree records have not been maintained. As a result, signs of inbreeding depression are evident. The yolk reserves may not be adequate to support the larvae for a full five days. However, based on conventional thumb rules, feeding in the hatchery typically begins only on the fifth day.

Solution: Implement rigorous culling practices and replace the existing broodstock with healthy, genetically diverse individuals, ensuring optimal population size is maintained. Provide broodstock with a specialized diet enriched with omega-3 fatty acids to enhance reproductive performance. Keep detailed records of broodstock lineage to ensure proper pedigree management

Issue 4: Low survival in rearing ponds

Fact: Fry are typically reared in pre-manured ponds, where zooplankton can sometimes grow larger than the fry themselves. The presence of aquatic insects like *Notonecta* species is also a common issue. Traditional feeds such as rice bran and oil cake are still being used, despite rice bran containing indigestible cellulose, which limits its nutritional effectiveness for fry.

Solution: During the initial 8–10 days, spawn should be provided with semi-digested feeds. Similar to shrimp seed rearing practices, maintaining a clean water rearing system can yield better outcomes—especially if pure cultures of specific plankton are produced in the lab and fed based on the mouth size of the fry. These plankton can be enriched with omega-3 fatty acids and other nutritional supplements. Additionally, specialized high-protein and microencapsulated diets available in the market can be effectively utilized during this critical stage

Issue 5: Temperature control

Fact: Seed production takes place during the monsoon season, when early morning temperatures can drop as low as 14 °C.

Solution: Induction water heaters can be used to maintain required temperature. Or indoor system can be used for spawning and fry rearing activity

Issue 6: Cormorant problem

Fact: Most seed production projects are located near reservoirs or other shared aquatic resources, where the population of fish-eating birds tends to be higher.

Solution: The entire farm can be netted like in the case of grape farms. Increased survival percent compensate the increased marginal cost.

Issue 7: Seed Counting

Fact: Seeds are counted on volumetric basis using mug, tumbler etc. Farmers are always unhappy with the counts. Issue is more severe in private seed farms

Solution: Seed can be sold on weight basis. Or imported seed count buckets can be used.

Issue 8: Data Management

Fact: Still using conventional ledger methods and word files in the computers

Solutions: There are softwares available to maintain the entire data set which can be retrieved any time anywhere

Issue 9: Unable to meet the seed Demand

Fact: Production is stable for two decades
Solution: By implementing above said strategies, seed quality and survival percent can be improved. However, Department need not produce the entire seed requirement of the state. It should show the process and take "**Participatory Seed Production (PSP)"** with the farmers. It should give certified spawn to the registered farmers and monitor the process. Seed can be collected in **seed village or seed bank** and distribute the seed on specified dates.

Regional seed centers have to be upgraded and PSP activities should be taken up in the districts where fisheries and aquaculture activities are good.

Larval Stage Fish Rearing Practices

India is abundantly blessed with a diverse range of natural aquatic resources, including rivers, reservoirs, lakes, ponds, wetlands, canals, and estuaries. Recognizing the immense potential of these resources, numerous farmers and entrepreneurs across the country have proactively developed thousands of fish farms—ranging from traditional earthen ponds to modern tanks and cages—to harness aquaculture as a sustainable livelihood.

Among the various components of aquaculture, nursery rearing has emerged as one of the most promising and profitable segments. This is primarily because it involves a relatively short production cycle—usually lasting only 4 to 10 weeks—yet yields high returns. During this phase, fish spawn are reared intensively in confined, well-managed systems where space is optimized for maximum output. Owing to the high stocking density (500-600 spawn/m^2; depth is not taken into consideration, because, the nursery rearing ponds usually will have 1.0-1.2 m deep) and efficient use of inputs such as feed, water, and space, nursery units can operate in smaller areas while still producing large volumes of fingerlings.

Moreover, nursery rearing ensures better control over environmental parameters, predator exclusion, and disease prevention, thereby enhancing survival rates and uniformity of fish seed. For fish farmers, hatcheries, and grow-out operators, nursery units serve as a critical link by supplying robust, healthy fingerlings ready for grow-out. This high turnover model makes nursery rearing not only technically viable but also economically attractive—especially for small and marginal farmers aiming for income diversification and entrepreneurship in rural areas.

Nursery rearing is the intermediate stage between hatchery and grow-out systems. It involves growing fish spawn or fry to fingerling size in a protected environment to ensure better survival, uniform growth, and health. This manual will help beginners, students, and farmers understand the core concepts, practices, and precautions in nursery rearing of fish seeds.

1. Objectives of Nursery Rearing

- **Improve survival** rate of fry.
- Ensure **uniform growth** and **healthy** fingerlings.
- **Acclimatize** fry to local environmental conditions.
- **Reduce mortality** due to predators, diseases, and environmental stress.

2. Types of Nursery Systems

a) Traditional Earthen Ponds

- Most common, low-cost method.
- Pre-fertilized for natural plankton growth.

b) **Hapa-Based Nursery**

- Ideal for limited space and small-scale operations.
- Fixed or floating nylon enclosures in ponds or tanks.

c) Cement or FRP Tanks

- Suitable for high-value species and intensive care.
- Allows water control, aeration, and hygiene.

d) Biofloc/Nano Bubble Tanks (Advanced)

- Controlled environment.
- Minimal water exchange, higher stocking density.

3. Water Quality Management

Parameter	Optimum Range
Temperature	25–30 °C
pH	7.0–8.5
Dissolved Oxygen	> 5 mg/L
Ammonia	< 0.02 mg/L
Transparency	30–40 cm (Secchi Disc)

Tip: Daily monitoring ensures early detection of stress or disease.

