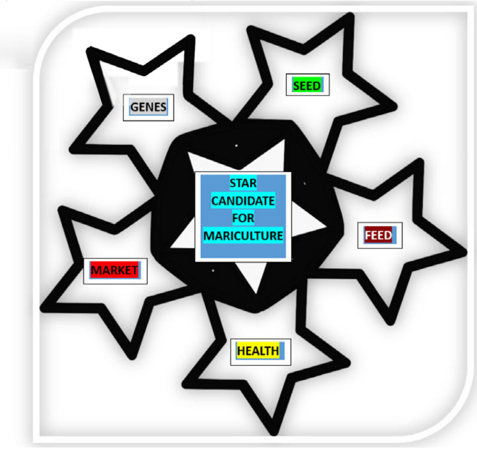
Marine Fish Farming Bottlenecks and Strategies for way Forward - SFHMG (Seed, Feed, Health, Marketing and Genetics)

Joe K Kizhakudan, Sekar Megarajan, Ritesh Ranjan, Biji Xavier, Jayshree Loka, RD Suresh

ICAR-CMFRI, Visakhapatnam Regional Centre, Pandurangapuram,
Andhra University Post, Visakhapatnam - 530003

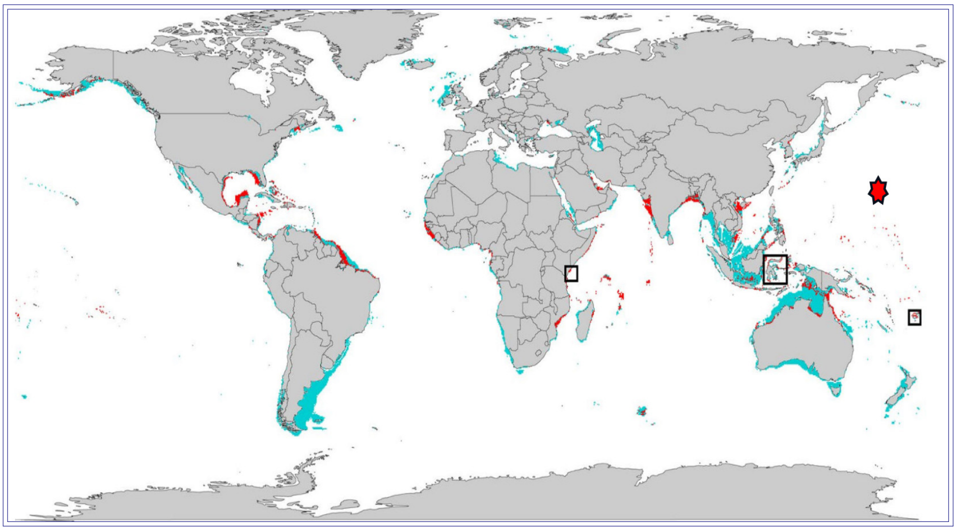
Aquaculture has been making encouraging progress worldwide and India is catching up very fast too, producing more food, employment, revenue, livelihood, enhance wild stocks, recycle wastes and upgrade low grade food, rewards farmers, invites investments and trade. The marine and the diadromous finfish species are valued at nearly 3 times the price of the fresh water species and its primarily this area, the focus of mariculture would be, in the coming years all over the world and in India as well. Mariculture is one of the fastest growing sub-sectors of aquaculture in the world. In contrast to the global scenario, where mariculture of finfishes is a well-developed industry, where as in India, it is gradually emerging out from its infancy. Therefore, these finfishes mostly high value marine species which are slightly difficult to breed and reproductive technologies, zootechnical, nutritional and environmental conditions required for the culture of marine finfish are significantly different from those of the fresh water.

