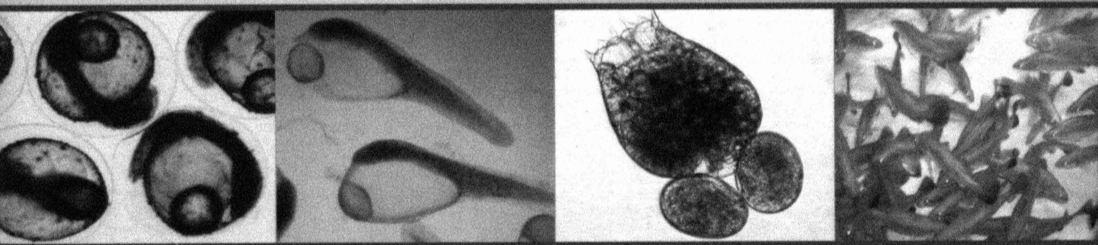
CIBA Special Publication No. 34

IMPROVED HATCHERY TECHNOLOGY FOR ASIAN SEABASS
Lates calcarifer (BLOCH)



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(भारतीय कृषि अनुसंधान पारिषद्)
75, सनथोम हाई रोड, राजा अण्णामलैपुरम, चेन्नई - 600 028

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CENTRAL INSTITUTE OF BRACKISHWATER AQUACULTURE
(Indian Council of Agricultural Research)
75, Santhome High Road, Raja Annamalaipuram
Chennai - 600 028

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IMPROVED HATCHERY TECHNOLOGY FOR ASIAN SEABASS *Lates calcarifer* (BLOCH)

A.R.T. Arasu, M. Kailasam, J.K. Sundaray, R.Subburaj,
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Photographs

Front Cover

Above : Asian Seabass

Below (left to right) : Embryonic development, hatched out larvae, rotifer, seabass juveniles

Back Cover

View of seabass pilot hatchery at Muttukadu Experimental Station of CIBA

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PREFACE

Indian aquaculture is contributing significantly to the food and livelihood security. Brackishwater aquaculture is synonymous with shrimp farming and is based on one species, the tiger shrimp, *Penaeus monodon* targeted at the export market. Shrimp farming which made quantum jump in 1980s faced a set back in the second half of 1990s due to the uncontrolled White Spot Syndrome Virus (WSSV) disease outbreak. The farmers continue to loose crops due to WSSV and also have to cope up with additional diseases like Loose Shell Syndrome. Lately, due to the dependence on export market, there has been a drastic fall in shrimp prices. Therefore, diversification of species has become an urgent need to overcome both disease and market risks. In this context, the Asian seabass, *Lates calcarifer* is considered as a suitable alternative fish species for farming in different farming systems in India.

The Asian seabass is suitable for farming in ponds and cages in the coastal, inland saline and fresh water ecosystems. It is a hardy fish capable of withstanding wide environmental fluctuations. It fetches good price in the domestic market and more than Rs. 200/- per kg in some places like Kolkata. The export potential is also good. Therefore it is considered as a highly suitable species for sustainable aquaculture.

The seabass is extensively farmed in ponds and cages in the South East Asian countries, Australia and France. However in India, seabass farming is limited to coastal traditional farms in some areas with low production and productivity. Large-scale adoption of seabass culture in India is mainly hampered due to the non availability of quality seed in adequate quantity. Realizing the potential of seabass farming in the country, the Central Institute of Brackish water Aquaculture (CIBA) identified technology development for Asian seabass *(Lates calcarifer)* seed production and culture as a priority programme. A breakthrough in the controlled breeding and seed production was made during 1997 by CIBA. Based on the work carried out on developing an indigenous seed production technology package, a bulletin titled "Hand book of seed production and culture of Asian seabass *Lates calcarifer* (Bloch)" was brought out. Since then, the technologies for breeding, larval rearing and high density of live feed culture have been further improved resulting in higher survival and improved seed quality. Through the Indo-French collaborative project on seabass seed production, which was completed in 2006, the technology for year round production of seabass seed has been perfected and it is possible now to breed the fish without hormonal administration. This facility would require an investment of Rs. 137 lakhs. The present publication describes the improved technology package which includes, the development of captive land based viable broodstock, protocols for maturation under captive conditions, breeding, larval and nursery rearing techniques. The seasonal seed production through the indigenously developed small scale hatchery requires a capital investment of Rs. 75.35 lakhs. I hope this special publication on the "Improved Hatchery Technology for Asian seabass *Lates calcarifer* (Bloch)" will be immensely useful for popularization of the seabass hatchery technology amongst industry, entrepreneurs, farmers and academicians and will lead to large scale seabass seed production.

Chennai- 600028
04.01.2008

A.G.PONNIAH
Director

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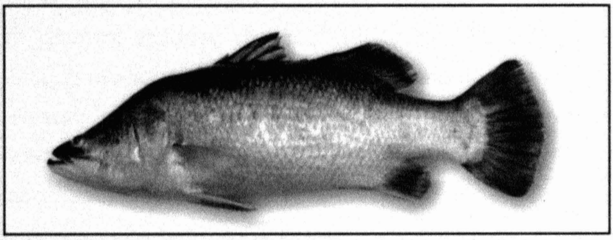
1. INTRODUCTION

The Asian seabass, *Lates calcarifer* known as 'Bhetki' in many parts of India, 'Pandu kappa' in Telugu, 'Koduva' in Tamil, 'Kaalanji' or 'Narimeen' in Malayalam, 'Jitada' in Marathi, is considered as a supplementary candidate species for farming in the saline, brackish and fresh water ecosystems. In recent years the aqua-farmers are looking for alternate species for sustainable aquaculture in the wake of uncontrollable diseases in the cultured shrimps.In this context, seabass farming in brackishwater culture system is gaining momentum. It is felt that the setback in coastal aquaculture is mainly due to the over dependence on single species of shrimp. Species diversification is advocated as one of the means to overcome some specific health problems in brackishwater aquaculture. As the pathogens encountered in the coastal aquaculture are mostly species or group specific, adoption of alternative farming practices with different species may be useful to deal with the proliferation of the pathogens. Shift in the practices may also help in improving the quality of farming system since the inputs such as feed and seed are changed. Under these conditions, a species capable of withstanding wide environmental fluctuations with fast growth, relatively easy to farm with less disease risks and better price in the domestic and export markets is recommended. Seabass fulfills these qualities. It grows well in fresh water and its culture in fresh water will be more profitable compared to carp culture. The prospects of seabass farming are immense, however commercial farming has not picked up in India because of the problems in getting the critical inputs like seed and feed in adequate quality and quantity. Availability of quality seed of required size is of paramount importance for sustainable farming practices.

The technology package for seabass seed production, under controlled conditions, has been standardized by the Central Institute of Brackishwater Aquaculture (CIBA), which can be scaled up to any required level. The technology package includes, captive land based broodstock development, maturation and spawning under controlled conditions, egg collection and incubation, live feed culture, larval rearing and development of formulated feed for fry, fingerlings and grow out phase.

2. BIOLOGY OF ASIAN SEABASS, *Lates calcarifer*

The Asian seabass (*Lates calcarifer*) commonly called as 'Bhetki' is an important food fish. It is euryhaline (capable of withstanding wide salinity fluctuations) in nature and catadromous (migrating towards sea for breeding) in behaviour. It is widely distributed in the tropical and sub-tropical areas of the Indo-pacific region.



Asian seabass *(Lates calcarifer)*

2.1 Taxonomy

Phylum	-	Chordata
Sub-phylum	-	Vertebrata
Class	-	Pisces
Sub-class	-	Teleostomi
Order	-	Perciformes
Family	-	Centropomidae
Genus	-	*Lates*
Species	-	*calcarifer* (Bloch)

2.2 Life history

Seabass spends the growing phase in shallow water bodies like estuaries, backwaters and freshwater and migrates to the sea during the reproductive phase. It spawns in the sea about 20-30 km away from the shore. Post larvae are transported passively through tidal currents and enter into coastal and fresh water bodies. Adult fishes migrate towards the mouth of the river from adjacent areas into the sea, where the salinity is high, favouring sexual maturation and spawning.

