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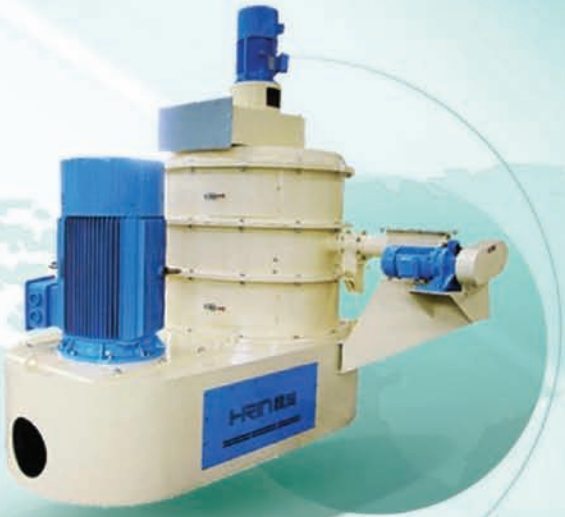

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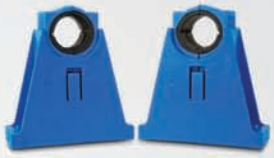

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Aquaculture diversification is the way forward for Blue Revolution in India

Dear Readers,

The February 2020 issue of *Aqua International* is in your hands.

In the News section, you may find news about –

Inaugurating Aquaculture Expo 2020 at Surat on January 8, organized by Aqua International, the Gujarat MLAs Mr Mukesh Bhai Patel and Mrs Zankhana Patel assured that they will put efforts to help for the development of shrimp aquaculture in the region well in the coming years. They told the stakeholders of the sector to do the follow up with them and other concerned policy makers.

MPEDA's Gujarat region senior officer gave an informative presentation during the inauguration of Expo that Indian fisheries and aquaculture is an important sector of food production and growing sector in India's export basket in recent years. In 2018 -19, we have exported 1.43 Million MT of Seafood valued at Rs 47,621 crores. The ministry of Commerce and Industries has set an ambitious target to export 2.1 million Mt of sea feed valued at Rs 85,000 crores by 2020 – 2022. Since the capture fisheries has almost reached a plateau and further increase would only possible by risking deleterious impact on the environment. MPEDA strongly feels that Aquaculture diversification is the way forward for Blue Revolution in India.

Fisheries Minister of Kerala J Mercykuttyamma said, sustainable development of marine fisheries sector should not be limited only on conservation of resources and the environment, instead it should follow a holistic approach giving greater importance on the role of fisheries as sources of livelihood for billions of people.

The Indian government is in the process of drafting the country's first ever national fisheries policy, requiring a budget of INR 450 billion ($ 6.3 bn) to promote marine fisheries, aquaculture and mariculture over the next five years, reports Firstpost. Currently in India, the only existing policy covers the 4.3 million metric tons produced annually from India's marine fisheries, but not the 23 m metric tons harvested from its inland aquaculture sites.

The Odisha state has 138 reservoirs, comprising 200,000 hectares of water, and it is thought that it could produce a minimum 125,000 tonnes of fish from its eight largest reservoirs, although the current production volume is considerably lower and 50,000 tonnes of carp species, including rohu (Labeo rohita) and catla (Labeo catla), are imported from neighbouring states. To increase production the use of circular cages is being promoted and the Government of Odisha aims to finalise its cage culture guidelines by March 2020, in the process opening up the reservoirs for cage culture by eligible investors.

In the articles section, article titled "Is Antibiotic a Boon or Curse in Shrimp Industry" by G. K Raswin Geoffery, Dr J. Stephen Sampath Kumar and Dr K. Veerabhadran discussed about Use of Antibiotics is wide and if it is properly used they are the precious tools. Economically important diseases of fisheries are mainly parasitic infestations and in shrimp farming it is of viral origin which does not require application of Antibiotics. Knowledge on Pharmacokinetics (PK) and Pharmacodynamics (PD) of antibiotics is very important. Efforts have to be taken to impart knowledge to farmers regarding the responsible use of antibiotics with right knowledge on safety, efficiency, dose, schedule of usage and withdrawal period of drugs. Prophylactic substances including probiotics, immunostimulants and disinfectants are also recommended.

Readers are invited to send their views and comments on the news, special feature and articles published in the magazine which would be published under "Readers Column". Time to time, we shall try to update you on various aspects of Aquaculture sector. Keep reading the magazine regularly and update yourself. Wish you all fruitful results in your efforts.

M.A.Nazeer
Editor & Publisher
Aqua International

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Aqua International will strive to be the reliable source of information to aquaculture industry in India.

AI will give its opinion and suggest the industry what is needed in the interest of the stakeholders of the industry.

AI will strive to be The Forum to the Stakeholders of the industry for development and self-regulation.

AI will recognize the efforts and contribution of individuals, institutions and organizations for the development of aquaculture industry in the country through annual Awards presentation.

AI will strive to maintain quality and standards at all times.

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Give greater importance to livelihood: Fisheries Minister

'Sustainable development should not be limited only on conservation of resources'

Kochi: Sustainable development of marine fisheries sector should not be limited onlyon conservation of resources and the environment, instead it should follow a holistic approach giving greater importance on the role of fisheries as sources of livelihood for billions of people, said Fisheries Minister J Mercykuttyamma.

Recognition of the social agency, well-being and livelihoods of people working in the sector is equally important in marine fisheries, she added. The minister was addressing delegates at the third international symposium on marine ecosystems being held at the Central Marine Fisheries Research Institute (CMFRI).

The minister said that fisheries management should focus on environmental, economic and social factors with equal importance. "In addition to aiming at ending poverty, hunger and malnutrition, the sustainable development should ensure universal access to health care to all with major emphasis on gender issues. It should also ensure the elimination of all forms of inequality everywhere", Mercykuttyamma said.

At the same time, it is need of the hour reduce the pressure on ocean resources, she said. Protection of key habitats and sustainable management of fisheries and aquaculture are vital to restore the productivity of the ocean. Marine resources have the potential to boost the economic growth of the world, but many anthropogenic activities in its environment have taken a heavy toll on ocean health, the minister added. Restoring the productivity of the ocean would help to ensure future growth, food security and jobs for coastal communities, she said.

The minister further said that the state government started promoting the concept of co-management in fisheries by setting up management societies at harbours and at fishing villages. "The government took series of measures to ensure sustainable development of the marine fisheries sector in consultation with the scientific community. The measures, including implementation of minimum legal size (MLS), regulation of engine power of fishing crafts and regulation of size of fishing crafts have had positive impacts on resources", Mercykuttyamma said.

Organised by the Marine Biological Association of India (MBAI), the symposium concludes on Friday. The meet would come up with a road map to deal with the issues being faced by the marine ecosystems. Guidelines and proposals for proper management of marine fisheries would be included in the road map, that could become a guide for policy makers for the next three years.

Indian government to draft first national fisheries policy

The Indian government is in the process of drafting the country's first ever national fisheries policy, requiring a budget of INR 450 billion ($6.3bn) to promote marine fisheries, aquaculture and mariculture over the next five years, reports Firstpost.

Currently in India, the only existing policy covers the 4.3 million metric tons produced annually from India's marine fisheries, but not the 23m metric tons harvested from its inland aquaculture sites.

Now, the country's new fisheries ministry is looking to create an overarching fisheries policy as part of the 2020 budget. The new policy will cover both wild catch fisheries and aquaculture farms, officials said.

Currently, two fishery schemes are being implemented in India, according to Firstpost: the first, funded by the Fishery Infrastructure Development Fund, will last for five years, while the second, a fishery development scheme funded in part by the World Bank, will remain in place for eight years.

A third funding scheme, announced in July 2019, aims to boost Indian seafood through policy, marketing and infrastructure support. It has yet to receive cabinet approval.

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Seminar on Challenges and Opportunities in Brackishwater Sector in WB

Dignitaries at the Seminar

As a part of Bengal Fish Fest Programme organized by Dept of Fisheries, Govt of West Bengal recently, the Seminar on 'Challenges and Opportunities in Brackishwater (bw) Sector in WB' was organized at

S. Saha, IAS giving introductory speech

ICAR-CIFE Kolkata Centre Seminar Hall-2. Sri S. Saha, IAS, Commissioner of Fisheries, GoWB in his introductory note spoke about importance of bw fish and shellfish farming sector in WB; 2nd position achieved by WB in India in export of bw fishes; above 70000 tonnes of shrimp produced now in WB / year. He hoped that lively interaction between eminent invited speakers and progressive fish and shrimp farmers from 3 coastal districts of WB present in Hall (addressing problems faced by them and challenges which have to be dealt with, why aren't they getting good price for their produce, how much to export among total production of L. vannamei, CAA registration of bw farms) will help to formulate new policies by Government.