A large number of finfish species are farmed in cages and yet there is a significant reliance on wild caught young ones for farming of some groups such as groupers. The main species farmed in brackish water are the Barramundi or Asian sea bass (*Lates calcarifer*) and the Milk fish (*Chanos chanos*). Global production has been relatively constant over the past ten years although production has decreased in Asia and increased in Australia during this period. In inshore marine cage farming, the major farmed species include *Seriola* spp., snappers (*Lutjanus spp*.), groupers (*Epinephelus spp*.) and cobia (*Rachycentron canadum*). The Japanese amberjack *Seriola quinqueradiata* contributes up to 17% of marine finfish production in Asia, with a production of about 160,000 tonnes annually. Other carangids that are becoming popular for culture are the snubnosed pompano *Trachinotus blochii* and the silver pomfret *Pampus argenteus*. Nevertheless, seabreams are the mainstay of Asian finfish mariculture production, and a range of species are currently cultured. Grouper culture has been expanding rapidly in Asia, driven by high prices in live fish markets of Hong Kong and China. Since grouper farming is mainly dependent on wild collected seed, the decreasing availability of wild seeds due to overfishing is a major constraint for the expansion of grouper culture. Southern blue fin tuna (*Thunnus maccoyii*) is cultured in Australia using wild caught juveniles. Although production of this species is relatively less (3500-4000 tonnes per annum), it brings very high prices in the Japanese market and thus supports a highly lucrative local industry in South Australia. Cobia(*Rachycentron canadum*) is a species of much interest for tropical marine finfish aquaculture. Most production currently comes from China and Taiwan Province of China and it was around 20,000 tonnes in 2003. Production of this fast-growing species is set to expand rapidly in Asia. Milkfish (*Chanos chanos*) is traditionally cultured in Phillippines. Indonesia is a major producer of seed, much of this coming from small-scale hatcheries. Milkfish culture is also practised in some Pacific Islands viz. Kiribati, Nauru, Palau and the Cook Islands. Although most milkfish culture is undertaken in brackish water ponds, there is increasing production from intensive mariculture cages.

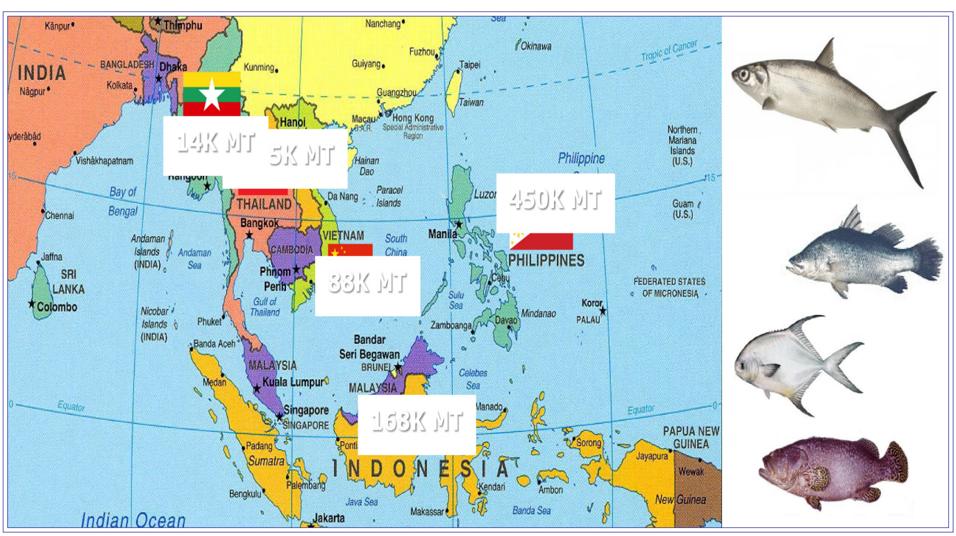


In recent years, with consistent efforts of ICAR-Central Marine Fisheries Research Institute (CMFRI), breeding and seed production of several commercially important species has been successfully bred and seed production technology for pompano (*Trachinotus mookalee* and *Trachinotus blochii*), cobia (*Rachycentron canadum*), grouper (*Epinephelus coioides*), snapper (*Lutjanus johnii*) and breams (*Lethrinus lentjan* and *Acanthopagrus berda*), established for the first time in the country. The scientific team at Regional Centre of the ICAR-CMFRI Visakhapatnam, AP, India, has been instrumental in this phenomenal leap in the country by contributing to the breeding and seed production science of three commercial species (Indian pompano, orange spotted grouper and John's snapper) and producing seed continuously for past few years. Almost a million seeds have been continuously and consistently produced in the last few years and have been distributed to research institutes, state government owned facilities and private entrepreneurs for nursery rearing and grow-out.