2.3 Food and feeding habits

Seabass is carnivorous in nature, however, the juveniles are omnivores. It is an opportunistic predator and its diet changes with size. Analysis of stomach contents of wild specimens (1-10 cm) contained 20% of plankton (diatoms and algae) and the rest were small shrimp, fish etc. In fish of 20 cm size, the stomach content consists of 100% animal prey (70% crustaceans and 30% small fishes). It showed preference for pelagic fish rather than benthic crustaceans. However, seabass juveniles can consume, as whole, smaller size individuals of the same age group.

2.4 Reproduction

Sexes are separate, but difficult to differentiate. In the same age group, males are generally smaller (2-3 kg) with a more slender and narrow body depth than the females. During the spawning season, if slight pressure is applied on the abdomen of the mature male, oozing of milt can be observed. The females are generally large, weighing more than 3 kg and can be recognized from the big soft round belly with the red-pink papilla extruding out at the uro-genital aperture. The mature females can be examined through biopsy also. Seabass is a protandrous hermaphrodite fish. Majority of individuals from early age classes (2 – 3.5 kg body weight) are males, but when they attain 4 kg and above (4 years old), the majority of them become females. As, gonads develop, the gonadopore or genital opening becomes visible just below the anal pore. Fecundity of seabass is related to the weight of the fish and in India, it has been recorded between 2 and 10 million eggs. However, in Philippines, the fecundity of seabass was receroded between 2.1 and 7.1 million eggs. Australian seabass has fecundity up to 17 million.

The gonadal development is extremely rapid coinciding with the fast growth that takes place just before spawning. The gonads of seabass are strongly dimorphic and the size of gonad varies in different size groups. Usually, the oocytes in the posterior end of the ovary are larger in size than the oocytes of anterior region indicating that the process of ovarian development is a continuous one and spawning process is multiple.

The males attain maturity at the size of 25 cm in total length. When the fishes are more than 2 years old, the fully matured males can be recognized. The testes become macroscopically visible as a semi-transparent thin strip or bead like and often bordered by fat.

Stages of gonadal development in seabass

Stage	Gonadal condition	
	Female	**Male**
I. Virgin	Glassy, rounded and occupies 1/4th body cavity in length.	Colourless thin strip lying along the blood vessel covering one half body cavity in length.
II. Maturing virgin and recovering spent	Distinct gonadal appearance. Length as in stage - I.	Whitish and has distinct gonadal appearance. Length as in stage - I.
III. Developing	Fills half the body cavity. Eggs can be distinguished separately.	Fills half the body cavity. Whitish in colour.
IV. Developed gonad	Yellowish and easily detectable as female. Occupies 2/3 of body cavity.	Whitish with gonadal appearance.
V. Fully ripe	Eggs are separate and fill the entire body cavity.	Milt fills the body cavity and can be expelled without difficulty, white and sticky.
VI. Spent	Ovary flaccid. May have some eggs remaining.	Testes thin although not as flaccid as ovary. Some spawner may have remains of the testes which fill one half of the body cavity.
VII. Resting	Ovaries reddish and small. Easily confused with stage - II. Identification under microscope may be necessary.	Testes are small and thin and looks sharp when viewed from the edge.

The males undergo in spawning several times before changing into females. They transform into females generally when they are 65-85 cm in total length and weigh above 4 kg. However, in Australia, the males change into females when they are 82-100 cm in length and about 7 kg in weight. In fully mature females, the diameter of oocyte usually ranges from 450-530 μm.

2.5 Spawning

The seabass spawns during the months of April to November in Indian waters. Spawning usually takes place in the sea. Seabass is a multiple spawner and releases the eggs in batches continuously up to three days. The fertilized eggs are usually transparent, pelagic and easily drift into coastal waters for larval development.

3. BROODSTOCK DEVELOPMENT

Successful seed production in the hatchery depends upon the availability of healthy matured fishes of both sexes. Viable broodstock under captive conditions has to be developed for selecting potential breeders.

3.1 Procurement of broodstock

The adult and sub-adult fishes can be procured from wild catch or from farm reared stock. The selection of a suitable gear or method of capture is very important in order to avoid injury to the fish. Seabass is caught using gill net, dip net, seine net and hook and line.

The fish procured for broodstock should be devoid of external injuries or internal haemorrhage. The fins should be complete and there should not be any loss of scales. The jaws, snout, opercular region, eyes and gills should not be damaged, since these parts are vulnerable to injuries during capture and this would lead to further infection after release into the holding tanks. The fish should be healthy and free from any parasitic infection.

3.2 Transportation

Fishes procured are to be carefully transported to the holding facilities in the hatchery. Fishes from distant places have to be transported using vehicles with water holding facility with inlet and outlet provisions and an inner lining of materials such as foam, so that the fish will not get injured during transportation. There should be provision for oxygen cylinder for aeration during transportation. Wild fishes caught from the sea can also be transported under anaesthetics by using 50-100 ppm Phenoxy ethanol.

In the case of small fishes, manual transportation from nearby areas can be done in buckets or troughs filled with water and covered with perforated lids. If the fishes are large (more than 4 kg) in size, they can be transported in specially designed large rubber tubes with perforation for water exchange. To avoid injury, the tube can be manually towed along the water-line to reach the hatchery.

3.3 Acclimatization

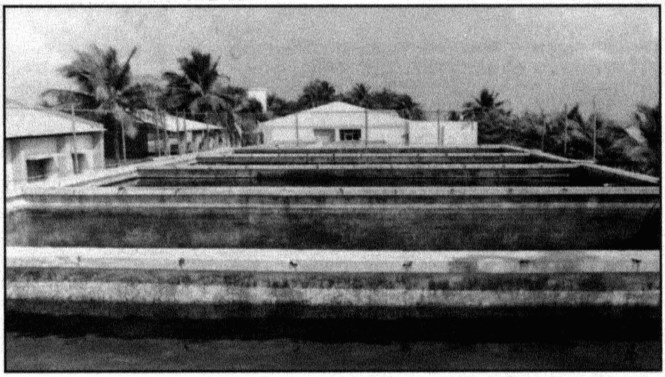
After the fishes are brought to the hatchery / holding facility, they are released in to the acclimatizing tanks filled with quality filtered and mildly aerated seawater of the same salinity, temperature etc., of the transported medium. Since the fishes would be under stress due to transportation, they should be kept in these tanks for 1 – 2 hr with flow–through water arrangement. After normalization, the fishes are treated with Acriflavin (1 ppm) for 10 minutes and later with 100 ppm formalin for one hour as prophylactic treatment to avoid infection due to minor injuries, if any. The fish should be closely observed for 3-5 days before shifting to the brood stock holding facility for further maintenance.

3.4 Quarantine

It is important to have quarantine tank facilities in the hatchery complex. Acclimatization of newly caught fishes has to be done in quarantine tanks with continuous observation. Quarantine tanks should be provided with flow-through and aeration facilities.

3.5 Broodstock holding facilities

Seabass attains maturity in 2 – 3 years. The females attain maturity when they are more than 3 kg and males 2 – 2.5 kg in size. These size group fishes can be maintained in broodstock holding facilities like cages/tanks.



Broodstock holding tanks

The fish holding cages in the size of 50 – 200 m^2 with a depth of 2 m (5 x 5 x 2 m or 10 x 10 x 2 m) made of polyethylene net webbing (mesh size of 4 – 8 cm) are used to rear broodstock. Floating net cages are preferred. The fishes are stocked @ 2 kg/m^3.

