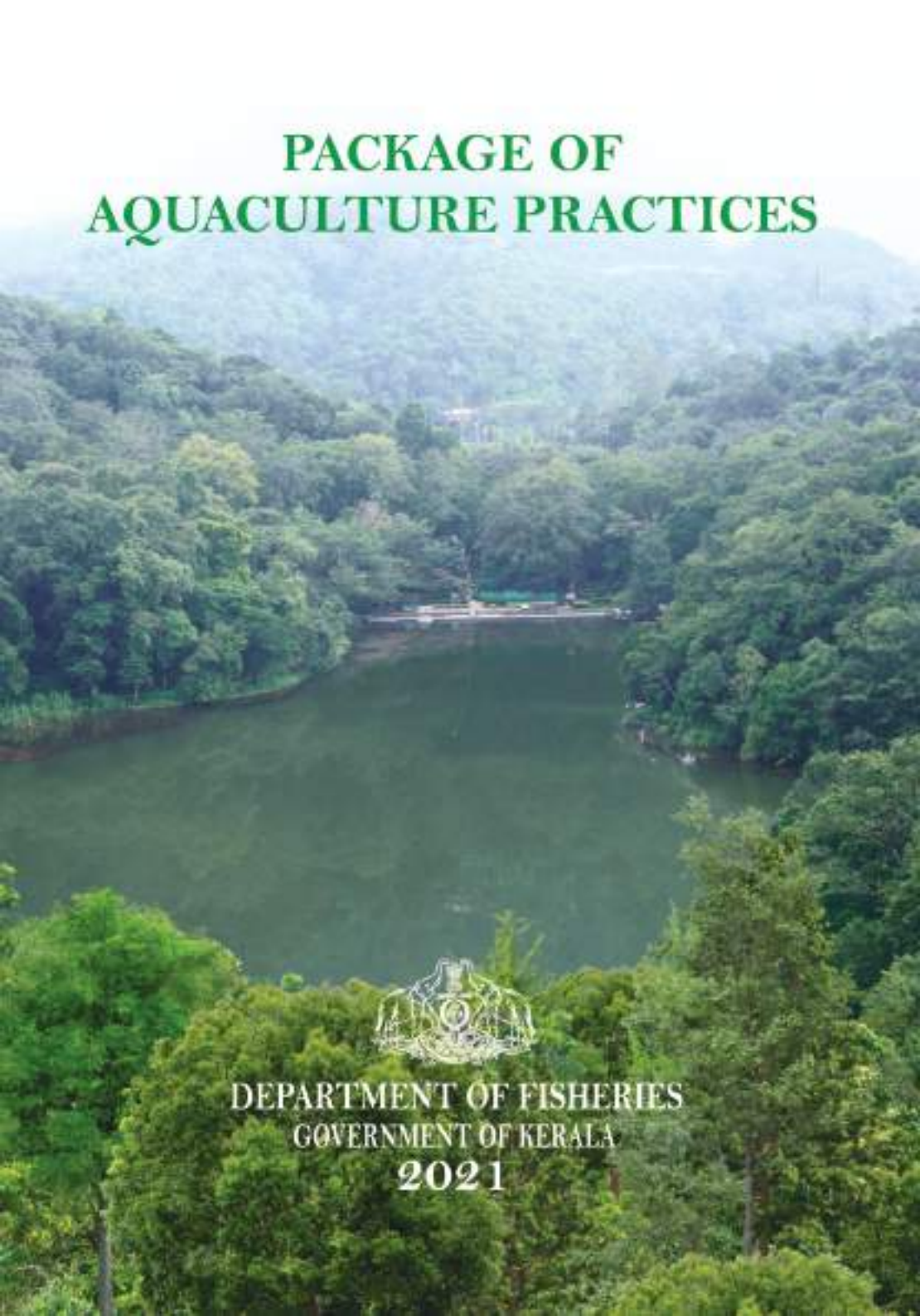
PACKAGE OF AQUACULTURE PRACTICES



DEPARTMENT OF FISHERIES
GOVERNMENT OF KERALA
2021

Package of Aquaculture practices

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Despite every effort, there may still be chances for some errors to have crept in unintentionally which may be communicated to the publisher so that it can be incorporated in the next edition.