SKILL AND HUMAN RESOURCES AND TECHNOLOGY



Global hot spots(blue and red) of Finfish mariculture – Red signifies areas with the highest (top 20%) potential productivity. ***Gentry, R.R., Froehlich, H.E., Grimm, D.*** *et al. Mapping the global potential for marine aquaculture. Nat Ecol Evol 1, 1317–1324 (2017)*



Asian countries producing nearly 745000 mt per annum of marine finfish through aquaculture

Fast progress in **"Business Aquaculture"** has benefitted mostly from R&D inputs especially in the advanced nations, and short-term oriented research goals had to find ways to grow a new animal, maximize profitability and to assure long term sustainability. Noting that there are a number of proven technologies and aquaculture technologies that could be expected to cater to the demand, governments are urging to give high priority to promote aquaculture to increase the harvests by 5-10 folds in the coming decades.

As the commercial seed production technology, as envisaged, is the only possible way to increase the availability of marine finfish seeds for the marine finfish farming and grow out production in the country. Unless the technology is not translated to develop skilled manpower, it may remain in laboratory. Hence, the present training programme was envisaged with an idea to provide the required technical know-how to the hatchery operators, technicians, students and scholars on large-scale marine seed production of cultivable species with special reference to Indian pompano, John's snapper and orange spotted grouper at Visakhapatnam Regional Centre of ICAR-CMFRI.

The information on revolution and globalization of markets will cause change in rural areas to be much faster during coming decades, and increasing speed will thus change values of land, but displacement of local fishers or farmers should not happen, instead they should be loaded with the skill sets to set them prepared to become part of the change. Establishing more and more species to the farming basket improves our leader status and awakens us from the so called "infant-industry argumentandbe the beginning of such a change and set the ball rolling in the country towards a greater blue economy revolution.

A variety of techniques and technologies — each with its own advantages and disadvantages — can be used to raise marine finfish:

Hatcheries	Most aquaculture fish begin their lives in a hatchery. In fact, the populations of many fish caught by traditional fishing are augmented in hatcheries, then released
Pond culture	One or many earthen ponds are used to culture some marine species.

Cage /Pen culture	Enclosed cages are submerged in aquatic environments. Careful protocols and monitoring help to minimize potential interactions with the environment.
Recirculating systems	fish, shellfish, and or plant-life are raised in "closed-loop" production systems that continuously filter and recycle water and waste
Integrated Multi-Trophic Aquaculture	several species are raised together in a way that allows one species' by products to be recycled as feed for another.

Types of farming: Pond, semi intensive (moderate SD and costs), intensive (high inputs and cost intensive high SD), zero budgeting (minimal water exchange), extensive, polyculture, net and pen enclosure(fixed and submerged holdings), cage (HDPE/GI/Wooden/square/Circular/single mooring/ anchored/ fixed/ floating/ submersible/automated), nursery(multi-level) ,raceways(running water), RAS, pond cum cage, open sea ,off shore, coastal, estuarine ,IMTA, satellite farming, batch farming,integrated and organic farming.

Customising Design, SD, grading sizes, sorting intervals, hide outs, shelters, hierarchy, stockable sizes, packaging densities and sizes, transport durations and shelf life, compatibility,resilience, tolerancelimits (salinity/temperature/nitrites and ammonium),

Candidate species and feeding nature: Carnivore, herbivore, omnivore, piscivorous, cannibalistic, continuous feeder, voracious, lethargic feeder, scavengers, parasites. Acceptance of pelleted feeds, conversion rates, better growth rates, better meat texture and flavour and colour, low-cost feeds and formulations and customisation of feed formulae decides the ease of farming a candidate species with better returns.

Customising the feeds -Protein, Lipid and DP/DE (Methionine, Lysine, Taurine,Arginine,Leucine,Isoleucine, Valine, Histidine,Phenylalanine,Threonine and Tryptophan) cholesterol and vitamins and minerals,Schedules, intervals and ratio.

The following factors should be carefully considered when selecting a location for pond aquaculture: abiotic factors (*e.g.* water supply, meteorological and hydrological conditions, and soil characteristics), pond inputs, and manner of operation.

1. Water

Water samples should be analysed for their physico-chemical (*i.e.* temperature, salinity, turbidity, suspended solids, pH, dissolved oxygen, and biological oxygen demand) and biological characteristics (*i.e.* microorganisms that are carriers of disease and abundance of plankton as primary productivity) In ponds when sudden algal blooms or bottom flushing is reduced, the oxygen levels may go down at early morning and late evening hours, therefore adequate aeration facilities to be alternatively considered. The SD and the feeding intensities and the sediment nature and chemistry have to be under frequent watch and remedial treatments addressed from time to time. Sudden fluxes are not tolerated by marine species and hence losses may be severe. The pond or open water systems have entirely different characteristics from the start till the end in any operation, when one is a flowing system with frequent fresh exchanges while the other is system and manual dependent and, more or less stagnant. Similar is the control of the crop as one needs extreme precaution as externalities cannot be completely under control nor treated in open water cages and pens, as in pond or RAS when the effluents can be screened and let out and infections can be attended to.