Sri A. Lahiri, Dy. Director, MPEDA spoke on 'Export issues of shrimp: regulation and needs', which, according to him, shrimp farmers must understand. In India, growth in seafood export has mostly taken place in WB; 69% and 31% shrimps and chilled fishes (inc other items) respectively exported from WB; 81% total cultured shrimp (19% captured) exported and contribution of L. vannemei is 93%; now P. monodon cultured only in traditional ghery(s); export growth of WB farmed shrimps (8.42% out of national av 3.3% during 2016-2019) occurred in USA, SE Asia and EU countries. He commended efforts of WB shrimp farmers and connoted them as 'deemed exporters'. He discussed about India's seafood export trend; export of value-added product through Kolkata port; major market-wise shrimp exports from WB; organic shrimp export to EU; illegal, unregulated and unreported fishing; inclusion of shrimps in Seafood Export Monitoring Programme; export rejections due to antibiotic (Ab) issue; need of strict regulations and enforcements in Ab use in shrimp culture and vigilance on shrimp seeds; need of shrimp farm registration and EIC certification; MPEDA's initiative on Aqua Shrimp Farm Enrolment. Sri Lahiri emphasized on 'farm traceability' as need of hour along with good quality produce, which should be in electronic form. Registered shrimp exporters not having information about shrimp production farm pond sites and whether it is completely free of WSSV and IHHNV. Importing countries considers such certification (also on Ab freeness) essential.

Dr D. De, Principal Scientist, Kakdwip Research Centre of ICAR-CIBA spoke on

Dr D. De speaking in Seminar

'Brackishwater aquaculture opportunities and challenges for meeting livelihood demand in Indian Sundarbans'. He discussed about potential for bw aquaculture in WB including inland salt-affected area; cost effective technologies CIBA developed to improve lives and livelihoods of people in Sundarbans; transforming and diverting livelihood of these people towards remunerative bw aquaculture; too much input use in L. vannamei culture and emergence of white faecal disease; research conducted on P. indicus to

improve growth rate after 90 days (it is at par with L. vannamei till 90th day); fish breeders in WB are not adopting standardized CIBA technology of round-the-year seed production of Lates calcarifer as huge cost involved and broodstock has to be maintained for 6-7 years; it can be cultured using forage fish and CIBA-developed formulated feed; breeding and culture tech package of milkfish (400-500gm in 5-6 months); feed developed for M. cephalus; demand of pearl spot as ornamental fish (Rs 12-15/- / 2 inch sized fish) in WB; mass-scale seed production tech of S. argus; research on selective breeding of P. indicus to cope up with growth of L. vannamei; more survivability of mud crab S. serrata in monoculture compared to S. olivacea; monosex culture of S. serrata and increased survivability; weaning L. calcarifer juveniles to formulated feed.

While explaining phases of L. calcarifer farming tech {spawn, fry (Rs 1.25/-/ piece), fingerling (Rs 2.50/-), advanced juvenile (50-60gm Rs 25/-), adult}, Dr De stated that Sundarban fish farmers in groups (cluster) can rear CIBA-supplied spawn to fry and higher stages and similarly FPGs can take up intensive culture of CIBA-supplied milkfish spawn to fingerling (6-8gm) and higher stages. Investment cost Rs 80-90/-/kg and adults sold at Rs 150/-/kg, on-farm demonstration given by CIBA in Sundarbans region. Mystus gulio seed production (4-5 cycles during April-July) possible in homestead hatchery,

Dr G. Dash speaking in Seminar

also that of pearl spot. Breeding frequency of pearl spot could be increased by reducing parental care duration. Production rate in bw polyculture (mullets, S. argus, M. gulio and shrimps) upto 3000-4800kg/ha using CIBA-developed feed 'Polyplus'; IMTA tech developed by CIBA using oyster, Ipomoea sp or seaweed components leading to improvements in water quality and fish growth; seed production and rearing of 5 species of bw ornamental fishes including orange chromid; CIBA-developed 'Plankton-Plus' tech to convert fish waste to wealth; plankton-booster in pond 'Fish waste hydrolysate' prepared causing 20% and 50% reduction in feed in shrimp and bw finfish farming respectively if applied; medium-scale aqua feed plant (1000kg/day) developed by CIBA; value addition and possibility of preparing pearl spot powder like lesser sardine powder; effluent treatment plant must be installed in bw farms; indiscriminate use of feed and overstocking must be stopped; lessening greediness on part of bw farmers will lead to increasing sustainability.

Dr G. Dash, Professor at Department of Aquatic Animal Health, WBUAFS spoke on 'Common and emerging diseases of shellfishes in India and their remedial measures'. He discussed about aquaculture as higher money-earning sector compared to agriculture; seed quality, fluctuating pond water and soil parameters and nutritionally balanced feed as factors affecting fish/shrimp health; Aqua-One Centres (AOC) for shrimp seed testing established at Contai and other places; bacterial disease AHPND in shrimps, PirAB toxin gene responsible for white faeces in affected shrimp, description of white faeces formation; Antenna cut/Rostrum cut disease and supplementation of Ca and Mg in feed; levamisole used in L. vannamei feed to control Gregarine parasite in white faecal disease and water must not turn thick or cloudy; microsporidian infection in shrimp; first report of IMV (or IMNV) disease in farmed shrimp from Contai region published by Dr Dash; IMV and WSD, their symptoms and abnormality; powerful prevalence of Shrimp Hemocyte Iridescent Virus in China. With poor management, high stocking density and complicated environment, we are inviting diseases.

Dr Dash also discussed about black gill fungal disease; Soldier Cap disease (due to improper pond bottom treatment); Loose shell syndrome (fresh tidal water must be let into ponds); diseases caused due to excess mineralization; SPF (V. parahaemolyticus) stock of L. vannamei seeds; concept of reservoir ponds in shrimp farms; high concentration (109cfu/ml and above) of Bacillus subtilis and multi-strain as probiotic for treating EMS; dosages of different immunostimulants in shrimp feed for growth of immunity and resistance; application procedure of water, soil and feed probiotics; maintenance of pond water quality in buffer condition to avoid disease occurrence; nutritional and farm management in disease prevention; aeration level maintenance in L. vannamei ponds; construction of shrimp toilets in shrimp farms at Namkhana, Contai, Haldia and finally he described Pond Automation as a novel idea for risk management in shrimp culture. Dr T. B. Mondal, Dy. Director of Fisheries, GoWB at FFRTC, Kalyani discussed in short about shrimp farming activities in WB and initiatives taken by Fisheries Department; Departmental schemes on bw aquaculture; PCR-tested disease-free shrimp seeds supplied to shrimp farmer beneficiaries in three coastal districts; excessive use of lime in ponds leads to increase in pH and facilitates multiplication of pathogenic bacteria and virus; ITK possessed by elderly experienced shrimp farmers in WB. It was a very good technical Seminar, News communicator Subrato Ghosh was present till end of it. On the same day, another Seminar on 'Challenges and Opportunities in Marine Sector in WB' was organized concurrently at Seminar Hall-1.

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Fishing for better returns: Taking technology to shrimp farmers

India produced more than 7,00,000 tonnes of shrimp in 2019 and exported more than 6,20,000 tonnes to the United States, European Union, Japan and China. The production comes from around 1,70,000 ha of shrimp farms along the country's coast, with Andhra Pradesh contributing a major share — of more than 4,00,000 tonnes.

Disease is one of the biggest deterrents to shrimp farming, though

Whenever Sreeram Raavi visited his village in Guntur district of Andhra Pradesh, he used to hear a constant complaint — shrimp yields were inconsistent, friends and relatives would say.

This prompted Raavi, a software engineer who has designed semiconductor solutions for high-speed broadband, to find a solution to their problem.

Very often, shrimp farmers could not correctly estimate the volume of shrimp in a pond and so could not give the right amount of feed, he found.