Any views or directions expressed in this book are not of the institutes where the authors belong but of the Department of Fisheries, Government of Kerala.

J. MERCYKUTTY AMMA
Minister for Fisheries,
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Government of Kerala

03-02-2021

MESSAGE

It is indeed a great pleasure to learn that Department of Fisheries, Kerala is publishing a book on "Package of Aquaculture Practices". The State of Kerala is blessed with rich marine, brackish and fresh water resources, exporting considerable portion of its seafood to foreign countries to the tune of 1.78 lakh metric tonnes yearly valued at Rs. 5919.06 crores. The inland fishery is also an age old practice in the extensive network of backwaters and rivers of Kerala.

Aquaculture is not only a food production sector, but also a means of livelihood and economic development. The State has been undergoing a paradigm shift in terms of technology, species diversification and intensification, formulating specific action plans for achieving self-sufficiency in food production, which is considered as of utmost importance especially in the wake of covid-19 and its aftermaths. it is implicit that "Package of Aquaculture practices" can contribute very much in achieving this goal.

This book is the result of a collaborative approach and exchange of exhaustive information between scientists, administrators, extension personal and farmers, and this will definitely serve as a guide light for the sustainable development of aquaculture sector. I wish all success for this endeavour.

J. MERCYKUTTY AMMA

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MESSAGE

The Department of Fisheries has successfully introduced highly intensive technologies like RAS, Biofloc, Cage culture, and Aquaponics, along with the introduction of promising new species like Pearlspot, Nile tilapia, Pompano, Asian sea bass, Cobia, Vannamei shrimp, crab, mussel and oyster etc. which have good consumer demand. The importance of fish in ensuring nutritional food security, as a rich source of essential amino acids, polyunsaturated fatty acids, vitamins and minerals is well known. The State is in the process of enhancing the aquaculture production from 0.25 lakh metric tonnes to 2 lakh metric tonnes by 2025.

Apart from this, serious adulterations are observed in the fish brought from outside the State, which also calls for the production of quality fresh fish locally. Culture fishery is a dynamic sector where technological innovations and interventions are a continuous phenomenon. The interventions in culture fishery focus at increasing both productivity and expansion of culture area and intensification practices hold the major key for enhancing productivity. It is essential to provide a strong base in the seed production and culture practices and also to standardize it, in order to achieve the goal of sustainable production. This book is a comprehensive approach for providing techniques of aquaculture in a uniform and concise way to achieve the objectives of production. I am sure this book will also be a reference for farmers as well as students and other stakeholders of aquaculture and provide extra support for technical staff of the Department of Fisheries. I wish all the best for this publication.

TINKU BISWAL

EDITOR'S NOTE

Fish is considered as the most promising food and its high nutrient profile is very relevant at present, as it helps to develop immunity against the emerging diseases. Even though, considerable quantity of fish is produced in the State of Kerala, about 2 lakh tonnes of fish is brought annually from outside the State to meet the domestic requirement. Enhancing aquaculture production can bridge this gap; for which a shift from extensive to intensive farming practices is needed along with expansion of aquaculture area and diversification of culture species.

The state fisheries department has conducted demonstration farming for the past few years related to high intensive farming practices such as farming of fish in cages, biofloc, aquaponics and recirculatory aquaculture system. The carps and shrimp centered aquaculture have got diversified with the introduction of Nile tilapia, pangasius, pearlspot, seabass, pompano, cobia, vannamei shrimp, mussel, oyster etc. However, introduction of exotic species may add new pathogens into the system and large-scale intensification of aquaculture would lead to disease outbreaks. The prevalence of pseudo-consultants, minting money from fish farmers with their popularity, is another major emerging issue in the State. Ignorance of basic principles behind aquaculture practices often leads to excessive use of feed, chemicals, etc. and adoption of very high stocking density. Hence a standard guideline regarding the aquaculture practices to be followed by the stakeholders becomes relevant, which is obviously lacking in our country.