4. Pond/Tank Preparation

Step-by-Step:

1. **Dewatering** and drying (3–7 days).
2. **Liming** (250–500 kg/ha) to adjust pH.
3. **Fertilization**:
   - Cow dung: 5,000 kg/ha
   - Urea: 50 kg/ha
   - SSP: 50 kg/ha
4. **Plankton Check** (3–5 days post-fertilization).

5. Stocking Fry

- **Age**: 3–5 days post-hatch (spawn stage) or 10–15 days (fry stage).
- **Density**:
  - Spawn: 4–6 million/ha (500-600 spawn/m^2)
  - Fry: 0.1–0.2 million/ha
- **Acclimatization**: Gradually mix pond/tank water in transport bag to match temperature and pH before release.

6. Feeding

Stage	Feed	Frequency
Spawn (1–10 days)	Egg custard, micro-diet, zooplankton	4–5 times/day
Fry (11–30 days)	Rice bran + oil cake (1:1), starter pellet feed	2–3 times/day

Note: Supplement with probiotics, vitamin C, or mineral premix for better health.

7. Health Management

- Use **potassium permanganate ($KMnO_4$)** (2–3 ppm) for external disinfection.
- Add **probiotics** to feed/water for gut health.
- Observe fish daily for signs of stress, poor feeding, or disease.

8. Predator & Insect Control

- Screen water inlets and outlets with fine mesh.
- Use **mahua oil cake** (250 ppm) before stocking to eliminate predatory species.
- Remove aquatic insects with light traps or repeated netting.

9. Monitoring Growth & Survival

- Sample fish weekly using a hand net.
- Record weight, length, and feeding behavior.
- Survival rate should be **above 70–80%** in a well-managed nursery.

10. Harvesting & Grading

- **Harvest** fingerlings after 3–4 weeks when they reach 30–40 mm.
- Use seine nets to minimize injury.
- **Grade** fingerlings by size to ensure uniformity and avoid cannibalism in next stage.
- Pack in oxygen-filled bags for transport.

Fish Seed Grading unit

Amur Carp Seed

11. Do’s and Don’ts

✅ Do’s

- Maintain daily records.
- Feed on time with quality feed.
- Check water quality regularly.

❌ Don’ts

- Don’t overfeed or underfeed.
- Avoid overcrowding.
- Don’t use untreated water sources.

Nursery rearing is the most critical phase in fish farming, directly impacting future yield and profitability. With proper knowledge, water management, feeding, and care, high survival and robust fingerling production can be achieved.

Fish Food Organisms

Fish food organisms play a crucial role in aquaculture, natural ecosystems, and the overall health and development of fish during various life stages. These organisms, often microscopic or minute in size, form the base of the aquatic food web and provide essential nutrition required for optimal growth, survival, and reproduction of fish, especially during their larval and juvenile stages.

Fish food organisms can broadly be classified into two categories: **natural live food** and **artificial feed substitutes**. Within the live food group, the most commonly utilized organisms include **phytoplankton** (like *Chlorella*, *Spirulina*) and **zooplankton** (such as *Rotifers*, *Moina*, *Daphnia*, *Artemia*). These organisms are not only rich in essential nutrients like proteins, fatty acids (especially omega-3), vitamins, and minerals but are also highly digestible and palatable to fish larvae. Their movement in water stimulates natural feeding instincts, making them indispensable in the early stages of fish rearing.

Phytoplankton serve as the primary producers in aquatic ecosystems and are vital for oxygen production and nutrient cycling. They also form the diet for herbivorous zooplankton, creating a direct link in the food chain. Zooplankton, in turn, become the principal live feed for many species of finfish and shellfish larvae. *Artemia nauplii*, for instance, are considered the gold standard in larval aquaculture due to their high nutritional value and ease of enrichment with additives like omega-3 fatty acids and probiotics.

Culturing fish food organisms under controlled conditions has become a core component of hatchery operations. Maintaining the right density, salinity, pH, and nutrient levels is essential for producing reliable quantities of live feed. Moreover, advancements in laboratory-based production of mono-algal cultures and zooplankton have enabled more consistent and contamination-free supplies.

The importance of fish food organisms extends beyond nutrition. A clean water rearing system with proper feeding schedules using live food reduces disease risks, enhances immune response, and minimizes cannibalism and stress among larvae. Furthermore, using appropriate food organisms based on the mouth gape and digestive capacity of the species helps in better feed conversion and survival. Natural food are fundamental to successful aquaculture practices and ecological balance. Their role in larval development, nutrition, and water quality management cannot be overstated. Emphasis on their quality, enrichment, and sustainable production is key to achieving higher productivity and profitability in fish farming.