The broodstock can also be maintained in well constructed ponds of 500 – 1000 m^2 area with proper water inlet and drainage facilities. Water depth in the pond should be more than 2 m and above. Regular water exchange is followed to maintain optimum water quality to reduce stress to the fishes.

Depending upon the production target, the number of broodstock fishes has to be decided for constructing the holding tanks. It is advisable to maintain fishes in large tanks, so that the fishes will have sufficient space for swimming. Broodstock tanks can be of 50 to 100 t water capacity with adequate water inlet and drainage provisions. In CIBA, the broodstock tanks of 12 x 6 x 2 m (gross capacity of 144 t with net water holding capacity of 100 t) are being used. Flow-through facility is desirable and provision for aeration is advisable.

The water pumping capacity should be in such a manner that the broodstock holding tanks can be filled within 1-2 hours and drained within ½ - 1 hour. It is advisable to cover the open concrete tanks to prevent exposure to direct sunlight exposure to control algal bloom and to maintain proper water quality.

3.6 Water source

Water can be drawn either from the open sea or from bore wells from where, water of the same salinity as that of seawater could be drawn. Open seawater source is desirable since it will be more natural than that of bore well water. However in certain months, when the near shore water gets diluted due to freshwater influence, bore well water with higher salinity can be used.

3.7 Water quality management

Broodstock fishes maintained in captive condition should be provided with required environmental conditions for maturation and spawning. Though it is not possible to provide all the conditions as that of sea, at least the water quality to that of the natural seawater should be maintained to the extent possible.

The desirable water quality parameters for broodstock development are:

Temperature	-	28 – 32^{0}C
Salinity	-	28 – 33 ppt
pH	-	7.0 to 8.2
Dissolved oxygen	-	more than 5 ppm
Ammonia	-	less than 0.1 ppm
Nitrite-N	-	less than 0.01 ppm
Phosphate	-	less than 10 – 20 mg/l
Suspended solids	-	less than 2 – 5 mg/l

Water should be clear and it is desirable if the water is filtered through biological filter or pressure sand filters for better water quality. The tank bottom and sides should be regularly cleaned and 70 – 80% of the water should be changed daily.

3.8 Stocking density

Fishes can be maintained @ 1 kg/m^3 in the broodstock tank. In cages the density can be doubled depending upon the water quality and feed management.

3.9 Feed management

Maintaining the fish by feeding with quality feed of nutritional value is essential for successful maturation, spawning and quality egg production. Seabass is generally fed with trash fishes. It is a voracious carnivorous fish, feeding mainly on crustaceans/small fishes in nature. But under captive condition, the fishes have to be slowly weaned to inert diet that can be easily provided. In the broodstock holding tanks, fishes are fed with frozen trash fish @ 5% of the body weight. Since the fish is adapted to feed on live fish in nature, it has to be gradually weaned to frozen fish. To start with, live and frozen trash fish are given in the ratio of 2 : 1 and slowly within a period of 15 – 20 days, the live fish is replaced completely with frozen fish. Feeding frozen fish is desirable since the daily availability of fresh feed is uncertain and further it will reduce the cost of collection. Moreover, transmission of pathogens, if any, from live fish to the broodstock can be controlled by feeding frozen fish. Fresh low cost fishes like tilapia *(Oreochromis mossambicus)*, sardines *(Sardinella sp)*, horse mackerel *(Decapterus sp)* etc., can be procured, cleaned and packed in polythene bags of 2 – 4 kg and stored in deep freezer at – 20^{0}C. At the time of feeding, the fishes can be taken out, thawed, washed and fed to the fishes. Since squid is a rich source of proteins, it can be fed once in a week. Quality feed helps in production of good quality eggs. This leads to higher fertilization, hatching rates and larval quality.

Since seabass does not prefer to take the feed settled at the bottom, care should be taken that the feed is in the sub-surface water column while feeding. The trash fish can be individually given if the size is small so that it could be ingested by the fish, otherwise it needs to be cut into pieces before feeding. Formulated diet can also be given. Feeding should be done once a day in evening hours. Excessive feeding should be avoided since the left over feed would deteriorate the water quality and the unused feed should be removed immediately.

3.10 Health management

Since brood fishes are maintained in higher densities compared to their distribution in wild, the fish will experience stress. Moreover, the fishes are frequently disturbed while cleaning the tanks and during observation for gonadal conditions.This may cause injuries leading to bacterial, fungal and viral infections. The natural pathogens, endemic to fish and pathogens in the water would also proliferate. These problems can be overcome by regular health checking and proper prophylactic treatment in time. It is better to have spare broodstock tanks, for use during disinfection period. The broodstock tanks are to be disinfected once in three months to avoid contamination. Healthy gravid fishes can be obtained in 6 – 8 months from well maintained broodstock fishes.

4. INDUCED SPAWNING

The seabass spends most of its growing phase in the coastal and inland areas and migrates towards the sea for maturation and spawning. The environmental conditions prevailing in the sea may be required for activating the hormones responsible for reproduction. If the sea-conditions can be simulated, the captive stock would mature and spawn. But simulating such conditions in hatcheries has limitations and not possible in all places. In some places like CIBA, this has been attempted and successful natural spawning occured. However, in majority of cases administering exogenous hormones responsible for ovulation and spawning has to be done. Luteinizing Hormone Releasing Hormone analogue (LHRHa) was found to be more useful in induced spawning of seabass.

4.1 Selection of spawners

The size of mature females will be 4 – 7 kg and males 2 – 3 kg. The males will ooze milt if the abdomen is gently pressed. The females will have eggs with diameter more than 450 μm. The gonadal condition is assessed by ovarian biopsy. A polythene cannula of 1.2 mm dia is inserted up to a distance of 3-4 cm through the ovipore and the other end of the canula is held in the mouth of the operator and aspirated gently and simultaneously the canula is pulled out.

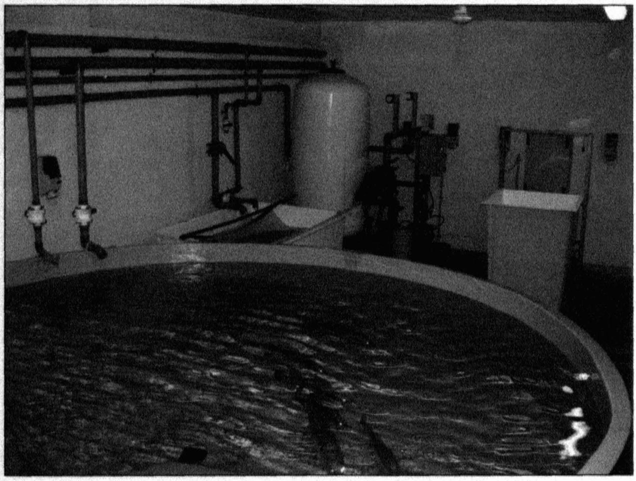
The eggs collected are measured and female fishes with more than 450 μm ova diameter are selected. Brood fishes selected for induction of spawning should be active, free from disease, wounds or injuries. Since spawning in seabass is influenced by lunar periodicity, the days of new moon or full moon or one or two days prior or after these days are preferred for inducing the spawning.

Seabass spawners

4.2 Spawning through environmental manipulation

The fish attains maturity when favourable environmental conditions like water depth, salinity, pH, dissolved oxygen etc., prevails. These favorable environmental features accelerate the endogenous endocrine system stimulating the gonadal hormones in adult fishes. In shallow lagoon, creek or backwater environments, due to lack of favourable environmental conditions, fishes might attain somatic growth but seldom reach gonadal maturity. The seaward migration facilitates the fish to reach favourable conditions. For example, in Indian coastal regions, the seabass breeds during the months of April to November. Provision of favourable conditions like salinity 28±2 ppt, pH 8.0± 0.5, dissolved oxygen >4 ppm, ammonia <0.1ppm and water depth of around 1.5 m along with recirculation will help in natural breeding of seabass though out the year.