The lack of a standard procedure for aquaculture practices in the state was noticed during my intervention in the aquaculture sector initially, as the recommendations to the farmers by different extension staff varied with personnel, which leads the farmers in a dilemma. It was also noticed that there is a large disparity between the dosages and other practices which were successful in the field and those written in the publications while reviewing the recommendations of various eminent researchers. It might be due to the difference between the controlled farming conditions for research and the un-controlled conditions prevailing in the field and the differences in agro-climatic conditions prevailing in various parts of the country. Hence, it was decided to demonstrate various new technologies in actual

field conditions at various farms under the State Government and collaborating with farmers belonging to various agro-climatic conditions of the State. The positive results received from the field especially in the case of breeding experiments made me interested to record the procedures in the form of a book.

The idea of preparing a Package of Aquaculture Practices was first conceived in 2014. As the past six years was crucial as far as aquaculture sector was concerned, due to the emergence of various intensive aquaculture systems and introduction of new species, and it took almost 6 years to include various innovative practices including biofloc technology in order to have a comprehensive book for aquaculture practices in the state of Kerala.

This "Package of Practices for Aquaculture" is prepared based on the already published results of research and development activities conducted by RGCA, KUFOS and ICAR institutes like CMFRI, NBFGR, CIFA, CIFE, CIBA, CIFRI and DCFR and modified to suit the agro-climatic and socio-economic conditions of Kerala State after conducting field trials, demonstration farming and hatchery operations at various locations in the state.

I acknowledge the Directors of Department of Fisheries, Kerala during last six years for being instrumental in providing institutional and personnel support and encouragement in developing this book.

I also acknowledge the scientists, academicians and officers who have provided photographs and technical details for this document. The contribution of all the resource persons for the book is deeply acknowledged. This book has been prepared to provide an overview of basic guidelines to be followed in aquaculture, presented in a lucid way, so that it is easy to comprehend and implement, not only by the specialist but also by the farmers.

B. Ignatious Mandro
Joint Director of Fisheries
Government of Kerala

FOREWORD

C.A. Latha I.A.S
Director of Fisheries

World aquaculture production of fish, crustaceans and molluscs by inland and marine waters is enhanced from 55.16 million tonnes (2009) to 82.1 million tonnes (2018) with an average annual growth rate of about 4.09%. In India, during the same period it is enhanced from 3.79 million tonnes to 7.07 million tonnes with an average annual growth rate of about 6.43%. Regarding major global aquaculture producers, India has second position behind China (47.6 million tonnes). In terms of value, India contributes USD 13.188 million to USD 250.16 million globally. Out of the total global production of aquatic animals, 21.89% is contributed by carps while in India it is almost 90%. At present considerable diversification in terms of species and systems for aquaculture is being witnessed in the country.

Aquatic ecosystems of Kerala are highly productive and provide significant contributions to food and nutritional security along with economic and social development by way of capture and culture fisheries. The culture fishery is considered as the important food production sector of this century and is placed as one of the high priority areas by many countries around the globe. The investment pumped into this sector for the past years stand as the testimony for the importance it is having in the present world. As fish acts as the largest single source of animal protein, its demand outstrips supply owing to the ever-increasing human population which has already crossed the level of 700 crores.

As far as Kerala is concerned, it is the land of fish consumers with highest per capita consumption. The annual per capita consumption of fish in Kerala is 19.59 kg compared to the national average of 3.24 kg. Capture fishery from sea and inland water bodies serve as the prime

source of this delicious live food, for the State but now it is on a declining trend. Over exploitation with increased mechanization makes the capture fisheries production more or less stagnant during recent decades. The traditional practice of hunting and gathering of fish from these natural waters alone cannot meet the requirement of the State especially when there is global demand for our fishery produce. There is no scope for intensification of capture fishery, which would adversely affect the sustainability of the natural fishery resources. The culture fishery is the sole alternative to play an important role in meeting the deficit.