2. Weather

Data on precipitation, temperature, humidity, and monsoon patterns in the vicinity should be weighed.Historical data on cyclones and floods to be reviewed for each site based on the elevation and orientation.

3. Soil

Visual and chemical analysis (*i.e.* pH, phosphorus, calcium, magnesium, dissolved organic matter) of soil should be conducted. The type of soil should be sandy clay to clay loam which is favourable for operation and to facilitate the growth of natural food in the pond bottom. Areas with a thick layer of organic soil should be avoided since it contributes to increased water seepage. If the soils are not good one should go in for plastic or synthetic lining ponds with sufficient depth and drain slopes and enough bird scare nets or covers.

4. Inputs

Fry, feeds, fertilizers, and other farm implements should be available near the area of operation.

Feeds and feeding management (Nursery and Grow-out)

The nutrient profile of feeds (appropriate protein, fat, cholesterol, should meet the requirements of the candidate species in target, marketable size and colour and flavour demanded in the market. The artificial feeds with better conversion and cost efficiency and locally available in all required size grades. Feed rations are divided into four to six parts during the nursery stage (normally 0800, 1100, 1400, and 1700) and three parts (0800, 1100, 1400, and 1700) during the grow-out phase and later to two times and finally to single time feeding also depending on the species grown. Unlike other cultured fish, a pompano feeding regimen should not be "by satiation" as they tend not to cease ingesting even when full while raw fish feeds during final stages can give more flavour and texture to the grown fishes the availability is to be ascertained, and proper sanitised handling is essential.While groupers and Cobia do well at satiated feeding but primary intakes are heavier. Recording the **daily feed consumption** is vital as this information can provide accurate values (economic returns and profit) when calculating performance parameters after harvest.Feed stocks should be kept in a cool and dry storage facility to prevent spoilage and extend their shelf life. The nutrient availability and palatability of the diets are highly likely compromised with the growth of Molds.

Feed management practices

1. Feed selection should be based on fish feeding behaviour, feed quality, nutritious feed and economical value of feed.
2. Feed should be available, affordable, accessible and acceptable in aquaculture site.
3. Source of feed is from trash fish and pellet feed. Trash fish should be in fresh condition. Commercial pellet fish should be registered in CAAI/MPEDA/or any Central Agency and properly labelled, meanwhile home industry pellet should meet the National Standard.
4. Fish should be fed with trash fish and pellet efficiently based on fish biomass and fish size. Feed should be stored appropriately. Pellet should be placed in cold and dry storage room to maintain its quality and should be used before its expired date. While, trash fish should place in the freezers at appropriate temperatures.

5. Avoid sharing storage room with fish drug and chemical agent.

6. Be aware of feeding frequency, time and methods. In the first stage of nursery, feed is given as often as possible until the fish is full, minimum three times a day. In the rearing stage, feeding frequency is reduced to two times a day and during grow out feed is eaten once a day in the morning. Spread the feed all over the cage ad libitum.

7. Feeding frequency should be precise to achieve good growth rate and the use of feed is efficient.

8. Feeding ratio should be accurate to lead feed efficient and providing good survival rate.

9. Do not give excessive feed. The excessive feed will decay and release toxic gases which are harmful for fish.

10. Vitamin C and multi vitamin should be given to avoid deformity of fish and to increase fish immunity as well to increase the survival rate.

11. Involve women for chopping and preparing trash fish.

5. Operation

The land area will depend on the type of culture system (*i.e.* extensive or intensive) and production targets. Similarly the open water body farming practices are to be ascertained by the access, depth,tide and flood levels, safety and poaching prevention, resource and space sharing and conflicts, flow and currents, period of steady parameters and productivity available, competition if any, proximity to discharges and effluents, industry outlets.The species culture densities,nature of crowding,growth rates,preference of substratum,acceptance to artificial diets, compatibility with other species,culture tenure, tolerance and preferences decide the farming methods and practices in the local site with the farmer and his dependent on his investment capacity and market demand.