In order to facilitate such spawning of seabass under captivity, selected brood fishes are stocked in 10 t capacity FRP tanks with male and female ratio of 2:1. The density was maintained around 2 kg /m^3 and provided with seawater recirculation system. The facility is well equipped so that the water recirculation rate can be increased or decreased depending upon the biomass of the fishes and the size of the individual fishes. Salinity can be adjusted in this system according to the requirement by adding brine solution.



Recirculation system in the seabass hatchery

The trials indicate that a minimum of 200 % recirculation of seawater per day is required. Seabass being an intermittent spawner, the same fish can undergo multiple spawning in one season and spawning of eggs varies from 1000 to 2 million. The fertilization rate is also found to be good since the fish spawns in the natural process. In the recirculation facility, it is possible to achieve year round breeding and seed production of seabass.

4.3 Induced spawning by hormone injection

The commonly used hormones in finfish hatcheries for induced spawning are:

LHRHa	-	Luteinizing Hormone Releasing Hormone analogue. Available with SIGMA CHEMICALS –USA -ARGENT CHEMICALS
HCG	-	Human Chorionic Gonadotropins. Available in Pharmacy – medical shops.
Ovaprim	-	A Glaxo Product

Puberogen - Consists of 63% FSH and 34% LH

In the case of seabass at CIBA, LHRHa hormone is found to be effective with assured result. Other hormones can also be used singly or in combination.

Hormone administration

4.3.1 Hormone dose

After selecting the gravid fishes, the requirement of hormone to be injected is assessed. The dosage level of LHRHa has been standardised @ 60 – 70 μg/kg body weight for females and 30 – 35 μg/kg body weight for males after many trials. The hormone in the vial (normally 1 mg) is dissolved in distilled water of known volume (4-5 ml). Care should be taken to thoroughly dissolve the hormone. The weight of the brood fish is assessed and the required hormone is taken from the vial using a syringe.

For example

If the content of 1mg vial is dissolved in 5ml, each ml will have hormone concentration of 200 μg. If the selected female fish weighs 6 kg, the dosage is @ 70μg/kg body weight and the hormone requirement will be 70 x 6 = 420 μg for female fish.

Then from the vial

$$\frac{1}{200} \times 420 = 2.10 \text{ ml}$$ has to be drawn for injection.

For the males – if the weight is 3 kg each, the requirement at a dose rate of 35 μg/kg body weight will be 35 x 3 = 105 μg.

Then

$$\frac{1}{200} \times 105 = 0.525 \ \mu l$$ has to be injected.

4.3.2 Hormone administration

In the case of seabass, a single dose of hormone administered intramuscularly is found to be effective. The fish is held firmly and to reduce the activity, the snout portion is covered with a hood. After removing one or two scales just below the dorsal fin (above the pectoral region), the syringe needle is inserted into the muscular region and the hormone is gently administered intramuscularly and then the fish is released into the spawning tanks.

4.3.3 Time of Injection

Since spawning normally occurs in the late evening hours, when the temperature is low, hormone is injected in the early hours of the day between 0700 – 0800 hr.

4.3.4 Spawning Tanks

The size of spawning tanks depends upon the size of the fish selected. Normally 10 – 20 t capacity tanks with provision for water inlet, drainage, overflow and aeration are used.

4.4 Sex ratio

The females are generally larger (more than 4 kg) and the males are smaller (2 – 3 kg). To ensure proper fertilization normally two males are introduced for one female in the spawning tank.

4.5 Spawning

Fishes administered with LHRHa hormone respond for spawning after 30-36 hours of hormone treatment. Spawning normally occurs late in the evening hours between1900-2000 hrs. At the time of spawning, the fishes move very fast and in the water surface a milky white substance appears. There will also be a fishy odour which can be felt even a few meters away from the spawning tanks. Seabass has high fecundity. It is a protracted intermittent spawner (releasing eggs, batch by batch). In one spawning the fish may release 0.5 – 1.2 million eggs. The process of spawning will continue in the subsequent day also. If the condition of the selected gravid fishes is good, spontaneous natural spawning occurs followed by good fertilization.

4.6 Fertilization

Fertilization is external. In natural spawning of seabass, fertilization is 70 – 90%. The size of the fertilized eggs is around 0.75 – 0.80 μm. The fertilized eggs float on the surface and are transparent. The unfertilized eggs are opaque and slowly sink to bottom. Due to water hardening sometimes, even the unfertilized eggs, for short duration remain on the sub-surface but sink subsequently.

4.7 Egg Collection

The fertilized eggs can be collected by any one of the following methods.

4.7.1 Overflow method

After spawning and fertilization, the water level in the spawning tanks can be increased and allowed to overflow through the outlet along with the eggs and collected in a trough covered with bolting cloth of mesh size 150 – 200 μm. The eggs can be transferred to the incubation tanks.

4.7.2 Scooping/seine net collection method

Since fertilized eggs float on the surface, a bolting net cloth of 150 -200 μm mesh size can be used for collecting the eggs from the surface. The cloth can be stretched as net and towed along the water surface. The collected eggs after washing can be transferred to the incubation tanks.

4.7.3 Siphoning method

The water in the spawning tank is siphoned into small tank covered with collection net cloth through which the water is allowed to pass through. The eggs collected in the net cloth can be transferred periodically into buckets for transferring to incubation tanks.

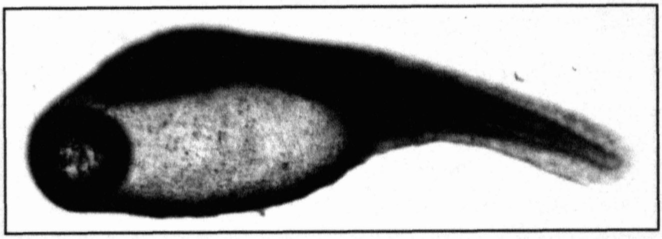
4.8 Incubation and hatching

The eggs collected from the spawning tank are washed to remove the debris and prevent its transfer to the incubation tanks. The hatching (incubation) tanks can be around 200 l capacity of cylindro-conical shape. The eggs are released @ 500 nos/l. Continuous aeration is provided. The water temperature of 27-28^{0}C is desirable. The eggs hatch out in 17-18 hours after fertilization, undergoing different developmental stages as follows.

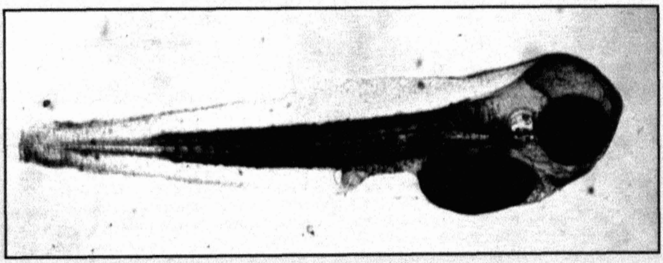
Embryonic Stage	Duration
One Cell stage	30 minutes
Two Cell stage	40 minutes
Four Cell stage	45 minutes
Eight Cell stage	60 minutes
Thirty two Cell stage	2 hrs
Sixty four Cell stage	2 hrs 30 minutes
128 Cell stage	3 hrs
Blastula stage	5 hrs 30 minutes
Gastrula stage	6 hrs 30 minutes
Neurula stage	8 hrs
Early embryo stage	11 hrs
Heart functional and tail movement	15 hrs
Hatching	17 – 18 hrs

Developmental stages of seabass

Embryonic development



Hatched out larva



2 days old larva

The hatchlings measure around 1.5 mm. The un-hatched /unfertilized eggs (dead eggs) in the incubation tanks should be removed by siphoning. The larvae can be scooped gently using plankton net and transferred into buckets of known volume. After taking random sample for counting, depending upon the rearing density, larvae are transferred to rearing tanks.