Tanks can be of any shape and size depending on the requirement of livefood

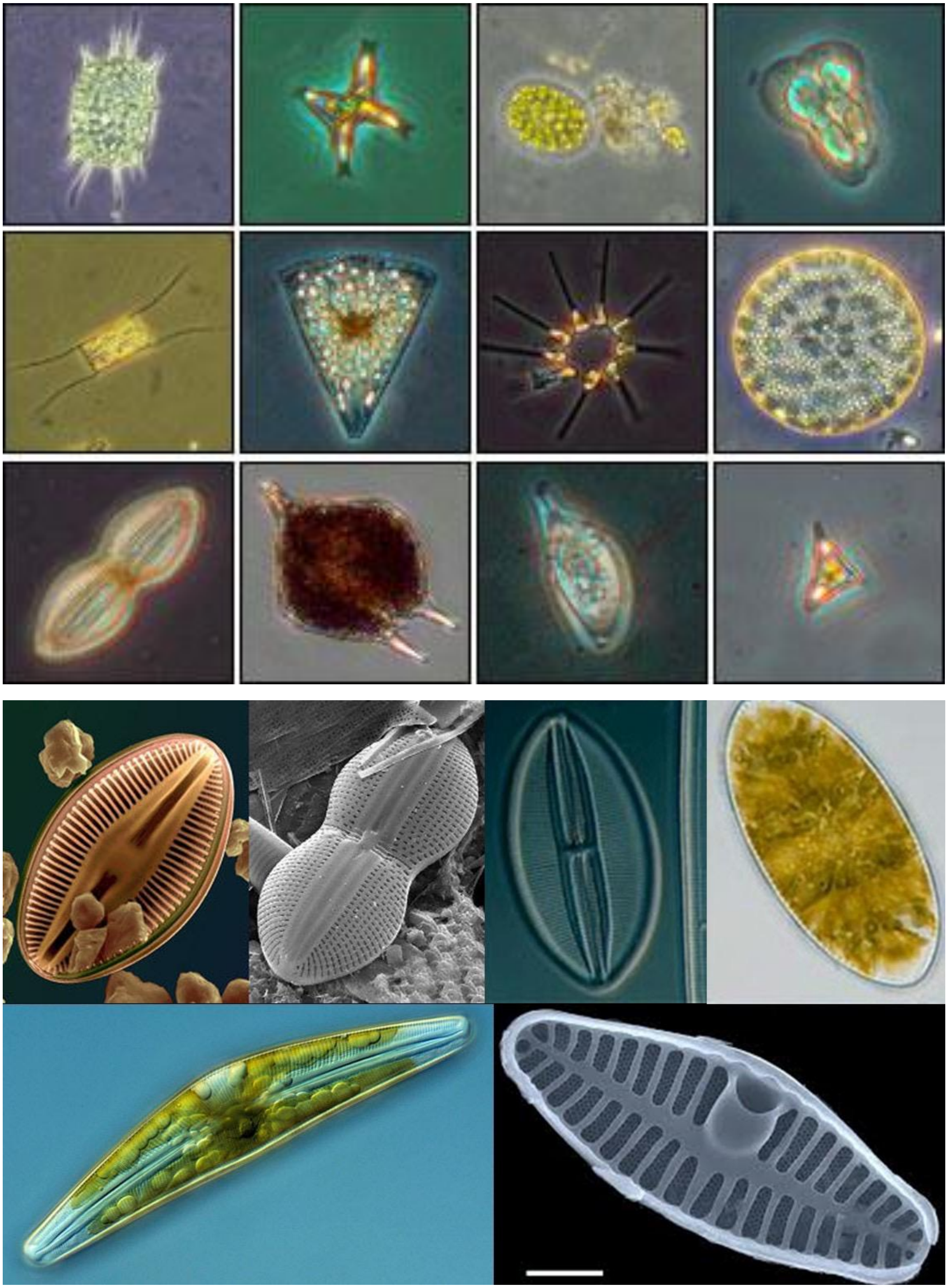
Larval Rearing/Live Food Production Unit

PVC tank for live food production

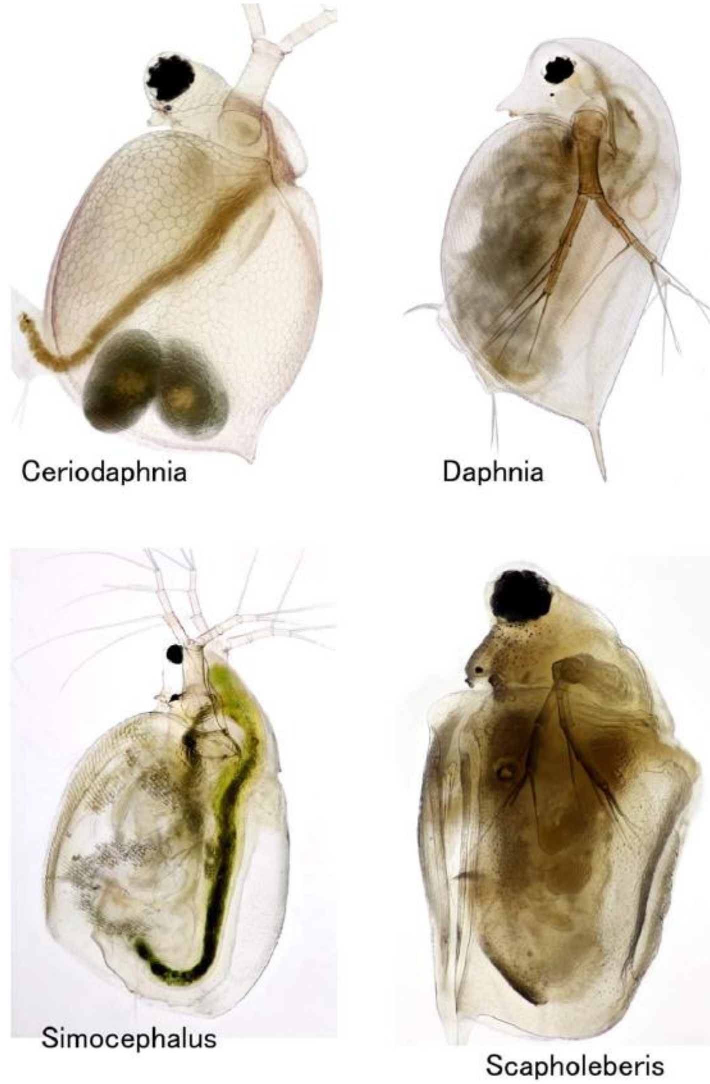
Scientific literature widely documents a range of planktonic organisms commonly used as live feed in aquaculture, including species of green algae, diatoms, rotifers, cladocerans, and copepods. However, aquaculturists need not limit themselves to these standard live feed options. A more location-specific and efficient approach involves studying the natural aquatic ecosystem to understand the existing food web and identifying the dominant plankton species already adapted to local environmental conditions. These native or locally dominant species can then be isolated and mass cultured for use as live feed.