Sampling of stocks

A sample size of at least 5 % of the total stocks is to be weighed in bulk periodically (every 30 days) to monitor fish growth. Sampling data can then be analysed for the prevailing average body weight of the fish to optimize feed efficiencyand feeding ration is adjusted after stock sampling of the average body weight and survival.

Feed rate recommendations serve as a guide to improve the nutrient efficiency of feeds and may be adjusted based on the prevailing condition of the fish and the environment. The feeding behaviour of fishes is adversely affected during inclement weather conditions particularly during cloudy and rainy days and rough sea conditions and thus the feeding should be properly monitored in relation to the behaviour and weather prevailing.

The average body weight is calculated using the equation below:

Average body weight (ABW) =total weight of fish sampled/total number of fish sampled.

The feed requirement is calculated using the equation below:

Feed requirement =(no. of stocks – mortality) × fish mean body weight × feeding rate/1,00

Monitoring

Water parameters such as dissolved oxygen, salinity, pH, temperature, and turbidity should be closely monitored. When parameters are below optimum, water change should be conducted via tidal cycles or pumping during emergency cases.Fish vitality should be checked, this is observed in the swimming and feeding behavior, physical abnormalities, and symptoms of diseases. During a suspected disease outbreak, live or fresh fish samples should be subjected to microbiological analysis. This is to ascertain the causative agent and the specific control measures to be applied.Monitoring of stocks (*i.e.* feeding and swimming behavior) should be done frequently and thoroughly.Cobia are susceptible to many viruses, bacteria, and parasites that commonly afflict other warm water marine species. In addition, producers need to check on specific local and federal regulations with regard to approved chemicals and drugs for use on any food fish.

Health management practices in cage farms:

1. Regularly monitor and control the fish health and growth by sampling including sampling on residue content in fish tissue during grow out activity.
2. Proper handling and treatment of diseases.
3. Avoid sharing the same tool and equipment within similar cage to prevent transmitting disease.
4. Avoid using antibiotic and other chemical agent which are not recommended.

5. It is necessary to observe ectoparasite and fish morphology through visual and organoleptic fish health monitoring is necessary.

6. Conduct water microscopic observation in laboratories, if necessary, for investigating pathogenic organism (endoparasites, fungi, bacteria).

7. Use vaccinated fish to prevent several diseases such as viral nerve necrosis (VNN) and Iridovirus (sleepy grouper disease) to avoid significant loses and vibriosis.

8. Recognize the health fish problem and adoption the right treatment procedure as earlier as possible.

9. Recognize fish behaviour such as lower response on feed and change in body colour as an indicator of disease occurrence.

10. Consult nearest aquaculture expert to solve the problem.

11. Do not throw all the waste material and dead fish into water since it will result in high level of pollution and contamination.

Regularly check the water quality parameter using appropriate water quality kit.

Nursery

Marine fishes in general have a protracted farming period when compared to the shrimp farming of 90-120 DOC and therefore the farmers hesitate to shift as the crop turnover and periods in a lease period is affecting their overall returns.Thus, an introduction of hatchery fry and fish seeds to raise to stockable sizes in ponds or cages an intermittent nursery phase with high density and even stunting with reduced feeding intensity or during unfavourable weather conditions (temperature/ salinities/rains) as a separate farming entity, equates the exercise with that of the crop periods as in shrimp farming. Further the advanced fingerlings can outperform in grow-out systems with better survival and growth rates,thus reducing the crop periods to 5-6 months. Fish should be acclimated to pond conditions (*i.e.* temperature and salinity) by gradually introducing pond water to opened container bags. The animals will be reared for 35-60 days or until they reach a body weight of 30-50 g.This could be still a little extended phase in groupers and Cobia.Fry should show no signs of physical deformities and disease symptoms (*e.g.* viral nervous necrosis and sea lice infection). Stocks should be homogenous in size (1-g body weight or

1.5-inch body length) to avoid cannibalism between fry as well as to ensure even sizes of fish during harvest. As much as possible, animals should be weaned to feed on formulated feeds prior to stocking in ponds or as is wanted for grow-out.

Packing and transport

Animals should not be fed 24 hours prior to packing. From the hatchery tanks, fish are harvested, counted, and settled in aerated baskets overnight prior to packing and transport early the following morning or choose lowering temperature by chilling or using ice blocks in package containers to keep the ambient temperature lower at transport.