5. LARVAL REARING

Rearing of hatchlings by providing the required environmental condition and feed is the most important phase in seed production technology. This is highly important in marine fishes like seabass, where the larval phase extends up to 21 days and during this time, the feed requirement, type of feed, etc., vary with every stage. The larvae have to be provided with nutritionally balanced diet. Moreover, seabass larvae are cannibalistic in behaviour. Differential growth is noticed even from the very early stages. The larger ones eat the smaller ones in the rearing tanks ultimately reducing the survival rate. Production of healthy fry depends upon taking care of all these aspects in the larval rearing phase.

5.1 Larval rearing tanks

Larval rearing can be done in indoor and outdoor tanks. Indoor tanks are desirable in the initial stage of rearing for close monitoring of feed, water quality and health. The influence of extraneous factors, like light intensity, algal blooms, etc., can be avoided. Outdoor tanks are mainly extensive type. Though the larvae may grow large, their ultimate survival will be very low.

Larval rearing tanks can be circular or rectangular FRP or concrete tanks of 5-10 t capacity with proper slope for drainage and provision for clear filtered sea water, freshwater and aeration for operational convenience. Larvae can be reared in the same tanks up to 20-25 days or they can be transferred /thinned to other tanks after 15 days depending upon the larval density.

5.2 Stocking density

Freshly hatched healthy larvae (hatchlings) from the incubation tanks are transferred carefully to the rearing tanks and stocked initially @ 20 -30 nos/l. Depending upon the age and size, the larval density is reduced to 15-20 nos/l on 10th day onwards and may be maintained around 10-15 nos/l after 15 days.

5.3 Water change

Water provided to the larval rearing tanks should be free from flagellates, ciliates and other pathogenic organisms. Water should be filtered through biological filters, pressure sand filters and treated with UV radiation to get rid of the pathogenic organisms. If chlorine treated water is used, it should be properly dechlorinated since fish larvae are highly sensitive to chlorine.

In the larval rearing tanks, the metabolites from the larvae as well the live feed supplied accumulate and deteriorate the water quality if they are not removed carefully. The bottom sediment is removed by slowly siphoning out along with water into a trough with filter net. Filter net with mesh size of 100-200 μm is used up to 9 days for water change and afterwards 200-400 μm mesh sized net can be used. The water will flow through the net filter and the larvae siphoned out along with the sediment will be retained in the trough. After the required water reduction is done (normally 30-40 %), the larvae along with sediment are carefully transferred to another small trough. Healthy larvae are picked up and reintroduced into the tank. Dead larvae and sediment are discarded. To maintain water quality in the larval rearing tanks, 30-40% water change is done daily. Quality seawater is used to bring up the water level in the rearing tanks.

5.4 Feeding

Feeding the larvae should be done with utmost care. While under-feeding may lead to starvation and cannibalism, excessive feeding will lead to accumulation of harmful metabolites in the tank through their metabolites. Feed rationing and feeding depends upon the condition of the rearing tank and the larvae.

The rotifers (*Brachionus plicatilis*) are given as feed to the larvae from 3rd day onwards. Algal water is added daily up to 15th day. The algal concentration is kept around 20,000 cells/ ml in the rearing tank. Since in the open culture of algae, there are chances of contamination with flagellates, ciliates and filamentous algae which are toxic to the fish larvae, care should be taken to use good quality algal water. Apart from being a source of feed for the rotifers, the algae also help in the conversion of harmful excretory products like ammonia and other metabolites in the rearing container into less harmful nutrients.

The rotifers in the larval rearing tanks are maintained @ 20-30 nos/ml initially and increased to 40-50 nos/ml from 4th to 8th day. Every day, after water exchange, the food concentration in the tank should be assessed and fresh rotifers should be added to maintain the required concentration.

In the early stages (3-5 days) the larvae may not be in a position to ingest the large sized rotifer. Hence, after collecting the rotifers from the tanks small size rotifers of less than 120 μ should be selected by using suitable mesh size (100μ) cloth nets and fed to the early larvae. Assorted size rotifers can be given as feed from 6th day onwards.

Brine shrimp (*Artemia*) nauplii are fed along with rotifers from 9th to 15th day and thereafter the *Artemia* nauplii alone were fed up to 21st day. The density of the nauplii in the rearing medium is maintained @ 2000 nos./l initially and gradually increased to 6000 nos./l as the rearing days progress. The daily ration is adjusted after assessing the unfed *Artemia* in the rearing tank at the time of water exchange.

Feeding schedule for seabass larvae is summarized below.

Days	Feed				
Larval stage	*Chlorella/ Tetraselmis/ Isochrysis* (10^3cells/ml)	Rotifer (*Brachionus plicatilis*) (nos/ml)	*Artemia* nauplii (nos/l)	*Artemia* biomass (nos/l)	Cooked minced fish/ shrimp meat (% body wt. per day)
3 – 8	20 – 30	20 – 30	-	-	-
9 –15	20 – 30	40 –50	2000-3000	-	-
16 –21	-	-	4000-6000	-	-
22- 30	-	-	-	1000-1500	30 - 40

By 25th day, the larvae will attain a length of 1.0 – 1.5 cm and the fry can be fed with *Artemia* sub adult (biomass) along with cooked minced fish/shrimp meat. The fry can also be weaned slowly to artificial feed.

5.5 Enrichment of live feed

Under circumstances, when the rotifers could not be fed with marine micro algae adequately, the nutritional quality of such rotifers may be poor. In such cases, the rotifers can be enriched with special enrichment media by keeping the rotifers in emulsified enrichment medium like cod-liver oil or SELCO DHA for 12-18 hours. By this process, the rotifers ingest the enrichment medium which is rich in Poly Unsaturated Fatty Acids (PUFA) required for larval growth. The rotifers are then washed and fed to the larvae. In this way *Artemia* nauplii/ biomass can also be enriched and fed. *Moina sp.,* a Cladoceran can also be fed to seabass larvae after 25 days.

5.6 Grading

Seabass larvae are highly cannibalistic and it is more pronounced in early stages. In the rearing tanks though the hatchlings are from the same spawner, few larvae grow larger and they are tempted to eat the smaller ones. To avoid this problem, regular grading has to be done. The large sized larvae, the "Shooters" are to be removed. To the extent possible, uniform sized larvae should be kept in the rearing tanks for better survival. Grading should be done once in three days from the 12th day onwards or whenever different size larvae are seen in the tanks. Grading can be done using a series of fish graders with different pore size of 2, 4, 6, 8 and 10 mm respectively. When the larvae are allowed to pass through the graders with different pore sizes, larvae will be retained according to the pore size of the sieves. Grading may cause injuries leading to mortality. Hence proper care should be taken in handling the larvae. Prophylactic treatment with 5 ppm Acriflavin can be given.

By adopting these practices, survival rate upto 48 % has been achieved with a survival rate of around 15 % in 25 days in larval rearing phase. After rearing the larvae in the hatchery for 25 – 30 days, the fry can be transferred to nurseries for further growth.

6. LIVE FEED CULTURE

Finfish larvae in the early stages of development are planktivorous, feeding mainly on zooplankton. Adequate quantity of quality live feed of required size that can be ingested by the larvae should be made available during the larval rearing phase. The different types of live feed used in the larval rearing of seabass include green algae, *Chlorella sp, Nannochloropsis sp, Isochrysis* sp. and *Tetraselmis* sp. protozoans, *rotifers* and *Artemia* nauplii. The culture and supply of live feed organisms have a direct bearing on the success of any larval rearing practice.

Pure cultures of the above organisms have to be continuously maintained in controlled laboratory conditions to ensure a constant source of starter culture. Live feed culture should be initiated at least one month prior to the spawning season, to provide continuous supply.

6.1 Micro algae

Micro-algae play an important role as a food source and together with bacteria have an important role in the oxygen and carbon dioxide balance in the cultures. More than 40 different species of micro-algae, isolated in different parts of the world, are being used in intensive cultures. The most frequently used species are *Isochrysis galbana, Isochrysis tahiti, Monochrysis lutheri, Tetraselmis* spp, *Dunaliella* spp and *Chlorella* spp.