Culture fishery is the husbandry of commercially important aquatic organisms such as fish, crustaceans and molluscs etc under controlled conditions. Even though culture fishery is developed as a commercial business recently; it was practiced in Egypt and China since ancient times by collecting small fish from natural system and growing in ponds. The contribution of aquaculture to national fish production has enhanced from 48.9 % 2011 to 56.12% (2018).

Over the years various practices and methods have been developed

This package of practice is prepared by referring published literature, conducting field experiments and exhaustive deliberations involving experts of scientific communities from central institutes, academicians and officers of the State fisheries department who are well experienced in different aquaculture practices. It covers all the variety of culture practices prevalent in the state with up to date information regarding the procedures to be followed for a particular culture after considering the ground realities in the state.

I acknowledge the Chairman of RGCA, Vice-Chancellor of KUFOS, and Directors of CMFRI, NBFGR, CIFA, CIFE and DCFR, leading institutes in fisheries research and development, for providing technical and personnel support in developing this book. I am sure this will be an important step for the States path towards achieving self-sufficiency in fish production and I wish success for this endeavor.

Vikasbhavan,
3.02.2021

C.A. Latha I.A.S
Director of Fisheries
Government of Kerala

PREFACE

Kerala is endowed with abundant marine and inland water resources like rivers, rivulets, streams, estuaries and backwaters, which are well known for their biodiversity offering immense scope for aquaculture development and expansion. It includes 590 km of coastline, 44 rivers having 85,000 ha area, 49 reservoirs having 34180 ha area, 65213 ha brackish water area, 53 backwaters having 46,129 ha area and 12,873 ha prawn filtration fields. Aquatic biodiversity includes multispecies marine, brackish water and freshwater fin fishes, crustaceans and mollusks including various indigenous species. The Western Ghats of Kerala has the unique specialty of cold water fishery resources in a tropical belt.

Fisheries play an important role in ensuring the nutritional security of the state. Fish is not only a source of cheap protein but also a means of income, which can contribute, to livelihood of the low-income group people. Kerala not only feeds fish to its own people, but exports large portion of the fishery produce to foreign countries. As production from capture fisheries is stagnated, aquaculture can be a reliable alternate for fish production. Aquaculture is the emerging sector, which is considered as the alternative for compensating the deficit in fish production. The state, which has started aquaculture activities as extensive practices, is now gearing up for a quantum jump in aquaculture production. As part of this, high intensive farming practices were introduced for the past few years.

"Package of practices for aquaculture" is carved out of an idea of providing farmers and all stakeholders concise and comprehensive information related to various intensive scientific practices in fish farming currently implemented in the state of Kerala.

The book provides meticulous, yet concise descriptions of aquaculture practices in an exhaustive number of fish and shrimp species. This book contains 30 chapters covering almost all aspects of

seed production technologies and hatchery operations necessary for successful management. It also describes farming activities right from pre-stocking management to harvest. The chapters cover essential information such as brood stock management, breeding technique, and nursery rearing. Regarding farming practices, it covers pre-stocking, stocking and post-stocking management to be followed in various systems. The contributors have put in their best effort to include the updated information at field level regarding new farming techniques like culture in biofloc tank, aquaponics and cage. Care has also been taken to consider the field level realities with respect to the existing agro-geographic conditions and other aspects prevalent in the State.

We hope that this book would be of valuable use to extension staff of the fisheries department as well as to students, researchers, academicians and farmers as a practical guide in field. This book includes culture practices for most of the potential species that can be cultured in the State.