Although the general culture protocols—such as maintaining appropriate water quality, aeration, and light exposure—remain consistent, the specific nutrient and environmental requirements may vary from species to species. Understanding these subtle differences and customizing the culture media accordingly ensures better survival, productivity, and nutritional value of the cultured plankton. By cultivating site-specific live feeds, farmers can reduce costs, enhance compatibility with the cultured fish species, and improve larval growth and survival outcomes.

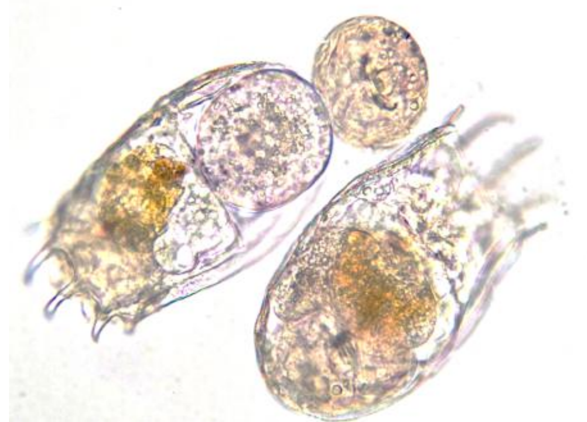
Phytoplankton



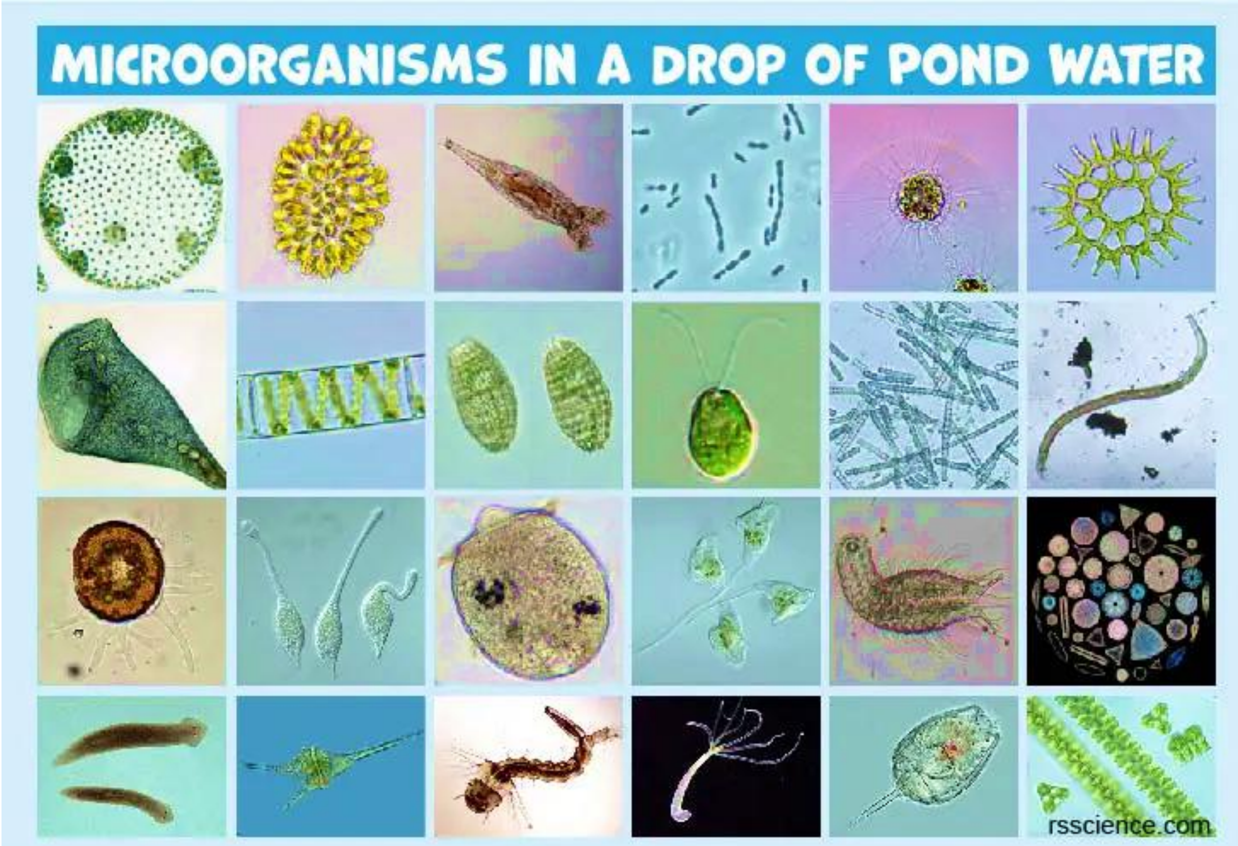
Zooplankton



Copepods



Rotifers



Natural food forms the foundation of a healthy and efficient fish production system. For most fish species, especially in freshwater aquaculture, live natural food such as phytoplankton and zooplankton provide essential nutrients that are easily digestible and suitable for the mouth size and developmental stage of the fish. Unless fish are being reared in a clear water system where natural productivity is absent or controlled, it is critical to maintain adequate plankton density in the pond through appropriate manuring and fertilization practices. A well-balanced plankton population not only serves as a readily available and cost-effective source of nutrition but also supports better growth, health, and survival of the fish larvae and fry. In addition, the availability of natural food reduces reliance on costly external or artificial feeds, thereby improving the overall economics of fish farming and enhancing sustainability.

In order to get better survival percent, like in the shrimp hatcheries, even in the fish hatcheries, pure algal culture can be done. Phytoplankton like spirulina, infusoria and zooplankton like daphnia, moina, rotifers can be culture and fed as one portion in the feeding schedule.

Common Mistakes

in Fisheries and Aquaculture

1. **Stocking Fry:** Natural water bodies are often stocked with fish fry that are less than 3–4 cm in size. However, these small fry face high mortality rates, particularly during the acclimatization phase, and a significant portion also falls prey to predators. As a result, such stocking practices rarely lead to satisfactory yields under any circumstances.
2. **Overstocking:** It is a common misconception among fishermen and fish farmers that stocking a higher number of fish in ponds or tanks will automatically lead to greater yields. In reality, overstocking often results in the opposite. High stocking density increases competition for limited natural food resources, reduces dissolved oxygen levels, and elevates the risk of disease outbreaks. Additionally, most farmers do not match the stocking rate with the pond's primary productivity—the natural capacity to support plankton and other food organisms essential for fish growth. As a result, high initial mortality is frequently observed. The stressed and undernourished fish that survive exhibit stunted growth, leading to significantly lower yields and financial losses. A scientifically calculated stocking density, aligned with the pond's ecological carrying capacity and supported by proper feeding and management, is crucial for sustainable and profitable fish production.

   Stocking fewer but well-grown fingerlings is considered a more effective management practice. In the North Eastern states and West Bengal, farmers often maintain fingerlings in smaller ponds at high densities throughout the year. These stunted fingerlings or yearlings are then stocked in grow-out ponds, where they quickly reach marketable size within 3–4 months.