"In some cases, the miss (in estimating the volume of shrimp and the feed needed) was as much as 20-50%," the founder of Eruvaka Technologies said.

So, Raavi went about building hardware and software to address the challenges.

In about 1,000 hectares (ha) of shrimp farms spread across Surat, Goa, Andhra Pradesh and Pondicherry, Eruvaka's products have been installed.

These include a feeder that dishes out feed based on the volume of shrimps in a pond and an underwater acoustics-based device -- ShrimpTalk -- that listens to the noise from shrimps to estimate their appetite and hunger. Eruvaka also has a device that measures the pH level (level of alkalis or acids) in water, to ensure that shrimps get the right amount of dissolved oxygen needed for their survival.

The entire data is fed on a Cloudbased solution that a farmer can access on his mobile app

"The farmers are seeing better yields," Raavi said.

Although this is not the first to attempt at finding a solution, Raavi has been able to build products that are user-friendly for farmers.

Eruvaka's products are sold in eight countries and installed in 6,000 ha of shrimp farms globally, the company said.

India produced more than 7,00,000 tonnes of shrimp in 2019 and exported more than 6,20,000 tonnes to the United States, European Union, Japan and China. The production comes from around 1,70,000 ha of shrimp farms along the country's coast, with Andhra Pradesh contributing a major share — of more than 4,00,000 tonnes

Aquaconnect, which launched an AI-driven advisory solution Farm MOJO, helps farmers improve productivity, predict disease and ultimately achieve higher income.

"Technology intervention optimises the farm input usage and improves yields by up to 10%," said Rajamanohar Somasundaram, cofounder, Aquaconnect. "A data-driven approach is the key to addressing the challenges in shrimp farming," he pointed out.

Farm MOJO provides insights into optimizing water quality and Feed Conversion Ratio (FCR), two critical factors to successful shrimp farming, he said.

It provides shrimp farmers alerts and suggestions to improve farm productivity. The platform works with 4,200 farmers in states such as Tamil Nadu, Andhra Pradesh and Gujarat.

FCR is an important metric when it comes to shrimp aquaculture. Somasundaram said Indian farmers spend 1.5 kg of feed for every kilogram of shrimp, which was "unsustainable."

By using Farm MOJO, however, this could go down to 1.2 kg for the same quantity of shrimp, resulting in feed cost declining by around 40%, he said.

"The water quality management is extremely helpful," said 35-year-old Arul Prakash who has cultivated 14 tonnes of shrimp using the FarmMOJO app. "It (the app) indicates in red if the ammonia value has gone up and even recommends the medicine that can be used to bring down the level. The convenience of seeing everything on the phone is very helpful.

Gujarat-based Manish Tandel has cultivated 32 tonnes of shrimp using the technology.

"I am able to track things like the market price of shrimp, which is something that we earlier did not have much idea about," he said. "This information at my fingertips is very empowering. All the records are digitised and easily accessible, making it easier to compare, which was

earlier a tedious process."

Disease is one of the biggest deterrents to shrimp farming, though.

In Andhra Pradesh alone, it is expected to have cut down production by 40% in 2019. Predictive analysis can bring down revenue lost due to pandemics like white spot disease.

The Central Institute of Brackishwater Aquaculture has built an android app that allows farmers to share inputs on their farms and get feedback on the type of feed needed and oxygen levels to be maintained. It provides real-time advisories on better farm techniques, besides methods to diagnose diseases in the shrimp, based on images taken and processed from the farm.

Experts say that sometimes there could be batches of shrimp where as many as six out of every 10 shrimp suffer from the disease.

"Population medicine, or epidemiology, is the only solution to combating one of the biggest constraints to shrimp culture — disease," said Professor Kenton Morgan of the University of Liverpool, who has over 40 years of experience in epidemiology. Morgan has tied up with Aquaconnect, IDH and The Sustainable Trade Initiative for a project to predict shrimp diseases by using machine learning.

"If farms adopt policies based on the epidemiological evidence, disease can be reduced by up to half, which is a significant economic gain, especially in a country like India where aquaculture is a sector with high economic value," he said.

While purchasing feed for shrimp, farmers who buy online have an edge over those who pick up their supplies from dealers.

"Farmers who buy from dealers have to pay at least a 10-15% crop credit," said Dr Cheran, a member of the Society of Aquaculture Professionals.

"The younger lot are extremely tech savvy and, while the online portals available to buy shrimp feed from are limited, they manage to get the feed from the few apps and websites that offer it at a much better price. The products are about 5-10% cheaper online, so that becomes an added saving for farmers who are willing to adopt technology for all levels of the process of shrimp cultivation," he said.

Aquaculture professionals said that there has not been much change on the supply chain side and that distance has been reduced by setting up more processing plants along the coast. Very few chemicals were being used to improve the shelf life of shrimps and grading was still being done by sieves with different sizes and not by cameras, they said.

However, efforts are on to streamline and digitise the supply chain.

In October, Walmart Inc announced a pilot blockchain technology for end-to-end traceability of shrimp sourced in Andhra Pradesh and shipped to select Sam's Club locations in the United States.

The pilot project was the first known use of blockchain to track shrimp exports from farmers in India to an overseas retailer. It was aimed at strengthening the shrimp supply chain and enhancing food traceability and transparency for consumers in the US.

Walmart said that the introduction of blockchain in the shrimp supply chain could help improve the quality of information on the product for compliance and monitor food safety procedures throughout the growth and processing of the shrimp.

"Now, Walmart can have provenance on any product that is there on their shelves," said Vinayaka Pandit, STSM and Senior Manager of IBM Research, which partnered with Walmart on the pilot.

"Blockchain as a technology can really help transform the way food supply chains work today, both in terms of bringing much needed visibility and helping to eliminate a lot of inefficiencies that exist in food supply chains," he said.

The barriers to adopting modern technology are coming down significantly, he added.

"As long as a farmer has access to a phone that can take pictures, that itself is sufficient. Even if they have a phone where they can send a message, then also they can send information about their supplies through SMSes," he said.

Odisha seeks major carp cage culture increase

Plans to kick-start the intensive cage culture of carp are currently being considered by the Indian state of Odisha.

Cage culture could allow farmers in Odisha to produce 125,000 tonnes of Indian major carp species such as rohu and catla, a year

The Odisha state has 138 reservoirs, comprising 200,000 hectares of water, and it is thought that it could produce a minimum 125,000 tonnes of fish from its eight largest reservoirs, although the current production volume is considerably lower and 50,000 tonnes of carp species, including rohu (Labeo rohita) and catla (Labeo catla), are imported from neighbouring states.

To increase production the use of circular cages is being promoted and the Government of Odisha aims to finalise its cage culture guidelines by March 2020, in the process opening up the reservoirs for cage culture by eligible investors.

Tathya reports that a high-level delegation led by Pradipta Kumar Mohapatra, Agriculture Production Commissioner, recently visited aquaculture operators in Pune, in a visit organised by WorldFish under its existing technical collaboration with the government of Odisha.

The delegation visited both the Vaidika Group in the Kasarsai Dam and the net manufacturer Garware Technical Fibres.

Currently, according to Thathya, only about 10,000 cages have currently been installed in reservoirs across India – largely for the production of pangasius and tilapia. Odisha started promoting cage culture in reservoirs in 2015. However, so far, only 320 rectangular cages have been installed in 13 reservoirs across the state.

All of them are farming pangasius, which has limited market potential in Odisha, there is need for large circular cages to grow catla and rohu. As a result, Fisheries and ARD Department has already installed two large circular cages in Hirakud reservoir and the carp production is under progress on pilot basis.

Aquaculture Vaccines Market Projected to Garner Significant Revenues by 2019 – 2027

Transparency Market Research, in its latest market intelligence study, finds that the global Aquaculture Vaccines market registered a value of ~US$ xx Mn/Bn in 2018 and is spectated to grow at CAGR of xx% during the foreseeable period 2019-2029. In terms of product type, segment holds the largest share, while segment 1 and segment 2 hold significant share in terms of end use.

The Aquaculture Vaccines market study outlines the key regions – Region 1 (Country 1, Country 2), region 2 (Country 1, Country 2), region 3 (Country 1, Country 2) and region 4 (Country 1, Country 2). All the consumption trends and adoption patterns of the Aquaculture Vaccines are covered in the report. Prominent players, including player 1, player 2, player 3 and player 4, among others, account for substantial shares in the global Aquaculture Vaccines market.