Criteria for selection of micro-algae are:

i) Size and feeding density, motility and floating capacity, nutritive value, digestibility, reproducibility and cost effectiveness

ii) Physical requirements for the culture of algae are

   a. Illumination

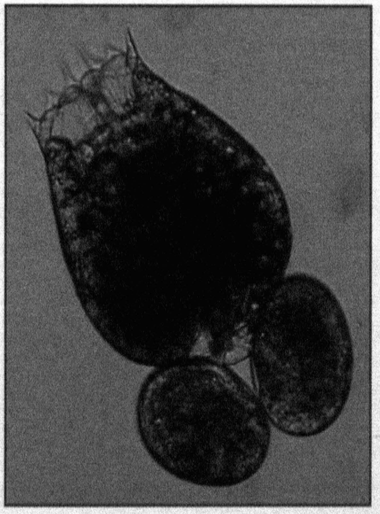
   b. Temperature and

   c. Aeration

Aeration is provided to keep the algae in suspension, to partly supply carbon needed for plant growth, to disperse dissolved materials and to avoid adherence of cells to the walls of culture vessels. Out door mass production of *Chlorella* consists of two stages. In the first stage, 500 l tanks are inoculated with starter culture and in stage two, tanks of greater capacity are inoculated from cultures drawn from 500 l tanks, after they attain harvest stage.

6.2 Rotifer *(Brachionus sp)* culture

Rotifers are microscopic organisms, abundantly found in all the aquatic systems. They thrive in the eutrophic condition. Rotifer succeeds normally after the phytoplankton bloom crashes out. It feeds on macroscopic unicellular algae like *Chlorella, Tetraselmis, Nannochloropsis* etc., Because of their appropriate size (100 -280 μ) the fish larvae can ingest them. Hence they are cultured in large scale and used in fish hatcheries. Rotifer is considered as an important live feed organism.



Rotifer (*Brachionus plicatilis*)

Three types of rotifers are cultured in the hatcheries and used depending upon the requirements.

1. SS (super small) type - 100 - 140 μ
2. S (small) type - 140 - 220 μ
3. L (large) type - Above 220 μ

For mass culture of rotifers, green water with algal density >20 x 10^6 cells/ml is added to cleaned rotifer culture tanks. Rotifers are inoculated to achieve an initial density of 10 nos/ml. The density is estimated by taking 1 ml aliquot with a glass pipette and counting the number of rotifers in the pipette and counting with a 10X magnifier. The culture is maintained for 7-8 days to increase the density of rotifers. Rotifers are harvested and concentrated using 48 μ plankton net. Some stock is reserved as starter culture for other tanks. After each harvest, rotifers are washed thoroughly before distribution to larval rearing tanks.

Culture of rotifer and algae should be properly scheduled to ensure uninterrupted production and daily harvest of rotifers. Culturists prefer rotifers to reproduce asexually, because of the shorter life span and better nutritive value of the asexual forms. This is accomplished by regulating feed, water, temperature, salinity and aeration during the culture process. Fertility is a measure of the general health of the rotifer culture. Under normal condition, more than 30% of the rotifers should be carrying eggs 24 hrs after initial stocking. This value will fall to 10% at the time of harvesting.

6.3 BRINE SHRIMP *Artemia* NAUPLII AND BIOMASS PRODUCTION

6.3.1 Brine shrimp *Artemia* nauplii production

Brine shrimp, *Artemia* is an important source of animal protein for the fast growing larvae of seabass. *Artemia* is rich in required PUFA and amino acids needed for early stages of the larvae.

Artemia culture in the hatchery starts with cysts. Cysts are the metabolically inactive encysted embryos. The dry cysts measure 232-240 μm in diameter and weigh about 3.70 μg. On an average 1 g cyst contains about 2, 65,957 live particles, which after immersion in normal seawater hatches into nauplii. After hydration of cyst it measures 237.4 ± 6.60 μm in diameter and weighs 3.70 μg. The nauplii at the first stage is known as INSTAR I. It metamorphoses up to INSTAR XII which is the adult stage of *Artemia*.

Artemia nauplii

In about 12 days, the individual animal attains 7.5 mm length. Sexual dimorphism is pronounced by this time. In males the antennae get transformed into hood like muscular graspers, whereas in the posterior part of the trunk region, a paired copulatory organ can be observed. The female *Artemia* can easily be recognized by the brood pouch which is situated just behind the 11th pair of thoracopods. They become gravid by 15th day, carrying a brood sac full of eggs. The total length of *Artemia* at this stage is 9-10 mm.

The production of nauplii by incubation of cysts in seawater is a very simple procedure. However, for large scale production of nauplii, several parameters are critical to achieve maximum hatching efficiency. The optimum conditions for cyst hatching are:

Temperature	-	25 - 30°C
pH	-	7.5 – 8.5
Salinity	-	26 ppt
Oxygen	-	above 2 ml/l
Illumination	-	above 1000 lux
Cyst density	-	1 g/l

Best hatching efficiency with high densities of cysts can be achieved with transparent funnel shaped cylindroconical FRP tanks of 20-30 l capacity that are aerated from the bottom. The hatching tanks are illuminated from a distance of about 20 cm with 60 W fluorescent lamp. Continuous aeration from the bottom of the tank ensures that all cysts are kept in suspension. Complete hatching takes place within 24-36 hrs. When hatching is complete, using a light source, the nauplii can be attracted and collected by siphoning.

6.3.2 Decapsulation of cyst

The hard dark brown external layer of cyst, the chorion can be removed without affecting the viability of the embryo by short term exposure of the hydrated cyst to a hypochlorite solution. Decapsulation improves the hatching efficiency.

Decapsulation procedure

The decapsulation solution requires a source of hypochlorite, usually liquid bleach (NaOCl) and an alkaline product to increase pH level of the decapsulation solution above 10. Usually technical grade caustic soda (Sodium hydroxide NaOH) is used. The first product is added at 0.5 g active chlorine per gram of cysts, and the second as 0.15 g sodium hydroxide per gram of cysts. For 1000g of hydrated cysts the procedure is as follows:

1. Prepare 0.5 g Cl x 1000 g cysts = 500 g of active chlorine, equal to 3.33 l of 15 % bleach.
2. Prepare 0.15 g NaOH x 1000 g cysts = 150 g of NaOH, equal to 0.375 l of 40 % NaOH solution.
3. Mix the bleach (3.33 l) and NaOH (0.375 l) in a suitable container (20 l plastic bucket) and to prepare the decapsulation solution make up to 14 l by adding 10.3 l of seawater.
4. Aerate this solution for 24 hours. Then stop aeration and sediment.
5. Drain out the hydrated cysts into fine mesh sieve.
6. Put the hydrated cysts into decapsulation container, add decapsulation solution, aerate and wait till cysts become orange in colour.

7. Drain the suspension of decapsulated cysts into a fine mesh sieve and rinse immediately, until the smell of hypochlorite is removed.
8. Soak and stir in O.IN HCl solution for less than 1 minute, wash, soak and stir in 0.1% $Na_2S_2O_3$ for less than 1 minute.
9. Wash and incubate for hatching.

6.3.3 *Artemia* biomass production

As the seabass larva grows, the feed requirement and the preying tendency of the fry increases. Adult *Artemia* biomass meets this requirement of the seabass fry. Biomass production under controlled conditions can be carried out either in batch or in flow through culture systems. In both the culture systems, provision is made to maximize oxygenation of the medium and to ensure food availability to all the larvae, when culturing in high density.