3. **Stocking based on waterspread area:** Determining fish stocking density solely based on the waterspread area of a pond or tank lacks scientific validity. Unlike terrestrial animals, fish do not consume water for sustenance; they rely on the pond's ecological balance, particularly its primary productivity—the ability of the waterbody to naturally produce food organisms like phytoplankton and zooplankton. Therefore, the quantity of water alone does not guarantee a productive environment for fish growth.

   A more scientific and sustainable approach to stocking involves assessing the tank's primary productivity through plankton counts, dissolved oxygen levels, and nutrient availability. Additionally, it is crucial to consider the existing fish population, especially if the pond has been previously stocked. Overstocking in such cases can lead to intense competition for food, depletion of dissolved oxygen, and increased susceptibility to diseases. Optimal stocking density should thus be calculated based on the biological carrying capacity of the pond rather than the physical area. This ensures that the pond environment can adequately support the stocked species, promoting better growth rates, survival, and ultimately, higher economic returns."

a. **A Case Study:** Many fishermen Cooperatives have bid the lakes in the HN Valley for the higher lease amount and getting poor yields. A decade ago, similar incidence happened at Gujjegowdana Doddi, Mysore where the tank of 300 ha situated in the elevated area and there is no catchment which brings nutrients. It is a large depression caused due to the rangoli powder extraction. The pH of the soil is more than 9.0 and it is saline land. The water was muddy color due to the high suspended solids. The primary productivity was insignificant. The growth of the catla was only 150 g in 12 months. After scientific evaluation, it was suggested to manure the pond intensively and feed the fishes with commercial diets.

4. **Feeding the fry with ricebran and Groundnut Cake:** In traditional aquaculture practices, it is common to feed a mixture of rice bran and groundnut cake in a 1:1 ratio, typically after soaking the mixture for a few hours to soften it. However, it's important to understand the developmental biology of fish larvae to apply appropriate feeding protocols during the early stages. After hatching, fish spawns (larvae) do not begin external feeding immediately. For the first 4 to 5 days, they rely solely on the nutrition derived from their yolk sac, which acts as a natural reserve. Once this yolk sac is absorbed, the fry transition to external feeding. At this critical juncture, they begin to consume naturally available micro-organisms in the pond, primarily phytoplankton and zooplankton.

This transitional feeding phase is scientifically termed the "Hjort Critical Period"—a biologically sensitive stage during which the mortality rate among larvae is significantly high. Nature has designed this phase as a survival filter, where only the fittest and best-adapted individuals survive. In the wild, this natural selection helps control population size. However, in controlled aquaculture systems, this period must be managed carefully to minimize mortality and improve seed output.

To enhance the survival and growth of fry during this weaning phase, farmers should ensure the availability of appropriate food sources that match the mouth size (gape) and digestive capacity of the larvae. Ideally, the fry should be provided with a dense culture of phytoplankton and zooplankton, or specialized predigested mash feeds with a protein content exceeding 50%. These feeds are tailored to be easily digestible and nutritionally dense.