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CHAPTER: 21

GROUPER

Groupers are important fish, particularly for live seafood markets in several Asian countries and highly prized for the quality of their flesh. Orange spotted grouper, *Epinephelus coioides* inhabits a depth of at least 30 m, over mud and rubble in shallow reefs and lagoons; while the juvenile are found in the shallow waters of estuaries over sand, mud and gravel and among mangroves. It is eurythermal and euryhaline. It feeds mainly on fish followed by crustaceans and molluscs. It is a diandric protogynous species, where male is either derived from a juvenile phase or the transition from post spawning female. The female matures at 320 mm size at an age of 2 years, whereas the primary male matures at 242 mm size at an age of 1 year. The sexual transition occurs at a size of 550-750 mm at the age of 5-6 years. The major spawning period is March to June. It probably spawns during restricted periods and form aggregations for spawning after the full and new moon.

Fig. 21.1 Epinephelus coioides

SEED PRODUCTION

Broodstock management

For developing broodstock, the adult fish weighing not less than 2 kg are sourced from wild using hook and line or from a farm. The collected adult fish are given mild sedation using 50 ppm 2 phenoxyethanol

solution and transported in covered tank containing aerated water. After arrival in the hatchery, the gas filled in the air bladder (barotrauma) is removed by inserting a needle in to gas bladder through anus.

Fig. 21.2 Collected fish from wild showing barotrauma

Once the fish is swimming normally with controlled buoyancy by maintaining its position in the water column, it is shifted to quarantine area for 2 weeks, where it is provided with a bath in 200 ppm formalin solution for 30 minutes followed by 5 minutes dip in freshwater, once in every 3 days. After quarantine, the fish are transferred to maturation cum spawning tank (125 t capacity) having re-circulatory water system. The fish is fed to satiation once daily in the morning with fresh or frozen squid. Micro nutrients namely, vitamin A, vitamin B-complexes, vitamin C, vitamin E and vitamin–mineral mix are supplemented once a week along with the feed.

Fig. 21.3 Maturation cum spawning tank

After one month, the fish are cannulated using fish cannula or baby feeding tube CH-6 having an inner diameter of 1 mm and outer diameter of 2 mm for collecting gametes. After anaesthetising the fish using 200 ppm 2-phenoxy ethanol for 2-3 min, the cannula is guided into the urino-genital orifice of male and the oviduct of female for a distance of 6-7 cm into the body and suction is applied to the other end of the cannula as it is withdrawn. After withdrawal, the sample within the cannula is expelled onto a microscope slide for immediate examination or into a vial containing 1% neutral buffered formalin for later measurement of egg diameter.

Fig. 21.4 Cannulation of orange spotted grouper

Water quality management

Re-circulatory water system connected with maturation cum spawning tank will provide optimum water quality for the fish. The water quality management practices are similar to that explained for the milkfish.

Sex Reversal

Generally the wild collected fish is female; however, both sexes are required for the spawning purpose. Hence, 50% of fish are implanted with pellet containing 17 α methyl testosterone and letrazole @ 5 mg/kg and 0.2 mg/kg of the body weight respectively. The pellet is prepared using gum acacia, cholesterol and 17 α methyl testosterone in the ratio of 1:2:1. The pellet is implanted on dorsal side of the broodfish below to

the dorsal fin in musculature. The female is converted to male within 2 months after pellet implantation.

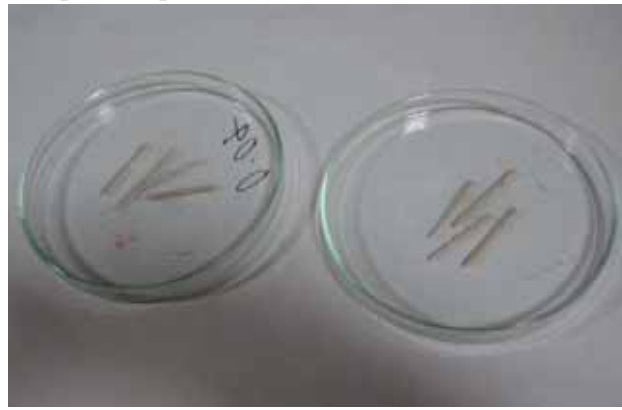

Fig. 21.5 Hormonal pellet for sex reversal

Spawning

Natural spawning starts from 4th month onwards after stocking, and they spawn 4-10 times in a month. The spawning continues round the year. Generally fish spawn during evening hours before sunset. The spawning pair shows courtship behavior with a typical vertical burst of swimming just before release of gametes. Fertilisation occurs externally and fertilised eggs are transparent and floating in nature having 850-900 µm diameter with a single oil globule. On an average, 2-3 lakh fertilised eggs are collected from each spawning.