Market segments and sub-segments

- Market trends and dynamics
- Supply and demand
- Market size
- Current trends/ opportunities/challenges
- Competitive landscape
- Technological breakthroughs
- Value chain and stakeholder analysis

The regional analysis covers:

- North America (U.S. and Canada)
- Latin America (Mexico, Brazil, Peru, Chile, and others)
- Western Europe (Germany, U.K., France, Spain, Italy, Nordic countries, Belgium, Netherlands, and Luxembourg)
- Eastern Europe (Poland and Russia)
- Asia Pacific (China, India, Japan, ASEAN, Australia, and New Zealand)
- Middle East and Africa (GCC, Southern Africa, and North Africa)

The report has been compiled through extensive primary research (through interviews, surveys, and observations of seasoned analysts) and secondary research (which entails reputable paid sources, trade journals, and industry body databases). The report also features a complete qualitative and quantitative assessment by analyzing data gathered from industry analysts and market participants across key points in the industry's value chain.

A separate analysis of prevailing trends in the parent market, macro- and micro-economic indicators, and regulations and mandates is included under the purview of the study. By doing so, the report projects the attractiveness of each major segment over the forecast period.

Highlights of the report:

- A complete backdrop analysis, which includes an assessment of the parent market
- Important changes in market dynamics
- Market segmentation up to the second or third level
- Historical, current, and projected size of the market from the standpoint of both value and volume
- Reporting and evaluation of recent industry developments
- Market shares and strategies of key players
- Emerging niche segments and regional markets
- An objective assessment of the trajectory of the market
- Recommendations to companies for strengthening their foothold in the market

Note: Although care has been taken to maintain the highest levels of accuracy in TMR's reports, recent market/vendor-specific changes may take time to reflect in the analysis.

The Aquaculture Vaccines market research answers important questions, including the following:

1. What was the number of units of the Aquaculture Vaccines sold in 2018?
2. Which distribution channel is best suitable for the distribution of Aquaculture Vaccines ?
3. How are the vendors overcoming the challenges associated with the use of Aquaculture Vaccines ?
4. What R&D projects are the Aquaculture Vaccines players implementing?
5. Which segment will lead the global Aquaculture Vaccines market by 2029 by product type?

The Aquaculture Vaccines market research serves a platter of the following information:

- In-depth analysis of the drivers, restraints, opportunities and trends influencing the growth of the global Aquaculture Vaccines market.
- Critical breakdown of the Aquaculture Vaccines market as per product type, and end use industry.
- Exhaustive understanding of the strengths, weaknesses, opportunities and threats of various Aquaculture Vaccines market players.
- Precise year-on-year growth of the global Aquaculture Vaccines market in terms of value and volume.
- Regional analysis further broken down into countries for minute details.

Why go for Transparency Market Research?

Transparency Market Research stays aligned with the fact the organization lands among the leading market research firms in India. Our analysts work irrespective of the time-zone, the result, we are being recognized worldwide. We abide by the notion that each client has his/her own set of requirements. With extensive primary and secondary research, our experts churn out the most accurate information regarding the desired the market.

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Aquaculture diversification is the way forward for Blue revolution in India: MPEDA

Gujarat MLAs for Aquaculture Development in the State

Aqua International organise 34th Aquaculture Expo at Surat

Olpad MLA, Mukesh L. Patel Inaugurating Aquaculture Expo 2020 at Surat on January 8.
Seen from left: Narendra Bhai Tandel , Pradip Navik, Dr Manoj Sharma, Maruti D. Yaligar, M.A. Nazeer and others.

Maruti D. Yaligar
Deputy Director, Aquaculture, MPEDA, Valsad, Gujarat Region

Narendra Bhai Tandel
President, Gujarat Aquaculture Association

Surat: A 2-day Exhibition and Technical Interaction Meet on aquaculture, 34th edition of Aquaculture Expo 2020, was held at Surat International Exhibition & Convention Centre, Surat, Gujarat, on 8 & 9 January 2020. Inaugurating the Expo, both the MLAs Mr Mukesh Bhai Patel and Mrs Zankhana Patel told that they will put efforts to develop shrimp aquaculture in the region well in the next few years. They told the stakeholders of the sector to do the follow up with them.

Mr Mukesh L. Patel, MLA, Olpad Constituency, Gujarat, in his address promised to do his best for the development of aquaculture activity in the region and in the state. He assured to raise this sector's problems in the State Assembly.

Mrs Zankhana Patel, MLA, 168 - Choryasi, Surat, Gujarat said that she is aware of the problems of shrimp farmers as her family was

Mukesh L. Patel, *MLA*
Olpad, Gujarat

Smt Zankhana Patel, *MLA*
Choryasi, Surat, Gujarat

VIPs on the stage released the brochure of India International Aquaculture Expo 2020

involved in aquaculture farming since long.

Pradip Navik
Vice President, Gujarat Aquaculture Association

She assured to help the farmers.

Mr Maruti D. Yaligar, Deputy Director, Aquaculture, MPEDA, Gujarat Region said that Indian fisheries and Aquaculture is an important sector of food production and growing sector in India's export basket in recent years. In 2018 -19, we have exported 1.43 Million MT of Seafood valued at Rs 47,621 crores.

The ministry of Commerce and Industries has set an ambitious target to export 2.1 million Mt of sea feed valued at Rs 85,000 crores by 2020 – 2022.

Since the capture fisheries has almost reached a plateau and further increase would only possible by risking deleterious impact on the environment.

According to us the production of Aquaculture in the country has to be increased at least by 50 % in the next few years to achieve the target and this targeted production has potential to almost double the income of 30 million people who depend on fishery / aquaculture as a source of income for their livelihood.

Around 2.07 lakh ha area is developed for aquaculture in India out of 5.30 lakh ha potential area suitable for aquaculture. We have already identified 50,000 ha of area across various states in the country that can be brought under aquaculture in the immediate future.

Gujarat has 90,000 ha area suitable for aquaculture from which only 14,000 ha has been developed in the recent years. We solicit cooperation and immediate action from Department of Fisheries in bringing additional land under aquaculture.

To popularize farming of diversified species, RGCA and MPEDA has localized breeding technologies for various species suitable for aquaculture in India main Mud crab, GIFT Tilapia, Seabass, Cobia, Scampi and Pompano.

Non availability of seed is one of the major stumbling block for popularizing culture of diversified species and in this connection RGCA-MPEDA hatcheries

M. A. Nazeer
Chief Executive, Aquaculture Expo 2020

alone cannot meet the emergency demand for seeds.

So, we have evolved a practical solution by establishing a model Multispecies Aquaculture complex at Vallarpadam, Kochi and such hatcheries have to be established in all maritime states.

This year at least ten marine fin fish hatcheries will be established in

The Exhibitors and farmers in Aquaculture Expo 2020 held at Surat shown interest to participate in "India International Aquaculture Expo 2020" to be held in Hyderabad on 17-18-19 June 2020

A view of participants in the Inaugural Session

India with NFDA and MPEDA technical and financial assistance which will boost aquaculture diversification.

China is producing more than one million MT of seafood every year from open sea farming, but we have not yet formulated leasing policy for open sea farming. CMFRI has already finalized the leasing policy and this year GO will be issued.

In my opinion Aquaculture diversification is the way forward for Blue revolution India, said Mr Maruti D. Yaligar.

The Expo was organized with the objective of bringing awareness among aquaculture farmers on shrimp and fish culture and various products, technology and services available to get better yield and results in aquaculture farming.

Large number of farmers from Gujarat, Maharashtra, Rajasthan, Chhattisgarh, Haryana, Madhya Pradesh, Andhra Pradesh, Tamil Nadu and other states participated in the Expo. The farmers felt that the Expo was a very good opportunity to update their knowledge on various aspects in aquaculture. Exhibitors also expressed satisfaction at the turnout of farmers in the Expo.

Companies dealing with manufacture and supply of products and services related to aquaculture sector displayed their products in the expo. The expo was organized by Aqua International, English monthly magazine on aquaculture sector.

Effective representation needed. Mr Narendra Bhai Tandel, President, Gujarat Aquaculture Association made a strong appeal to the government on the need of support through Land allotment, Electricity tariff and other facilities to aquaculture farmers.

Mr Pradip Navik, Vice President, Gujarat Aquaculture Association also spoke on the occasion.