Unfortunately, in many field situations, to reduce costs, farmers continue using traditional farm-made feeds such as soaked rice bran and groundnut cake. However, young fry lacks the enzymatic ability to break down complex carbohydrates like cellulose, especially those found in rice bran. As a result, the nutritional uptake is poor, and survival rates remain low.

To address this challenge and improve outcomes, it is strongly recommended that for the first 10 days of fry rearing, farmers should feed either microencapsulated diets or high-quality mash feeds. If these are not available, at the very least, the traditional rice bran and groundnut cake mixture should be thoroughly cooked before feeding, which helps in breaking down some of the complex compounds, making it more digestible for the delicate fry.

A slight investment in the right nutrition during the critical early stage can significantly boost fry survival, reduce the production cycle, and ultimately improve economic returns for hatchery operators and farmers alike. In the shrimp and fish feed industries, a significant amount of feed dust is generated during processing. This byproduct, known as mash feed, is often sold for use in fish farming. Although it is a fragmented form of the complete feed, it generally retains a nutritional composition that is nearly equivalent to that of the original formulated feed.

5. **Improper species ratio:** In many cases, fish farmers tend to stock their ponds or tanks based on the availability and affordability of fish seed in nearby hatcheries, rather than on scientific or economic considerations. While this may seem practical in the short term, it often leads to suboptimal outcomes in terms of growth, survival, and overall profitability. Fish stocking should not be a random or convenience-driven activity—it requires a planned and case-specific approach.

   To achieve the best results, farmers must stock ponds with the right species composition tailored to the ecological characteristics of the waterbody (such as depth, water temperature, primary productivity, and weed infestation) and the intended market demand. Furthermore, stocking should involve healthy, right-sized fingerlings—preferably uniform in size and age—to ensure uniform growth and avoid dominance and competition within the stocked population.

   Species selection must also consider compatibility in feeding habits and ecological niches (e.g., surface, column, and bottom feeders) to ensure optimum resource utilization and minimize intra- and inter-species competition. A well-thought-out stocking strategy improves feed conversion efficiency, reduces mortality, enhances growth rate, and leads to higher returns on investment. Therefore, species selection, stocking density, and fingerling size should always be planned based on scientific assessment of each individual pond or tank rather than on generalized practices or short-term convenience.

When fish seeds (**spawn or fry**) must be reared in **small ponds** for a period of **40–60 days**, they should subsequently be transferred to larger tanks for further growth. To assess their performance and ensure accountability, a known quantity of seeds can be maintained in hapas for close observation. This practice helps monitor growth, survival, and overall health effectively.

Studies on Economic Aspects of Carp Seed Rearing and Farming in India

Shivakumar, M*, C Rajanna[1] and Naveenkumar, B.T [2]
*Professor of Aquatic Biology, College of Fisheries, Karnataka Veterinary, Animal and Fisheries Sciences University, Mangalore-575002, India
shivakumarmagada@gmail.com
[1]Assistant Professor, Zonal Agricultural Research Station, UAHS, Shivamogga, India
[2]Senior Scientist, ICAR-CMFRI, Mandapam, Tamil Nadu, India

Abstract:

Till recently, carp seed rearing and farming at any scale was highly profitable because of the low cost for the inputs. But it no longer continues, as the cost of basic inputs like cow dung, poultry manure, ground nut cake, rice bran and land costs are increased by many folds, while the gate value of the fish seed and fish remained almost constant. To know the scale of economy and present economics of the fish rearing at different stage, the assessment was carried out in 258 villages of Southern Karnataka. It is found out that fish seed rearing for 50 days, the Benefit Cost ratio (BC ratio) in catla 1.23, rohu 2.04, common carp 1.65 and grass carp 2.82. The return on investment (RoI) is high in grass carp (103.10) followed by rohu (87.59), common carp (60.46) and catla (49.96). In fish culture for 10 months period, the BC ratio in feed-based farming was 1.63 as against 1.89 in conventional feed-based system and 2.01 in extensive method. The RoI was 25.44, 17.22 and 10.14 in feed based, conventional feed and extensive method respectively. While input rates may differ across locations, this study provides an overview of the economic trends, enabling farmers and entrepreneurs to strategically plan their scale of operations according to available resources and capital.

Key Words: Fish seed rearing, BC Ratio, Return on Investment, Economics of Aquaculture

Introduction:

Although aquaculture production models display high dynamism, sustainability hinges on evaluating the economics and comprehending the scale of the economy associated with a specific activity. In the early sixties, most aquaculture production systems were either extensive or modified extensive. Inputs such as rice bran, groundnut cake (GNC), and cow dung were readily available at lower costs. Notably, the cost of GNC was Rs. 3.80 in 1983, escalating to Rs. 60/kg in 2023. Similarly, rice bran, priced at Rs. 1.60 earlier, now ranges from Rs. 28 to Rs. 36/kg. In contrast, the cost of fish seed was 28 paisa or Rs. 280/1000 seeds in the past and has remained relatively stable. This price constancy is attributed to the equilibrium between supply and demand.

However, despite this stability in seed costs, farmers and entrepreneurs often incur significant losses when engaging in aquacultural activities without a comprehensive understanding of the economics of seed production and fish farming under ideal conditions.

It is noteworthy that many research findings lack critical economic evaluation and, as a result, struggle to find practical application in the field.

Seed Production

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 2020-22, it was over 28.6 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 categorized 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) (Radheyshyam, 2010).