In batch culture system, nauplii are reared up to adult stage, without any water renewal in airlift raceways. Freshly hatched nauplii are stocked at a rate of 10,000/l and fed with rice bran. The water transparency is maintained at 15-20 cm. As *Artemia* is a nonselective filter feeder, it can be cultured by feeding with a wide range of feeds like *Chaetoceros*, *Skeletonema*, marine algae, yeast etc. Adequate food must be available in the medium at all times as *Artemia* is a continuous filter feeder. Faecal pellets and exuviate are to be removed regularly from the culture medium from the 4th day of culture onwards, as they affect water quality. The pH should be maintained at the level above 7.5. Harvesting is done with a scoop net.

More intensive *Artemia* culture can be achieved with flow-through system in which continuous renewal of culture water will be required to be maintained, but in all other aspects it will resemble the batch culture system. Continuous inflow of fresh culture medium along with food is provided to the culture tank. The continuous water change results in removal of all metabolites and hence intensive *Artemia* culture @ 20,000/l can be carried out .

7. NURSERY REARING

Seabass (*Lates calcarifer*) can be cultured in grow out ponds or net cages. Before stocking in grow out culture system, seabass larvae grown in the hatcheries are to be further reared for a period of 30 – 45 days till they attain the optimum size that can be stocked in the culture systems. Nursery rearing is an important phase in the seed production, since this transitional phase can be used for acclimatisation and weaning to artificial feed and environmental conditions of the grow out systems. In the nurseries, the fry can be reared in higher densities. This would save space and time in grow out phase. The preferred stocking size of the seed is 5 – 10 g. Nursery rearing of sea bass needs special care because of cannibalistic tendency and differential growth of the fish. Cannibalism is more common in the first two months when the fishes are 1 – 20 cm long. Nursery rearing can be done either in the hatcheries or in the farm.

7.1 Nursery rearing in hatcheries

Seabass fry of 20 – 30 days old in the size of 1.0 – 1.5 cm are stocked in the circular or rectangular (RCC or FRP) nursery tanks of 5 – 10 t capacity. Out door tanks are preferable. The tanks should have water inlet and outlet provisions. Flow through provision is desirable. *In situ* biological filter outside the rearing tanks would help in maintaining the water quality. The water level in the rearing tanks should be 70 – 80 cm. Good aeration facility should be provided in the nursery tanks. Nursery tanks are prepared one week before stocking. After filling with water up to 30 – 40 cm and fertilized with ammonium sulphate, urea and superphosphate @ 50, 5 and 5 gm (10:1:1 ratio) respectively, the natural algal growth would appear within 2-4 days. In these tanks, freshly hatched *Artemia* nauplllii @ 500 – 1000 l are stocked after leveling the water to 70 – 80 cm. The nauplii stocked are allowed to grow into biomass (refer the sections 6.3 *Artemia* nauplii and of 6.3.3 Biomass production) by feeding rice bran. When sufficient *Artemia* biomass is seen, seabass fry are stocked @ 500 – 1000 nos/m^3. The pre-adult *Artemia* would form good food for seabass fry. The fry would not suffer for want of food in the transitional nursery phase in the tank since the larvae are habituated to feed on *Artemia* in the larval rearing phase. Along with *Artemia* biomass, supplementary feed consisting of mainly ground fish/shrimp meat particles of 3 – 5 mm and cladocerans like *Moina* sp are also given. The fish/shrimp meat is fed 3 – 4 times daily @ 100 % of the body weight in the first week of rearing. This is gradually reduced to 80 %, 60 %, 40 % and 20 % during 2nd, 3rd, 4th and 5th weeks respectively. 70 % of the water is exchanged daily. The left over feed and the metabolites are to be removed daily and aeration should be provided. During 4-5 weeks of rearing the seed attains the size of 1.5 to 3 g/ 4-6 cm with a survival rate of 60-70 %. Adopting this technique at a stocking density @ 1000 nos/m^3 in the hatchery, the survival rate up to 80 % has been achieved. Regular grading is to be done and shooters are to be removed for better survival. "Grading" should be done using specially designed vessels with different mesh sized nets. When the seeds are sieved into the containers, the seeds are separated in to different grades according to the mesh size. Care should be taken that they are not injured while handling. If the number is less, they can be manually graded.

The major problem encountered in nursery rearing in the hatcheries is infection. Normally the infected fishes will have an inflammated opercular region, with gills exposed. With a whirling movement, the fishes die within a few hours. This may be due to the bacterial or viral infection. This problem is chronic during October – November months. As a precautionary measure, treatment with 100 ppm formalin is done. To avoid such problems, the hatchery should be hygienically maintained and water temperature of 28 – 29°C is desirable.

7.2 Nursery rearing in grow- out site

Rearing fry up to stockable size in the hatchery itself has some problems. All hatcheries may not have such facilities since the requirement of space is 5 – 6 times more than larval rearing section and it also requires additional man power, energy etc. Above all, transportation of large sized seed to culture site would be expensive. To avoid these problems, wherever possible, nursery rearing can be done in the grow out site.

7.2.1 Nursery rearing in ponds

Nursery ponds can be 200-500 m^2 area with provision to retain at least 70 – 80 cm water. Adequate provisions for water inlet and outlet should be provided. Towards drainage side there should be a slope. Both the inlet and outlet should be guarded with 1 mm mesh screen nets to prevent entry of unwanted fishes as well as escape of the fry.

The pond is prepared before stocking by repeated netting, draining and drying to remove predators/pest fishes. In case, complete draining is not possible, water level is reduced to the extent possible and treated with Derris root powder @ 20 kg/ha or Mahua oil cake @ 200-300/kg/ha to eradicate unwanted fishes. Use of other inorganic chemicals or pesticides is avoided because these may have residual effect. After checking the pond bottom, quality water is filled. If the pond bottom is acidic, neutralization is done with lime application.

In order to maintain abundant natural food, the pond is fertilized with chicken manure @ 500 kg/ha, keeping the pond water level at 40 - 50 cm. The water level is gradually increased. After 2-3 weeks when plenty of natural algae develop in the pond, freshly hatched *Artemia* nauplii are introduced. Normally 1 kg of cyst is used for 1 ha pond. These stocked nauplii grow and form sufficient biomass which is available as food for the seabass fry.

Nursery rearing ponds

Seabass fry acclimatized to pond condition is stocked @ 20-30 nos/m^2 during the early hours of the day. Acclimatization is done in the following way. The fry in the transport container are emptied into another tank and the pond water is gradually added into the container. This process is continued for a day or two depending upon the difference in the water parameters. When the water temperature and salinity in the pond and tank water reach same level, fry can be released into the pond. Water is changed @ 30% daily. Supplementary feeding is done with chopped, cooked fish/shrimp meat. The fry can be weaned to artificial feed at this stage. The feeding rate can be as described in tank nursery protocol. Care should be taken not to give excess feed as it would deteriorate the pond condition and also promote filamentous algal growth. The excessive algal growth would deplete dissolved oxygen level during early morning hours, leading to mortality.

7.2.2 Nursery rearing in cages/hapas

Rearing seabass fry in cages/hapas is commonly practiced. This method is advantageous than other methods since it can be easily managed and installation of rearing facility requires less space and capital investment. It can also be extended to any scale depending on the necessity and the capability of the farmer. It can be maintained in a corner of the grow-out pond or near the grow-out cages itself. Since cages or hapas are in *in situ* condition, it provides natural environmental condition. The water flow in the cage site washes away the metabolites and excess uneaten feed.

Nursery rearing in hapas

Floating net cages/hapas can be in the size of 2 x 1x 1 m to 5 x 2 x 1 m depending upon the requirement. The cages are made with nylon/polyethylene webbing of mesh size 1 cm. The fry can be stocked @ 200 – 500/m^2 and fed as described in tank nursery protocol. The net cages are to be checked daily for damages caused by other animals like crabs. Further, the net cages get clogged by the adherence of suspended and dissolved materials and silt or due to fouling organisms resulting in reduction of water flow. This would restrict the water exchange in the cages leading to unhygenic conditions. To avoid this, cages/hapas should be cleaned everyday. Regular grading is desirable to avoid cannibalism and to increase the survival rate. Even in higher stocking density @ 500/m^2 farmer could get a survival of 80 % by adopting trash fish feeding and other management strategies mentioned above.