Incubation

After 14 hours of spawning, the eggs are collected using hapa net (1x1x1 m) of 500 µm mesh size fixed in the egg collecting chamber. The collected floating eggs are disinfected with 20 ppm active iodine solution for 10 minutes and stocked in aquarium (100 l capacity). Fertilisation rate is estimated by taking sample from aquarium. The fertilised eggs are either incubated in the aquarium at a density of 400 no./l with mild aeration or directly stocked into indoor nursery-rearing FRP tank (2 t) at a density of 10 no./l. The eggs hatch-out within 18-20 hours at 28-30ºC. Average hatching rate is more than 85%. The newly

hatched larva has an average total length of 1.6 mm with yolk sac. Mouth of the hatchling appears after 48-56 hours with an opening of about 120 µm.

Live feed production

The production method is same as that explained for other marine finfish. Live feeds used for orange spotted grouper larval rearing comprises of microalgae (*Nannochloropsis* sp. and *Isochrysis* sp.), copepod nauplii and adult (*Parvocalanus crassirostris*), small rotifers (*Brachionus rotundiformis*), large rotifers (*Brachionous plicatilis*) and brine shrimp (*Artemia*) nauplii.

Rearing of larvae

The sea water used in larval-rearing tank is passed through sand filters to remove particulate matter and is then sterilized by ozone treatment to eliminate pathogens. Generally fertilised eggs are stocked in larval rearing tank just before hatching.

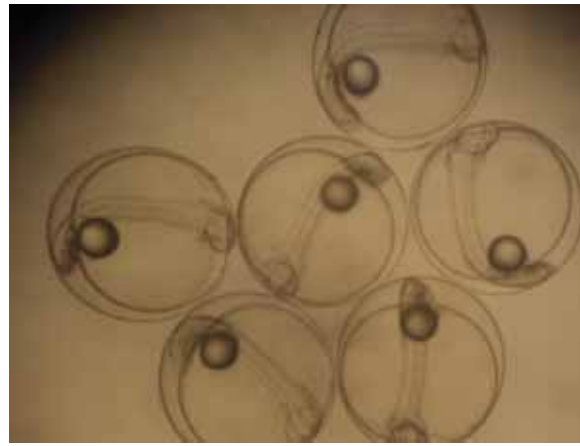

Fig. 21.6 Eyed stage eggs before hatching

After hatching, bottom of the tank is siphoned to remove any un-hatched eggs as well as eggs shells. Tank is covered with black cloth till the first feeding. Oil is added to form a thin film on the water surface (around 0.2 ml/m^2) during 1st to 4th dph for preventing surface aggregation mortality in early-stage grouper larvae. The yolk sac

(endogenous source) provides nutrient for 2-3 days in grouper larvae. Then, the exogenous feeding starts when the mouth opens after the 3rd day. Its initial mouth gape is very less and therefore, it has to be provided with appropriate size of feed i.e. copepod nauplii and screened rotifers. *Nannochloropsis* sp is introduced into the larval-rearing tank on 2 dph at an algal cell density of 1×10^5 no./ml. Rotifers filtered with 80 µm mesh and copepod nauplii filtered with 100 µm mesh are introduced into the larval rearing tank on 2 dph, after the larval mouth opening has been formed. The rotifer and copepod nauplii density in the larval-rearing tank is maintained at 5-7 and 2-3 no./ml during 2 to 5 dph. After 5 dph, small rotifers (filtered with 150 µm mesh) are introduced at density of 10-15 no./ml, which is gradually increased to 20 no./ml from 11 to 18 dph. Freshly hatched-out *Artemia* nauplii are used as feed at density of 0.5 no./ml from 17 dph and their size increasing with advancement in rearing period. Adult copepods are given as feed during 16 to 20 dph in larval-rearing. Weaning of grouper larvae with artificial diet starts from 20 dph. Artificial diet with a particle size of 200-300 µm is used initially. The formulated feed is sprinkled onto the surface of the water in small amounts frequently throughout the day. The size of particulate feed is increased to 400-800 µm from 30 to 40 dph.