Mr M. A. Nazeer, Editor, Aqua International and Convener of the Expo said that though the industry is moderate in size in Gujarat, due to proper mapping, infrastructure facilities and the good productivity achieved in Gujarat state, it attracted lot of companies dealing with supply of seed, feed, nutrition and healthcare products, aerators, P-Line products, processors, exports etc to participate in the Expo in large number.

He also stated that if land allotment is done more, Gujarat can become the biggest producer of shrimps in the country earning livelihood to lakh of educated and uneducated people, besides enhancing revenue to the entrepreneurs and to the government. Aquaculture is a big science and it requires good technology to produce quality shrimp, fish, crabs etc with better productivity. This sector needs government support to have sustainable growth, he added.

Dr Manoj Sharma, President, Gujarat Aqua Feed Dealers Association and Mr Harendra Singh Bhelari of Aquaculture Professionals group were present on the occasion.

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Govt of Gujarat, Department of Fisheries

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GAPS did well in "Farmers - Technical Experts Interaction Meet" during the Expo at Surat

Aqua International organise 34th Aquaculture Expo at Surat

Surat: Aquaculture Expo held in Surat on January 8 & 9 is one of its kind comprehensive event of national level, which was aimed to bring all the needs of every facade of industry at a single platform during expo period, and brought buyers, suppliers of different medicines, feeds, probiotics, other supporting accessories suppliers as well as corporate farmers, scientists, consultants, educationalists, enthusiast aquaculturists and various prosperous entrants who are planning to try aquaculture this year.

This year it had a unique central dome which was made for "Farmers - Technical Experts Interaction Meet" (both the days from 11 am - 4 pm), which was aimed to make easy understanding of various aspects of aquaculture and getting a clear idea of various do's and dont's of aquaculture to attain the goal of sustainable aquaculture for which a panel of 5 subject specific experts (from site selection, pond preparation until harvesting) gave their advices and services as volunteer during whole Expo period.

The Experts were: Mr Harendra Singh Bhelari (CAS in Marine Biology), Dr Nitin Pipralia (Unit of Antwerpen, Belgium), Mr Shyam Sunder Paul (CAS in Marine Biology), Mrs Gopika J. P (Pondicherry unit), Mr Zishan Ahmad (CIFE, Mumbai) and Mr Abhijet P Naohate (CIFE, Mumbai).

Although it was new experiment, still within first half of first day, it became the USP of the Expo with by its tremendous positive response from almost all the visitor farmers and company executives as well as exhibitors since they reached there and discussed about technicality and recent updates.

More than 1500 queries were discussed in the interaction session and cleared many myths and misconduct habits of aquaculture for the welfare of farmers in future.

Along with aquaculture, the aquaculture professionals also promoted esteemed vision of ***Aqua International*** magazine to promote and bring awareness among aquaculture farmers about maintaining good practices in the culture and produce quality shrimp, fish etc for the prosperity of farmers and the country.

It will be pleasure to work like this in all their upcoming events too, said the professionals.

Together supporting one another we can work smartly as well as efficiently towards sustainability of Aquaculture, stated.

GAPS members expressed congratulations for the successful event of Aquaculture Expo 2020 at Surat.
Looking forward to listen about your IIAE 2020 in June at Hyderabad.

Technical Association of Aquaculture Professionals
Short name "GAPS" --- TAAP registered office is at Surat, Gujarat

Members of GAPS:
Director: Mr Harendra Singh Bhelari

Core working committee members:

Mr Harendra Singh Bhelari (CAS in Marine Biology)

Dr Nitin Pipralia (Uni of Antwerpen, Belgium)

Mr Shyam Sunder Paul (CAS in Marine Biology)

Mrs Gopika JP (Pondicherry uni)

Mr Zishan Ahmad (CIFE Mumbai)

Mr Abhijet P Naohate (CIFE Mumbai)

About GAPS and its Objectives:

- GAPS also has Advisory Committee.
- Objective is to work for sustainability in Aquaculture in the country
- After some time to have a body of office bearers
- Free services to Farmers
- Has 300 members in GAPS
- • Working at arm level to top level
- We also train farmers about every aspect of shrimp aquaculture present team of experts
- We have microbiologists, biotechnologist, chemistry formulations.
- Experts with over 5 years. Some are with 15 to 20 years experience.
- We want technically skilled persons on aquaculture sector to be member of GAPS.

Expo Chief Executive and Editor, Aqua International, M. A. Nazeer Presenting Mementos to Exhibitors at Aquaculture Expo 2020

Mementos Presentation to Exhibitors

Mementos Presentation to Exhibitors

Mementos Presentation to Exhibitors

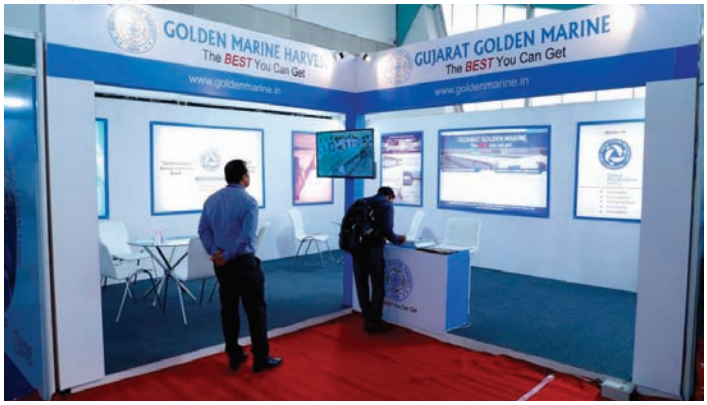









A view of Aquaculture Expo 2020 held at Surat, Gujarat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34th Edition
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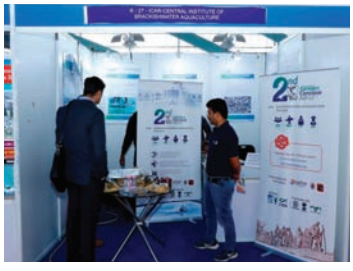

Thank You

Let us all Meet again in
IIAE 2020 on 17-18-19 June 2020,
Hyderabad, India

Aqua International DIARY of Events 2019

A Special Feature

January 2019
- Scientists told to focus on Real Science.
- Mariculture Policy: Traditional Fishermen to be Given Priority.
- Tamil Nadu to formulate new brackishwater aquaculture policy.
- Cocanada Aqua Professionals Association formed at Kakinada.

February
- International Workshop Gets Underway at CMFRI.
- Secretary, DADF, Tarun Shridhar applauds accomplishments of. CIFT.
- Budget 2019 proposals on fisheries to boost seafood export.

March
- Proposal of separate fisheries department to lift exports.
- Govt decides to start piloting vannamei shrimp farming.
- CMFRI issues advisory as US ban on wild-caught shrimp hits exports.

April
- Seafood exporters hope to expand Japan Business.
- White-spot virus returns to A.P., wild crab highly affected.
- Mud Crab Hatchery to be Established in Maharashtra.
- Withdrawal of GSP benefits by US to India not to affect seafood exports.
- Rising shrimp exports unshrink aquaculture segment: Report.

May
- Kerala: Fishing in polluted waters.
- Vegans call for compassion at India's first Animal Liberation March.
- Aquaculture set to get major boost in AP State.
- Vietnam, India compete for Japanese shrimp market share.
- Nandini Gears, the first Indian Aquaculture Aerators / Equipment coy to make HDPE Float and Covers in India with imported machinery.

June
- Seafood industry stress on sustainable farming as shrimp output set to fall.
- Ornamental Fish Entrepreneur for Promotion of Brackish Water.
- After cyclonic storm Fani, comes bonanza for fishermen.
- Tilapia, a fish to feed the world, and the deadly virus that may destroy it.
- India's shrimp exports to US set to rise after Trump's China tariffs.
- China, world's largest aquatic exporter for 17 years, reports making positive changes.
- Grobest Feeds working to become a Leading Player in Aquaculture Feed Market in India.

July
- Huge potential for Tuna fishing: Union Fishing Secretary.
- Black tiger shrimps from MPEDA hatchery, a big hit among farmers.
- Shark, 15 other fish species along Maharashtra coast under threat.
- India hosts Asian Pacific Aquaculture (APA) 2019.