8. ESTIMATE FOR ESTABLISHING AND OPERATING A SMALL HATCHERY

8.1. Indigenously developed small scale hatchery

Non-Recurring (One time Investment)			(Approximate cost-Rs.)
1.	Land: Govt./Private, 2400 Sq.m. (1 Acre)		3,00,000
2.	Buildings: Hatchery- Spawning tanks, Egg incubation tanks, Larval rearing tanks. (Area required 75'x40'- 3000 Sq.Ft - 300 Sq.m)		15,00,000
3.	Tanks:		
	Brood stock holding tanks (100 t capacity open tanks)	2 Nos.	12,00,000
	Larval Rearing tanks (5 t capacity)	10 Nos.	6,00,000
	Maturation & Spawning tanks (20 t capacity)	2 Nos.	8,00,000
	Egg incubation tanks (500 l capacity)	10 Nos.	50,000
	Live feed culture tanks:		
	Algal culture tanks (5 t capacity)	10 Nos.	6,00,000
	Rotifer culture tanks (5 t capacity)	10 Nos.	6,00,000
	Artemia hatching tanks (100 l)	20 Nos.	40,000
	Live feed culture facilities A/C rooms, etc., 20 Sq.m.		1,00,000
4.	Air Blowers (5 hp Capacity)	2 Nos.	1,20,000
5.	Generator 22 KVA	1 No.	2,00,000
6.	Biological filters	2 Nos.	2,00,000
7.	Pressure sand filters	2 Nos.	1,80,000
8.	UV filter	1 No.	75,000
9.	Seawater /Fresh water facilities (Including pipe lines)		
	5 hp Pumps	3 Nos.	
	2 hp Pumps	3 Nos.	
	1 hp Pumps	3 Nos.	
	0.5 hp Pumps	3 Nos.	8,00,000

10.	Microscopes	50,000
11.	Heaters and Thermostat	70,000
12	Miscellaneous equipments – Refractometer, pH meter, etc.,	50,000
	Total capital input	75,35,000

	Recurring (Annual)	**(Approximate cost-Rs.)**
1.	Man power: Sr. Technician 1. @ Rs. 12,000/PM Technician 2 @ Rs. 10,000/PM Labour 8 @ Rs. 5,000/PM	 1,44,000 2,40,000 4,80,000
2.	Brood stock: Female brood stock of average weight 5 kg (20 Nos. 100 Kg. @ Rs.200/ kg live fish) Transportation cost Male with average weight 2-3 kg (40 Nos. 100 kgs. @ Rs.200/kg) Transportation Cost	 20,000 10,000 20,000 10,000
3.	Feed: Brood stock feeds (5% of the body weight. Monthly requirement 300 Kg daily 10 kg. 4 tons @ 18,000/tons) feed for larval and fry (*Artemia* cyst requirements /year 100 kg @ Rs. 2000/kg)	 72,000 2,00,000
4.	Fertilizers and chemicals	10,000
5.	Hormones LHRH-a	50,000
6.	Electricity @ Rs. 15,000/PM	1,80,000
7.	Fuel @ Rs. 10,000 /PM	1,20,000
8.	Miscellaneous: Nets, plastic wares, glass wares. etc.,	25,000
	Total operational cost	15,81,000

Say Rs.15, 80,000

Production schedule

Total runs: 8

Each run: Total fertilized eggs from 2 spawners = average 2 million

Hatching @ 70% hatchlings = 1.4 million hatchlings

30 days old larvae @ 15 % survival 2.10 lakhs fry /one run and for 8 runs 2.10 x 8 = 16.80 lakhs

Fingerlings @ 60 % survival rate from fry to fingerlings- 1 million fingerlings of 4 – 5 cm size

Sales

1 million seed @ Rs. 3 per piece	=	Rs. 30, 00,000
Profit over Recurring cost	=	Rs. 30, 00,000 – 15, 80,000
	=	Rs. 14, 20,000

8.2. Improved small scale hatchery for year round production

Non-Recurring (One time Investment)			(Approximate cost-Rs.)
1.	Land: Govt./Private, 2400 Sq.m. (1 Acre)		3,00,000
2.	Buildings: Hatchery- Spawning tanks, Egg incubation tanks, Larval rearing tanks (Area required 75'x40'- 3000 Sq.Ft - 300 Sq.m)		75,00,000
3.	Tanks:		
	Brood stock holding tanks: (100 t capacity open tanks)	2 Nos.	12, 00,000
	Larval Rearing tanks: (5 t capacity)	10 Nos.	8, 00,000
	Maturation & Spawning tanks (20 t capacity)	2 Nos.	10, 00,000
	Egg incubation tanks: (500 l capacity)	10 Nos.	70,000
	Live feed culture tanks:		
	Algal culture tanks (5 t capacity)	10 Nos.	4, 00,000
	Rotifer culture tanks (5 t capacity)	10 Nos.	4, 00,000
	Artemia hatching tanks (100 l.)	20 Nos.	70,000
	Live feed culture facilities A/C rooms, etc., 20 Sq.m.		1,00,000
4.	Air Blowers (5 hp Capacity)	2 Nos.	2,00,000
5.	Generator 22 KVA	1 No.	2,00,000
6.	Biological filters	2 Nos.	2,00,000
7.	Pressure sand filters	2 Nos.	1,80,000
8.	UV filter	1 No.	1,00,000
9.	Seawater /Fresh water facilities (Including pipe lines)		8,00,000
	5 hp Pumps	3 Nos.	
	2 hp Pumps	3 Nos.	
	1 hp Pumps	3 Nos.	
	0.5 hp Pumps	3 Nos.	

10.	Microscopes	50,000
11.	Heaters and Thermostat	50,000
12	Miscellaneous equipments – Refractometer, pH meter, etc.,	70,000
	Total capital input	1,36,90,000

	Recurring (Annual)	**(Approximate cost-Rs.)**
1.	Man power: Sr. Technician 1 @ Rs. 12,000/PM Technician 2 @ Rs. 10,000/PM Labour 8 @ Rs. 5,000/PM	1,44,000 2,40,000 4,80,000
2.	Brood stock: Female brood stock of average weight 5 kg (20 Nos. 100 kg. @ Rs.200/ kg Live fish) Transportation cost Male with average weight 2-3 kg (40 Nos. 100 kg. @ Rs.200/kg) Transportation Cost	20,000 10,000 20,000 10,000
3.	Feed: Brood stock feed (5% of the body weight. Monthly requirements 300 kg daily 10 kg. 4 t @ 18,000/t) Larval feed and feed for fry (*Artemia* cyst requirements / year 200 kg @ Rs. 2000/kg)	72,000 4,00,000
4.	Fertilizers and chemicals	10,000
5.	Hormones LHRH-a	50,000
6.	Electricity @ Rs. 20,000/PM	2,40,000
7.	Fuel @ Rs. 10,000 /PM	1,20,000
8.	Miscellaneous: Nets, plastic wares, glass wares. etc.,	25,000
	Total operational cost	**18,40,000**

Production schedule

Total runs: 10

Each run: Total fertilized eggs from 2 spawners = average 2 million

Hatching @ 70% hatchlings = 1.4 million hatchlings

30 days old larvae @ 20 % survival 2.80 lakhs fry /one run and for 10 runs 2.80 x 10 = 28.00 lakhs

Fingerlings @ 60 % survival rate from fry to fingerlings-1.68 million fingerlings of 6 – 8 cm size.

Sales

1.68 million seed @ Rs. 3.50 per piece		Rs. 58, 80,000
Profit over Recurring cost	=	Rs. 58,80,000 – 18, 40,000
	=	Rs. 40,40,000