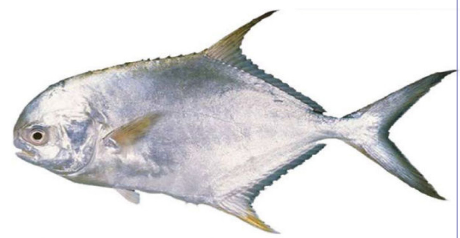
- Stock your pond only once per crop. Organize stocking so that all the farmers in your area stock within 3-4 days. Within one area, try to stock the seed from the same batch in neighbouring ponds. The guidelines that follow will help you to select good quality seed.
- Do not feed the seed for 12 hours prior to shipment.
- Maintain dissolved oxygen levels >5ppm by filling each bag with 1/3 chilled, filtered seawater and 2/3 pure oxygen, bubbled into the water in double polyethylene plastic bags into polystyrene boxes and maintain the water temperature at 18-22°C (putting ice into the boxes where required) for transport times >6 hours. Refill the bags with pure oxygen during shipping if the transport time exceeds 24 hours. Avoid direct sunlight at all times.
- Check if the hatchery has the certificate for good seed. If they do, make sure that all the bags of seed that you buy have a hatchery label. Try to buy the seed from a hatchery that has these labels.
- Select seed batches with good activity, uniform sizes and real colours.
- Take another 20-30 seed from the batch, put them in a glass tub full with the water theycame in, add an equal volume of freshwater and wait for twenty minutes. If more than onequarter dies, look for a better batch (Pompano, sea bass, grouper, snapper).
- If the seed can be tested for and bacterial and viral infection it should be done in any nearby laboratory before collecting.

Commonly available cultivable marine finfish in India

Orange spotted Grouper *Epinepheluscoioides*

Indian Pompano *Trachinotusmookalee*

John's Snapper *Lutjanusjohnii*



Silver pompano *Trachinotusblochii*

Emperor bream *Lethrinuslentjan*

Vermiculated spinefoot: *Siganusvermiculatus*

Mangrove red snapper L. *argentimaculatus*

Asian Sea bass *Latescalcarifer*

Cobia *Rachycentroncanadum*

Farming

Acclimatizing grouper juveniles in floating net cages-Stock 6-10 cm juveniles in ponds at 5,000-10,000 juveniles/hectare or floating net cages at 15-20 juveniles/m^3. Feed juveniles with fresh or frozen chopped fish daily at 10% of average body weight (ABW) or artificial diet at 3% ABW, with half of the ration given early in the morning and the other half late in the afternoon. Cobia produced in cages should be located in sites that provide warm (26 °C and above) clean water and adequate flow rates through the cage system to provide high dissolved oxygen levels continuously. Harvest numbers vary depending on the stocking rates and water temperature, but the grow-out period for pellet fed cobia is generally about 1-1.5 years, with fish reaching a final weight of 6-10 kg at harvest densities of 10-15 kg/m^3.By using both floating and sinking pellets (42-45 per cent crude protein, and 15-16 per cent lipid), typically fed 6 days a week at a rate of 0.5-0.7 per cent BW/day towards the end of the grow-out phase. Depending on pond management, culture density, feed rate, and water exchange rates, the aquaculture production of cobia in ponds may result in water quality issues and excess nutrient loading in the effluent. Large-scale production of cobia at various life stages could potentially impact any coastal areas where such activities are located and production discharge would require monitoring. Cobia grow-out thus far has been reported in near shore and offshore cage systems which, no matter where they are located, will also have some form of environmental impact. These operations carry with them some inherent risks including, but not limited to, escapees (genetic pollution), disease transmission, and nutrient loading in and around farm sites.

Harvest

Site specificmethods employing techniques to crowd and net or pump fish and place them into a chilled container on a tending vessel or pre-loaded vehicle with tanks with ice for chilling the live fish can reduce discolouration and spoilage to the fishes.The fishes are to be typically starved the day before harvest and appropriate marketable sized fish or larger are selected, killed, bled for fillet or chilled before packing in ice. Cobia enters the market whole/gutted, headless, or filleted, depending on the final market destination. Similarly, the groupers, however Pompano are mostly whole chilled and frozen for IQF.

Market

Since wild caught cobia does not represent a major fishery and the farming of cobia is in its infancy, details regarding the market and trade of this species are notably lacking. As a result of its current limited availability, many seafood consumers have probably never tasted cobia; increasing supplies from aquaculture, combined with effective marketing of this firm-textured, white-fleshed fish will be critically important for future market expansion.