August
- CIBA celebrates National Fish Farmers Day on July 10 with the Costal Fishers of Tamil Nadu and West Bengal.
- Aqua field faces shortage of skilled staff.
- Budget 2019: Nirmala Sitharaman announces 'Matsya Sampada Yojana' as Blue Revolution gathers pace.
- Biomed Techno Launches : Peptigrow.
- An Online Platform for Fish Sales, Marketing to be Developed Soon.
- Uni-President sells 40,000 metric tons feed in India annually.
- Aquaculture Round Table Series discussed on the future of 2 mn production capacity Aqua Feed industry in India depends on how well the Feed Manufacturers Meet the Challenges.
- Juvenile pomfrets swamp fish market.
- INFAH's role becomes more significant to meet newer Challenges, Adopt new culture & practices – Be more Proactive towards its role in Policy making.

September
- Chennai lab revolutionising ornamental fish industry in India, develops indigenous feed.
- Harnessing the fruit of the Sea.
- Forecasting model to be developed for long-term prediction of Sardine availability: Experts.

October
- Aquaculture, a vehicle for rural development: Venkaiah Naidu.
- India looks to cast its net wider as China's fish exports face US curbs.
- Government to Invest 25,000 Crores in next 5 years for Fisheries Development.
- India's pangasius industry next aquaculture segment poised for explosive growth.

November
- Regional cooperation key to boost fisheries in Afro-Asian nations: AARDO Secretary General.
- As aquaculture booms, it's consuming more fish than it produces.
- Shrimp Market - Growth, Trends, and Forecast (2019 - 2024).
- Vietnam targets 65 percent growth in Marine Aquaculture industry.
- World Aqua feed Market Research Report 2019-2025: Processed Soybean is the World's.
- Largest Source of Animal Protein Feed.

December
- US restrictions continue to hit exports of wild-caught shrimps.
- Focus on aquaculture for economic growth: Union MSME Minister Pratap Chandra Sarangi.
- Plastic free water bodies: CMFRI invites public to join 'Blue Green Brigade'.
- Live oyster a big hit at CMFRI fest
- Latest Research Report to uncover key Factors of Global Water Treatment for Aquaculture Market


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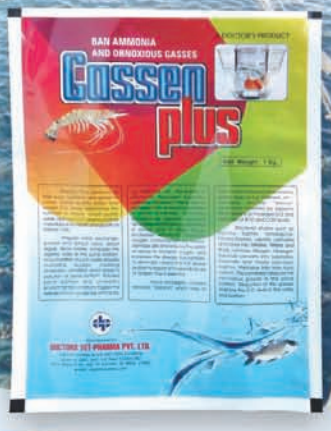

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Mullet farming in freshwater ponds at Gosaba Block, West Bengal

Highlight Points

Gosaba at South 24 Parganas district, WB is a main deltaic island in Indian Sundarbans, farthest from Kolkata city and closest to the forest. Elderly, experienced and dedicated fish farmer Sri Tulsi Halder, residing at Gosaba Block, was conferred the prestigious 'Krishak Ratna' award by Hon'ble Chief Minister of WB on 14th March 2016. He is practicing grow-out farming of mullets Liza parsia and L. tade in rainfed freshwater ponds successfully in association with major carps. Author had intimate conversation with Sri Halder at his fish farm premises on 7/9/2019 and his management practices have been presented here.

Subrato Ghosh
122/1V, Monohar Pukur Road, Kolkata – 700026

Problem with water availability at Gosaba GP

Gosaba Block is located at extreme eastern corner of Sundarbans region close to the international border with Bangladesh. The village of Gosaba lies at extreme ends of West Bengal peninsula. Sri Tulsi Halder, aged 68, is practicing commercial fish farming since year 1976 at Vill. Arampur-Katakhali under Gosaba Gram Panchayat (GP), P.O. Arampur, Block and PS Gosaba, South 24 Parganas. Sri Halder mentioned that in this GP, fish farming is dependent on monsoon rainfall and underground water is almost unavailable. Freshwater fish farming is done for six months. One will be able to get groundwater when dug at not less than 3000feet depth but is not potable and semi-saline in nature, unsuitable for fish culture. Fish farmers in this GP will not be able to draw out ground water using submersible/shallow pump machine. Round-the-year fish farming is not possible here. Drinking water is supplied in this GP from another GP namely Taranagar-Radhanagar located at 9-10km distance.

Freshwater fish farming practice

Residence and fish farming plots of Sri Tulsi Halder are located at 1.5km from Gosaba ferry ghat, where four brackish water rivers namely Durgaduani, Saraswati, Hogol and Bidyadhari meet. Sri Halder makes 85% of his three lands/plots usable for potato, mustard and mung bean (*moong daal*) cultivation after post-monsoon; rest portions are utilized for digging small ponds with embankment. Such ponds (1.8-2.0mt water depth) excavated at one end of the plots serve as the shelter for fishes when water from main plots completely recedes. Sri Halder owns three fish ponds and as well three such freshwater plots (impoundments) of 110dec, 235dec and 280dec in area (during monsoon and post-monsoon). Plots get dried up since mid-November and fishes shelter in ponds.

View of few sampled L. parsia

Good quality hatchery-produced advanced carp fry (Indian major carps, *Puntius javanicus* and *Cyprinus carpio*; 3.6-4.8cm size, 200-220 pieces/kg) is bought from local fish seed traders @ Rs 220-250/-/kg and stocked @ 70kg fry / 16dec pond. It is stocked during May and harvested from mid-October; fishes attain 300-500gm body weight. During rainfall (June-July) and thereafter, the entire plots along with ponds takes the shape of single sheet of large water body (water depth: 75-80cm) and fishes get a much bigger space to grow. During culture period, Sri Halder uses a mixture of 40kg cow dung, 5kg wheat flour, 5kg rice bran (with little amount of fine risk husk), 3kg soaked mustard oil cake, 250gm common salt, 1kg molasses or by-product of confectionary/sweet shops and semi-boiled geminated wheat seeds as dough balls to feed his fishes; 4.0-4.5kg applied daily for every 70kg fishes initially and increased thereafter. He applies lime @ 20kg/110dec plot every month.

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Lates calcarifer at Sri Halder's pond

Marketable-sized fishes are harvested partially during September-October to mid-January. Harvest begins at 2.30-3.00am, it may be conditions of rain or cool weather but still Sri Halder monitors all activities sincerely at this old age. In March, ponds are dewatered and settled bottom silt/sediment is removed. Pre-stocking management practices followed (application of mohua oil cake in March-April) in ponds for oncoming culture season.

Farming of mullets and sea bass

Every year Sri Tulsi Halder buys *Liza parsia* ('Aainsh parsey') seeds (200pieces/kg; 24-36mm size) from Rampur fish market and mullet seed traders in North 24 Parganas district, that costs Rs 600-700/-/kg. The 72-96mm sized L. tade seeds costs Rs 16-18/-/piece. It is available during January-February till end-March and seeds obtained during the beginning of season exhibits good growth.

These are stocked (20kg L. parsia and 500 pieces L. tade in 16dec pond) in February in a separate rearing pond (depth: 50-60cm) where brackish water is let in during high tide. It is necessary for nursing these early stages, Sri Halder stated. After two months, grown-up juveniles of these two species are stocked in freshwater plots. A mixture of 2kg pulverized paddy grains, 2kg wheat flour and 500gm pulverized mustard oil cake is used in dry form

Sri T. Halder applying feed for mullets

by Sri Halder to feed mullets everyday. Like carps, these are harvested during September-October to January. L. parsia and L. tade attain 60-100gm and 500-900gm respectively, sold at Gosaba fish market by Sri Halder @ Rs 350-400/-/kg for L. parsia and Rs 200-250/-/kg for L. tade. Farmed mullets are mainly preferred by tourists visiting nearby Sundarbans forest and have good demand.

Sri Halder has experienced that L. parsia will attain 150-180gm in farming plot in absence of major carps. In order to produce monosex Tilapia, Sri Halder uses one-fourth amount of single Veterinary hormone tablet along with 3.5-4.0kg feed to early fry of Oreochromis niloticus, once in a fortnight. Marketable-sized monosex Tilapia is supplied locally. L. parsia attains gravid condition from mid-October, with increase in weight and fetch high price. Marketable-sized major carps fetch Rs 120-140/-/kg to Sri Halder, which is much less compared to L. parsia. His total profit margin is Rs 3,00,000-3,50,000/- / year. Sri Halder opined that both L. parsia and L. tade grow well in grow-out

Sampled L. parsia of Sri T. Halder's pond

freshwater ponds (impoundments; zero salinity) as like in brackish water ponds. He completes harvest of freshwater and brackish water fishes within end of December. From mid-November, the water-less main plot is ploughed to eliminate obnoxious gases and other crops are cultivated.