Pond construction

Construction of fish ponds vary with place to place depending on the soil type, topography, capital and culture activity. There are different methods of construction viz. step-up ponds, dug out ponds, plastic lining tanks, trench method etc. The cost of construction is highly variable. The rates as per Public Works Department (PWD) SR rates are fixed as per the region and soil type. Going by PWD rates will be exorbitant. To know the range of cost of construction, in this study, about 6 different soil categories were chosen and the average of 28 different sites are taken for the results.

Materials methods:

The survey was carried out in 258 villages of Mandya District of Southern Karnataka, India. Multiple aquaculture interventions were implemented in these villages under Ratreeya Krishi Vikasa Yojana (RKVY). Fish Farmers of the district are actively involved in the fish culture practices and aqua-ecological, soil and climatic conditions and others are homogeneous throughout the district. A baseline survey was conducted to collect the information about carp culture scenario in the study area. Participatory Rural Appraisal (PRA) tools were employed to identify and prioritise the field problems.

Survey was conducted for 50 days and 10 months for carp seed production and farming respectively. During the survey, detailed information about fixed cost, variable cost, production level and other parameters were collected. Although pond sizes may differ, standardized production protocols are consistently followed. For the purpose of economic and production calculations, unit-wise production metrics are considered uniformly.

Results:

Table 5. Fish Economics of fish seed rearing for 50 days

Particulars	Qty. required for 1 ha	Unit cost (Rs.)	Total Cost (Rs.)
Fixed cost			
Pond construction	10000 m^2	30-42/m^2	3,00,000-4,20,000
Pipelines and sluice gates	-	5/m^2	50,000
Total	-	**-**	**4,10,000**
Operational Cost			
Deweeding, bund compaction	25 man days	200/person	5,000
Lime	200 kg/ha	10/kg	2,000
Fish spawn (Catla/rohu/common carp/grass carp	Any of species can be stocked @ 500/m^2 = 50 lakhs.	1000/lakh	50,000
Feed (Rice bran and ground nut cake in 1:1 ratio)	1875 kg Ground Nut Cake & 1500 kg Rice Bran	48/kg GNC & 28/kg for RB	1,32,000
Labour for feeding other maintenance	50 man days	400/day	20,000
Raw cow dung	4 t/ha in 4 split doses	2/kg	8,000
Harvesting expanses	12 man days	500/person	6,000
Transportation of inputs	-	-	15,000
Watch and ward, Miscellaneous	-	-	15,000
Total	**-**	**-**	**2,35,000**
Production/ha (In 50 days)	**Production**	**Unit cost (Rs.)**	**Gross Revenue (Rs.)**
Catla @ 30% survival	15,00,000	0.35	5,25,000
Rohu @ 40% survival	20,00,000	0.40	8,00,000
Common Carp @ 50% survival	25,00,000	0.25	6,25,000
Grass carp @ 30% survival	15,00,000	0.60	9,00,000
Profit by Species	**Net Returns (Rs.)**	**BC Ratio**	**RoI (%)= Net returns/Total investment X 100**
Catla	2,90,000	1.23	44.96
Rohu	5,65,000	2.04	87.59
Common Carp	3,90,000	1.65	60.46
Grass Carp	6,65,000	2.82	103.10

Table 6. Economics of fish culture for 10 months

Particulars	Qty. required for 1 ha	Unit cost (Rs.)	Total Cost (Rs.)
Fixed cost			
Pond construction	10000 m^2	12/m^2	3,00,000-4,20,000
Pipelines and sluice gates	-	2/m^2	50,000
Total	-	**-**	**4,10,000**
Operational Cost			
Deweeding, bund compaction	25 man days	500/person	12,500
Lime	200 kg/ha	5/kg	1,000
Fish seed (Catla + rohu+ common carp and grass carp in 4:2:2:1 ratio)	Stocking @ 1/m^2 = 50 lakh	0.5/seed	5,000
Feed (Rice bran and ground nut cake in 1:1 ratio) (CF)	1000 kg Ground Nut Cake & 1000 kg Rice Bran	48/kg GNC & 25/kg for RB	73,000
Commercial feed (PF) with 28/4	2000 kg	40/kg	2,05000*
Raw cow dung (EF)	8 t/ha in 16 split doses	1/kg	8,000
Harvesting expanses	12 man days	500/person	6,000
Transportation of inputs	-	-	10,000
Feeding, Watch and ward, Miscellaneous	-	-	25,000
Total	**-**	**-**	**PF: 2,75,700** **CF: 1,32,000** **EF: 59,500**
Production by culture system	**Production kg/ha**	**Unit cost (Rs.)**	**Gross Revenue (Rs.)**
Commercial feed based	4500	100	4,50,000
Conventional feed based	2500	100	2,50,000
Extensive method (no feed, watch and ward) Exp.=47,000	1200	100	1,20,000
Profit by culture system	**Net Returns (Rs.)**	**BC Ratio**	**RoI (%) = Net returns/Total investment X 100**
Commercial feed based	1,74,300	1.63	I year 25.44
Conventional feed based	1,18,000	1.89	I year 17.22
Extensive method	69,500	2.01	I year 10.14

PF: Pelleted Feed; **CF**: Conventional Feed; **EA**: Extensive Farming

**The economics may vary based on the gate value of the produce*

Results and Discussion:

A significant gap in the country lies in the availability of economic data for specific species in aquaculture. For effective business planning and growth analysis, up-to-date information is crucial. Unfortunately, there is currently no organized and authentic system for assessing such data. Utilizing outdated data is ineffective for business planning and market assessment, particularly due to the rapidly evolving nature of the aquaculture sector (Anand and Uamakanth, 2014). In recent years, the Indian economy has experienced a gradual increase in the inflation rate, leading to a rise in the costs of ingredients and fertilizers. This, in turn, has impacted the cost of production and profitability in fish culture practices. However, there is a glaring lack of economic information available for carp seed rearing and farming. In light of this, we conducted a survey on the economics of carp seed rearing and farming, focusing on basic inputs. This survey gives a clear understanding the real-time economics, so that stakeholders can make better choices based on their available resources and make best economic advantage.