Improve marketing practices

1. Organizing in farmer group is the only way of small-scale farmers to achieve better efficiencies in marketing.
2. Farmer group can easily facilitate the purchase of the quality production inputs at cheaper prices, hence reducing the cost of production.
3. Several local farmer group can join together to market the farmed product including groupers for better prices.
4. Certified cobia/Pompano/breams/grouper are in demand in international market. This can strengthen farmers competitive international market not only to successfully sale their product but also to sell at premium prices.
5. Organize farmers group to bargain for better price from the buyer.
6. Produce high quality product to have good market base.
7. Establish information centre where farmers can seek information on better market and find problem solution.Capital strengthening through empowering farmers group or SHG.FFPOs/Development Service Unit (DSU)through the Fisheries dept or NFDB, so the farmers will have easy access to capital, either from social assistance, revolving funds, loan from bank or financial institution and other financial support sources, i.e., economic empowerment , coastal community program, community business loan program, energy and food security loan program and corporate social responsibility program, as well as patron-client scheme. Requirement to obtain the loan include: an obligation to establish or join in a group, fulfilling administrative requirement, produce business feasibility analysis, provide collateral in the form of land certificateand crop insurances.

Concernsand way forward to Responsible Aquaculture Practices

Cage sites may be close to sensitive coral reef would also require producers to monitor impacts and the nutrient loading of the nearby ecosystem. Cage culture environmental impacts are site-specific and, while water exchange rates and dilution factors in many areas are sufficient to prevent excess nutrient loading, every site has a carrying capacity that needs to be considered.

Another environmental consideration is that since cobia/sea bass/groupers are higher trophic level carnivores, it is necessary to use feed containing fairly high crude protein levels (the specific nutritional requirements are currently being investigated) with a certain portion of this protein obtained from fish meal. For aquaculture to continue supplythe increasing demand for seafood worldwide, additional research into supplemental or alternative protein sources for use in feeds for such species is imperative. To that end, research on the specific nutritional requirements of this species in terms of protein and lipid levels and fish meal substitution in feed has been conducted and is ongoing. The remedial measures for diseases and infections in open systems are to very cautiously handle to avoid AMR developing in the wild resources. Best management practices should be implemented during the entire production process and include detailed monitoring of broodstock and production, the use of high quality and nutritionally complete diets, frequent sampling and observation of stock for diseases and/or parasites, and the timely removal of sick fish. Aquaculture expands in the future, the efficient production of a high-quality product with minimal environmental impact during culture should be the desired goal.

Suggested Readings

Berry, F. and E.S. Iverson. 1967. Pompano: Biology, Fisheries and Farming Potential. Proceedings of the Gulf and Caribbean Fisheries Institute 19: 116-128.

Fermin, A.C. and Seronay, G.A., 1997. Effects of different illumination levels on zooplankton abundance, feeding periodicity, growth and survival of the Asian sea bass, *Lates calcarifer* (Bloch), fry in illuminated floating nursery cages. Aquaculture, 157(3-4), pp.227-237

Hauville, M.R., Zambonino-Infante, J.L., Bell, G., Migaud, H. and Main, K.L., 2014. Impacts of three different microdiets on Florida Pompano, *Trachinotus carolinus*, weaning success, growth, fatty acid incorporation and enzyme activity. Aquaculture, 422, pp.268-276.

Jayakumar, R., Nazar, A. K. A., Tamilmani, G., Sakthivel, M., & Gopakumar G., 2014. Farming of silver pompano *Trachinotus blochii* in coastal aquaculture ponds [Brochure]. Kochi, India: Central Marine Fisheries Research Institute.

Ladja, J. M., Opiña, N., Catacutan, M., Vallejo, E., & Cercado, V., 2012. Cage nursery of high-value fishes in brackishwater ponds: seabass, grouper, snapper, pompano. Tigbauan, Iloilo, Philippines: Aquaculture Department, Southeast Asian Fisheries Development Center.

Tutman, P., Glaviæ, N., Ko•ul, V., Skaramuca, B. and Glamuzina, B., 2004. Preliminary information on feeding and growth of pompano, correct transportation of broodstock is critical to the provision of high quality broodstock that will survive the stress of transportation and be able to produce healthy seed in the hatchery maturation system.

SEAFDEC Aquaculture Department. (2016). Grouper hatchery and grow-out [Brochure]. Tigbauan, Iloilo, Philippines