Sri Halder also procures Lates calcarifer juveniles @ Rs 10/-/piece (36-48mm size) from fish seed farms at Canning and Rampur and stocks in one of his plot for culture. Considerable population of normal early fry of O. niloticus serves as its food and Sri Halder has acclimatized growing L. calcarifer juveniles to accept freshly dead fishes. As observed on 7/9/2019, L. calcarifer attained 300gm in two months and L. parsia 60-70gm in five months. A 1kg sized L. calcarifer will be sold for Rs 400/-.

Epilogue

During 2009-2010, Sri Tulsi Halder obtained 7-days training on fish farming at Gosaba-Rupayan, managed by Ramkrishna Mission and participated in 4-days training on freshwater and brackish water fish farming separately on three occasions, organized at Gosaba Block office by

Sri T. Halder applying fish feed (dough balls)

Asst. Director of Fisheries, South 24 Parganas. Sri Halder grieved that he incurred heavy loss in fish farming during the Aila supercyclone that happened in May-June 2009. Monsoon rainfall delayed in current year 2019 which is a setback in fish farming at Gosaba; it occurred from mid-June in earlier years but from August in 2019.

Sri Halder has experienced that Penaeus monodon grows upto 80-90gm in his freshwater impoundments in four months, when 60mm sized riverine seeds are stocked (1 month old; Rs 2/-/piece). He informed that normal Tilapia fry and higher stage has a large mouth portion in comparison to monosex Tilapia; the latter possesses an attractive purple-coloured caudal fin and unique blackish-purple small spots on dorsal sides. Normal O. niloticus has black caudal fin. Fish farmer Sri Sagar Halder, brother of Sri Tulsi Halder has prepared a formulated feed for mullets and other fishes comprising 20-22kg boiled rice, 20kg good quality wheat flour (Rs 14-15/-/kg), 15kg cow dung, 7-8kg rice bran, molasses and commercial probiotic. It is used for every 1000-1200kg fishes daily. Finely-powdered marine shrimp meal, if supplemented with feed gives good result. Mass of semi-moist duckweed Lemna minor is also used in fish farming plots on every alternate day @ 250kg/1000-1200kg fishes. Sri Sagar Halder owns two freshwater fish farming plots of 165dec each, having deeper region as ponds on one side.

State-level awardee fish farmer Sri Tulsi Halder possesses good depth of Indigenous Technological Knowledge; he discussed the utility of Helencha weed Enhydra fluctuans in curing eye defects, his indigenous preparation which can cure diarrhoea-affected chicken, his farmed watermelon of remarkable 12-14kg size, his indigenous formulation of supplementary fish feed. Simple and disciplined way of living of elderly village persons like Sri Tulsi Halder and Sagar Halder, their cordial behaviour, ability to work hard, principles and modest nature have taught author many things. Author believes that such persons can play a centric role in research problem identification, prioritization (Farmer-FIRST programme of ICAR) and contribute strongly in farmer-scientist interface for technology development and application (Courtesy: ICAR-ATARI, Meghalaya).

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Poultry house and fish farming plot

Is Antibiotic a Boon or Curse in Shrimp Industry

Highlight Points

▶Use of Antibiotics is wide and if it is properly used they are the precious tools. ▶Economically important disease of fishes are mainly parasitic infestations and in shrimp farming it is of viral origin which does not require application of Antibiotics. ▶Knowledge on Pharmacokinetics (PK) and Pharmacodynamics (PD) of antibiotics is very important. ▶Efforts has to be taken to impart knowledge to farmers regarding the responsible use of antibiotics with right knowledge on safety, efficiency, dose, schedule of usage and withdrawal period of drugs. ▶Prophylactic substances including probiotics, immunostimulants and disinfectants are also recommended.

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Introduction:

Antibiotics is one of the exceptional discoveries of humanity which is being used for years in controlling bacterial infections in agriculture and animal husbandry. With regard to its wide benefits and use it is now playing a great role in production sector also. But unfortunately the lack of knowledge in using these has led to the development of resistance pathogens and build-up of their residues in nature leading to environmental toxicity. Further, these residues may affect the natural micro flora and fauna which has a great role in maintaining the environmental balance. However the wide use of antibiotics make them as the essential requirements for healthcare systems and food production but it is necessary that they should be used responsibly in these fields. Hence it is essential that cautious effort has to be taken to preserve the effectiveness of available antibiotics in order to maintain sustainability in the field. When considering aquaculture industry, prophylactic and metaphylactic use of antibiotics in super and high intensive fish farming requires awareness.

Uses of antibiotics:

Antibiotics are good choice for the responsive management of bacterial diseases. Antibiotics were first isolated by accident but it has been found that this huge group of compounds are boundless in microorganisms and are used by them to ensure access to food sources. Recently it has been found that many animals, including invertebrates, produce antibiotics . If they are properly used, they are very precious tools. They can stop serious disease problems very quickly. They also have the potential of modifying the flora of the guts in animals thus improving feed conversion ratios. They are widely used prophylactically often at levels that are more likely to lead to resistance rather than eliminate bacteria that might pose problems. The most commonly used antibiotics were Norfloxacin, Oxytetracycline, Enrofloxacin and different Sulphonamides. Now-a-days the development of resistance has led to many undesirable conditions and serious negative consequences, ranging from human disease problems with strains of bacteria that are resistant to common antibiotics. Antibiotics are commonly used in aquaculture during the production cycle, both in the larval and growth phases. The use of antibiotics in aquaculture is always associated with environmental and human health problems, including bacterial resistance, prevalence of disease in the aquatic environment, and effects on the biogeochemical composition of the sediment.

Risk factors:

Antibiotic degradation rate depends almost entirely on environmental temperature and photo period hence the degradation of antibiotics in environments in tropical countries including India is expected to be faster when compared to temperate regions. In most of the developing countries including India according to one estimate more than 70 percent of the urban sewerage does not pass through treatment plants which pose a serious threat of anthropogenic activities in contaminating the natural water bodies with antibiotic residues and antibiotic resistant microbes. Some studies reveal that residues of chloramphenicol cause aplastic anemia and lead to very serious bone marrow infections .In addition to this the counter sale of antibiotic is a common practice in India which is complicating the process of regulating the medical use of antibiotics. Although cultured aquatic animals are consumed with high level of preference, antibiotic residues accumulated in aqua products cause allergies / toxic effects.

Antibiotics in shrimp farms:

In Indian fish production, more than half of production is still from capture fisheries whereas aquaculture is dominated by freshwater carp farming and semi-intensive brackishwater shrimp farming. Moreover, it is quite interesting to know that economically important disease of fishes are mainly parasitic infestations and in shrimp farming, viral diseases are main causes. Either of the case does not permit the application of antibiotics. But

many farmers use antibiotics in shrimp farming where it is not necessary. This is because of ignorance and lack of awareness regarding disease outbreaks and the need to use antibiotics in shrimp farms.

In shrimp, most of the disease burden is due to White Spot Syndrome Virus (WSSV) followed by Yellow Head Virus (YHV). As both these diseases are viral in origin, there is no significant benefit of using antibiotics routinely in shrimp aquaculture. Knowledge on Pharmacokinetics (PK) and pharmacodynamics (PD) of antibiotics is very important in developing awareness towards therapeutic approach. Pharmacokinetics is the study of the time course of absorption, bioavailability, distribution, metabolism, and excretion of the drug, while pharmacodynamics is study of the physiological, biochemical and molecular effects of drugs on the body. Therefore Information on PD and PK of a particular drug will help in determining the dose and its response therafter.

Majority of the antibiotics classes are banned for aquaculture application. For the best utilization of the permitted antibiotics, it is very important to know their PK and PD in aquaculture. Generally drugs are used in aquaculture for treatment and prevention of disease, controlling parasitic infestations, tranquilizing aquatic animals for weighing or transportation. Antibiotics are generally applied orally and in such situation, their assimilation and stability in the host is very important. Drug fed to fishes is metabolised in liver/hepatopancreas and excreted either through kidney or with faecal matter. Antibiotics such as tetracycline are excreted by glomerular filtration. Oxytetracycline is one among the USFDA approved antibiotics and widely used drug which has a withdrawal period of six to ten days in various organs of Penaeus vannamei at a temperature of 28°C.