Fig. 21.7 Larval-rearing unit

The larval rearing tank is maintained without water exchange until 7 dph, and then from 10 dph, 5-10% of daily water exchange is required to maintain the water quality. Bottom siphoning of the tank should be started on 7 dph. From 12 dph, faeces, dead larvae and uneaten food which accumulate on the tank bottom should be siphoned out at least once daily for maintaining the water quality. Daily water exchange is increased to 20%, when both rotifers and *Artemia* are given together as feed (15 to 20 dph) and it is gradually increased to 50% from 25th dph, and 100% from 35 dph onwards.

Metamorphosis of larvae takes place within 30-40 dph. Cannibalism is a serious problem during metamorphosis due to its size variations which can be controlled by proper size grading and by increasing feeding frequency.

Fig. 21.8 Metamorphosed larvae

Rearing of fry

After 40 dph, the larvae are shifted from larval rearing tank to fry rearing tank. Fry rearing is carried out in light coloured tank. The seeds of 1.5-2 cm are stocked at 1000 no./m^3. During the fry rearing, the larvae are size graded once weekly, to avoid cannibalism. The fry is fed initially with a formulated micro-encapsulated feed of 800-1000 µm size and progressively changed onto an extruded larval feed of 1.2 mm by 50

dph. Water is exchanged 100% daily. Feeding frequency varies from 5-7 times in a day. The seed is harvested at 5-6 cm size by 60 dph.

Second phase of nursery-rearing is required for growing 5-6 cm to 10-15 cm for stocking in cage as well as in pond. During this period, the fingerlings are reared either in pond based hapa (4 mm mesh size), flow through cement tank or in re-circulatory system. The fry is fed with a floating pelleted feed with 45% protein and 10% fat of 1.2 mm and 1.8 mm sizes @ 10% of the body weight thrice in a day.

Fig. 21.9 Orange spotted grouper fingerlings

Packing and transportation

The seed is usually transported for long distances in oxygenated plastic packet @ 10 no./l and for short duration in open tank system with oxygenation or/and aeration. DO level is maintained above 8 ppm using oxygen cylinders. Fish is starved for 48 hours before transportation.

FARMING IN CAGE

Site selection

The farming of grouper is preferably carried out in cage. A calm area with more than 10 m water depth, 30-50 cm/s water current velocity with sandy or muddy bottom is suitable for sea cage farming.

Water quality requirement

The optimum water quality requirement is given below.

Salinity	:	15-35ppt	TAN	:	< 0.1 ppm
Temperature	:	23- 30°C	DO	:	> 5 ppm
Nitrite	:	< 0.05 ppm			

Cage design

Cage made up of HDPE or GI material are used for culture of grouper. The size of the cage (diameter and depth of net) depends upon operation feasibility. Circular cage of 6 m diameter and 4 m net depth are easily managed with the involvement of 5-6 people. HDPE cage is better for off shore cage farming while GI cage is used in protected areas or in backwaters.

Different mooring systems are used for cage culture such as grid type anchoring system, single point mooring, *etc*, based on the suitability of the site selected. Generally, cement blocks connected with 14 mm alloy steel long linked chains are used for single point mooring of the cages, which allow free movement of the cage in 360^{o} depending upon the current direction.