Seed Rearing:

In the study, we assessed 258 villages of Southern Karnataka with an average 2000 m^2 pond area. The ponds were prepared according to standard management practices. Stocking was done at 500/m^2 of fish spawn (Catla/rohu/common carp/grass carp) and reared for about 50 days. We have collected the data of fixed cost and operational cost for the seed rearing. The study revealed that, fixed cost is about for Rs.4,10,000/ha and operational cost is about Rs. 2,35,000/ha required for the 50 days seed rearing period. According to Kumar *et al.,* (2008) study states that, hatchery is a lucrative operation and the returns increased with increase in hatchery size. Taking all hatchery (Small, Medium and Large) sizes together, the variable input cost is about, 12,511 and 14,533 and 30,054 US $ in India, Bangladesh and China respectively. In another study by Central Institute of Freshwater Aquaculture (CIFA), variable cost for the carp seed rearing is about Rs. 59,000/ha in India during 2008. It is increased by four times in 2022 and in our study, it was Rs. 2,35,00/ha. The difference in the variable cost of seed rearing might be due to the increase in the basic inputs like cow dung, poultry manure etc. When we compare our study with the previous studies, it reveals that, the variable cost has been increased over a year.

In our survey, net profit of fish seed rearing among the species reared (catla, rohu, common carp and grass carp) were highest in grass carp following by others. The BC ratio of catla is 1.23, rohu is 2.04, common carp 1.65 and grass carp is 2.82. The return on investment is high in grass carp (49.96) followed by rohu (87.59), common carp (60.46) and catla (103.10). According to CIFA, net income of about Rs. 46,000/ha/crop can be obtained by carp seed rearing practice. The profit from the carp hatcheries (small, medium and large) is about 50,224 US $ and rate of return is about 167.1% (Kumar *et al.,* 2008).

Fish culture:

Several authors reported that, carp culture was profitable (Jayaraman 1999). But we need to conduct annual survey on economics of fish culture on region basis, variation in price of the basic input. In earlier days, rice bran, ground nut cake (GNC) and cow dung etc. are available at cheaper rate. But, now, the cost of GNC of Rs 3.80/kg (1983) has been increased to Rs. 48-60/Kg in 2023. The cost of rice bran was Rs 1.60/kg and it is Rs. 28-36/kg now. This shows that, over a period of time the cost of input has been increased but there is no remarkable increase in price of table fish. Our survey revealed that, the fixed cost is about 3,00,000-4,10,000/ha/crop, Operational cost is about Rs. 1.50,000-Rs. 2,75,000/ha/crop. But, the distributions of variable and fixed cost are similar for all the culture system (Commercial feed based, Conventional feed based and Extensive method). Among variable cost, the cost of feed and seed are the most important item, it determines the yield and profit.

In a commercial feed-based culture system, the production reaches approximately 4500 kg/ha/crop, while the conventional feed-based culture system yields about 2500 kg/ha/crop. In contrast, the extensive method (without feed) results in a production of approximately Rs. 1200 kg/ha. The gross income for the commercial feed-based culture system is around Rs. 4,50,000, followed by Rs. 2,50,000 for the conventional feed-based culture system and Rs. 1,20,000 for the extensive method. Net returns are estimated at about Rs. 90,000 for the commercial feed-based culture system, Rs. 62,500 for the conventional feed-based culture system, and Rs. 42,000 for the extensive method.

This analysis definitely demonstrates that the commercial feed-based culture system stands out as the most profitable, followed by the conventional feed-based culture system and the extensive method. Notably, the net income observed in this study surpasses the Farm business income documented in carp culture in leased-out ponds in the Thanjavur district, Tamil Nadu, India (Jayaraman, 1997; 1999). The variations in net income can be ascribed to fluctuations over the years in the prices of basic inputs and the market price of table-size produce. Consequently, it becomes imperative to conduct an annual assessment of the economics of carp seed and farming to comprehend its dynamics before determining the scale of the aquaculture business.

Hatching troughs at Govt. Tilapia Hatchery, Hesaraghatta, Bangalore

Dr N Manjappa showing hatching of carps in Glass Jar Hatchery at FRIC, Bangalore

Dr Shivakumar Magada has done his masters and doctoral degree in Aquaculture. He has 32 years of experience in the profession where 30 years in academics and 2 years as Aquaculture Consultant dealing with marine shrimp and freshwater prawn seed production and farming. In his career, Dr Magada handled 28 research projects funded by DBT, NADP, European Union, NFDB and RKVY.

He has written 16 books, 24 handbooks and 22 research papers, hundreds of popular articles. Dr Magada is a popular science writer and motivational speaker and he has delivered 393 talks covering more than one lakh farmers and youths, organized 53 training programs covering 7800 beneficiaries and organized several professional events.

Special Achievements:

- Developed Package of Practice for reclamation of problematic soils
- Developed Beach Tourism Plan for the Government of Karnataka
- Developed Productivity Index Scale for stocking natural waterbodies