Fig. 21.10 Circular HDPE cage

The cage bag is a flexible mesh material, which can be prepared by different synthetic materials, including HDPE, polyester (PES) and polypropylene (PP) or polyamide (PA). Among all, the Polyester material offers economic and technical advantages such as breaking

strength, resistance to fouling and resistance to abrasion. The square shaped mesh size is always preferred and to get the proper shape, the net panel is attached to head rope with a hanging ratio (E) of 0.71 to produce square meshes, which helps against fouling and provides maximum surface area. Two net bags are used in a cage, i.e., inner and outer net bags in inner ring and outer ring of the cage respectively. The mesh size of both the net bags depends on the size of the fish stocked for culture. Initially, inner mesh size of 6-8 mm are used then increased to 12 mm after 3-4 months and finally, 18 mm mesh size is used after 6 months. A ballast of 60 kg weight is attached to the bottom ring of inner cage net to maintain the shape of the net bag.

Stocking and feeding

After acclimatisation, the seeds of 30 g size are stocked at a density of 35 no./m^3 in rearing cage. After 4-5 months of culture period, the stocking density is reduced to 20 no./m^3. The fish are initially fed with pelleted feed having 40-45% protein and 10-12% fat, @ 8-10% of the body weight as two rations in morning and evening. As the fish grows to a size of 100 g, it is fed with low value fish @ 10% of the body weight twice in a day.

Care and maintenance

Cage with net and mooring system should be checked periodically during the culture period. Generally algae grow on the cage frame, which makes the frame slippery, hence it is scrapped once in a month to keep cage frame clean, so the worker can easily work by standing on the cage. The chain and floats attached to the mooring system is inspected not later than once in a month for any damage such as shackle loosening and chain damage. If any damage is noticed, it should be repaired immediately. The mooring system is compulsorily checked after every bad weather conditions such as cyclones, storms, depressions, *etc*. As the cage net is always inside the water, settlement of fouling organisms such as barnacle, algae, *etc* would happen; hence it is frequently checked for assessing the extent of fouling and if 50 % of the net meshes are clogged, the net must be replced. The inner net of the cage

should be changed every month for first three months, followed by once in two months. The net must be checked frequently for any damage.

A warehouse and a boat with 24x7 round the clock security including watchmen and CCTV camera are provided for the storage and transportation of feed, net, *etc*. For net exchange, ballast is released from the inner net and hang freely in the outer cage net with help of PP rope. Inner nets are lifted half, followed by inserting the cleaned net from one side of the cage frame to the other side and tied on the hand rail. Then, the older net knots are released from the hand rail and the net is dragged from one side to the boat, while doing so, the fish will move from the older net to the cleaned net from the other side of the net. Then the nets are dried in sunlight and cleaned and repaired.

Fig. 21.11 Harvested orange spotted grouper

The fish stock is regularly observed without unduly disturbing them and this provides a general understanding of how they behave under normal environmental conditions. If something wrong is observed, then fish are sampled and examined. Fish sampling is done at least every month, so that their growth is monitored regularly. This information is required for calculating the feed requirement for the stock. It will give a fair idea about the stock performance and the feed requirement for the future. Records of the farming practices such as daily mortality, feed consumption, and growth rate should be maintained. It is crucial in understanding the epidemiology of diseases and allows to identify the

critical management point in the production cycle. The growth pattern is given in Table 21.1.

Table 21.1 Growth rate

DOC	ABW in g
0	30
30	52
90	110
150	268
210	455
270	735
330	1070
390	1420

Harvesting

Harvesting of fish is done continually or in batches depending on how the production cycle is managed. Before harvesting, the fish are starved for a day to have empty gut, which helps in increasing the shelf life of the produce. Fish are harvested in-situ or the cages are towed to convenient places where the netting operation is carried out without any obstacles. The process of harvesting is simple, where the net is lifted up and the fish are concentrated to a small volume and scooped out and are then placed into a chilled container, chill killed and packed in ice, prior to transportation. A production of 16 kg/m^3 is expected from one crop with survival rate of 80-90%.