Regulation in india:

Nitrofurans are forbidden to be used as veterinary medicine in EU vide Council Regulation 2377/90 since 1993. Detection of Nitrofuran & other antibiotics metabolites in internationally traded aquacultured products exported from India in the recent past years has caused much concern. This resulted in slowdown of shrimp imports causing economic loss to producers in India. This in turn created negative reflections in farmed shrimps, fish and other aquaculture products. Many Indian seafood consignments were detained by EU due to the presence of antibiotic residues in products.

Therefore a national flagship ICAR programme, All India Network Project on Fish Health is being operated since 2015 with ICAR-CIBA, Chennai as lead institute with nine other participating centers covering states with major aquaculture activity. One of the major objectives of the program is to monitoring the farms through regular survey, profiling and study of drugs/chemicals usage in the aquaculture covering freshwater, brackish and marine rearing systems. The information generated through this will be used to develop standards for preparation of legal guidelines for the use of drugs/chemicals in aquaculture. Two major national network projects, National Surveillance Programme for Aquatic Animal Diseases (NSPAAD) funded by National Fisheries Development Board (NFDB) and Consortia Research Project on Development of Vaccines and Diagnostics (CRP on V&D) are also underway. Under the NSPAAD, existence of different infectious diseases of aquatic animals in brackishwater aquaculture in the country are being monitored while under CRP on V&D efficient disease diagnostic tools which are cost effective and sensitive are produced. Also prophylactic measures such as probiotics, vaccination, and immune stimulants are being developed.

Approved drugs in aquaculture:

Very few countries have regulations on drug usage in aquaculture but no such regulations is present in most of the developing countries including India. This has lead to use of unapproved drugs or misuse of approved drugs in aquaculture posing potential risk to human health. Development of antibiotic resistance is considered as a major risk factor in addition to possible toxicity, allergy or carcinogenicity to humans. Establishment of regulations and guidelines are the key for reducing the risk of antimicrobial resistance arise out of aquaculture activities. The several international organizations have recommended the responsible and prudent use of veterinary antimicrobial agents in aquaculture.

Food and Drug Administration (FDA) Center for Veterinary Medicine legally approves the use of drugs and chemicals for aquaculture use in the US.

Oxytetracycline HCl, Sulfamerazine and a combined preparation that contains Sulfadimethozine and Ormetoprim are the FDA approved antimicrobial agents, for use in aquaculture. Information on composition of the commercial product, target species, route and schedule of application, tolerance limits and withdrawal periods for each target species is also provided by FDA. Though information on disease diagnosis and Better Management Practices are available for aquaculture activities, data on the quantities of antimicrobial agents used and the standard methodologies for their application in aquaculture is not available in India. This has lead to presumption by the international agencies about the improper use of these substances in Indian aquaculture.

CAA has listed out the banned Antibiotics and other pharmacologically active substances for using in shrimp aquaculture are

1. Chloramphenicol
2. Nitrofurans including: Furaltadone, Furazolidone, Furylfuramide, Nifuratel, Nifuroxime, Nifurprazine, Nitrofurantoin, Nitrofurazone
3. Neomycin
4. Nalidixic acid
5. Sulphamethoxazole
6. Aristolochia spp
7. Chloroform
8. Chlorpromazine
9. Colchicine
10. Dapsone
11. Dimetridazole

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12. Metronidazole
13. Ronidazole
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15. 15. Other nitroimidazoles
16. 16. Clenbuterol
17. 17. Diethylstilbestrol (DES)
18. 18.Sulfonamide drugs (except approved Sulfadimethoxine, Sulfabromomethazine and Sulfaethoxypyridazine)
19. Fluroquinolones
20. Glycopeptides

Conclusion:

Regulatory guidelines are essential for Indian aquaculture and effort is being made under ICAR funded All India Network project on Fish Health. Efforts has to be taken to impart knowledge to farmers regarding the responsible use of antibiotics with right knowledge on safety, efficiency, dose, schedule of usage and withdrawal period of drugs. Awareness should be given regarding the banned drugs in the countries where product is being exported. There is an urgent need to develop such regulations with guidelines for the sector so that the farmers are aware of drugs legally permitted to use. Prophylactic substances including probiotics, immunostimulants and disinfectants are also recommended.

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****More References can be provided on request***

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Marine ornamental species culture: From wild to microcosm / mesocosm

Highlight Points

►Considering the sustainability of the ecosystem, production of marine ornamental fishes in captive condition is very much essential to reduce the dependence on the wild stock. ►The aquaculture of marine ornamental species can also help to gain knowledge on their life history to improve the management of natural stocks. ►Knowledge about rearingpractices of marine ornamental fishes will help farmers to generate a good income and employment opportunities

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Introduction

The marine aquarium tradehad spread worldwide and expanding continuously in recent yearsas a multi-million dollars industry. This economic activity iscovering a remarkable range of species (Rhyne et al., 2012a) that are commonly termedas marine ornamentals.Marine ornamental species trade included theimmense diversity of organisms dominated bypopular taxonomic groups. Out of the total ornamental fishes used in aquarium keeping, almost 10 to 15 % is contributed by marine spp. It was also estimated that nearly 1.5 to 2 million people engaged in marine aquarium keeping either for recreation or livelihood.

Aquaculture is commonly considered as a promising way of reducing fishing pressureon the wild populations of marine ornamentals. The aquaculture of marine ornamental speciesalso make easy for the researchers to gain knowledge on their life history (e.g., larval development, reproductive behavior, age at maturity, fecundity, etc.) to improve the management of natural stocks. Additionally, cultured marineornamentals could provide novelty which is commonly associated with the collection and trade of rare or endemic species to an industry that is always willing to pay higherprices for rare or unique specimens. Also, the trade's dependence on wild collectioncan be possibly reduced by aquaculture through the sustainable production of livestock (Palmtag and Holt, 2007).

Need for Cultured Species

The ever-growing demand of marine ornamental species for the marine aquarium trade is highly dependent on the wild collection which results in an adverse impact on environment and sustainability. The over-exploitationand the use of destructive fishing practices (e.g., cyanide fishing) negatively affect not only the targeted species for marine aquariums but also theother speciesin the ecosystem. Themarine ornamental species aquaculture is well promoted as the most suitable alternative to the collection of wild specimens from coral reefs to fulfill the ever-growing demand. Instead, the need for cultured specimens in thisindustry, not all species traded should be for culture in captivity. In this case, the decision treesand SWOT analysis can play a key role to decide what species to culture, where andhow. Additionally, the aquaculture of rare or endangered species, the breeding of designer fish and the use of newtechnological solutions for growing corals can provide newopportunities for those culturing marine ornamental species.

Aquaculture of marine ornamental species

The extensive series of aspects involved in the success of a marine ornamental aquaculture facility of which the complexity of legal issues, the selection of a suitable location, the feasibility of the culture systems and the use of high-quality feed found as a critical issue. The fairsettlement of a facility depends upon the characteristics of the surrounding media (accessibility, weather conditions, water quality), the targeted species, the culture phases to be performed and other aspects related to the final destination of the organisms produced.

- **Location**

The success of the whole operation mainly depends on the selection of a suitable location for an aquaculture facility for the production of marineornamental species.All sites have theiradvantages and disadvantages. So,for the selection of a suitable location, all thefavorable and less favorable features of the target location need to be carefully balancedand accordingly decision should be made, if the overall combination will be suitable for developing the infrastructure.It is essential to highlightother relevant details that are important for site selection, such as: (1) the species to be cultured; (2) culture techniques to be employed; (3) the phases of marine ornamentals culture that will be implemented (e.g, broodstock management,hatchery, growout); and (4) what the target

market(s) will be for the organisms being produced (e.g., local, regional, national or international).The following features for the selection of location must be addressed: cost of land and concessions, climate conditions, water supply, availability of essential inputs for production and shipping (e.g., broodstock, seedstock, feeds, goods for packing and shipping cultured specimens), reliability of electrical network and energy price, potential use of renewable energy, availability of skilled labor, proximity to target markets and/or infrastructures that allow shipping to those markets (e.g., roads, airports).Licensing and other legal issues should be carefullyevaluatedbefore selection of any location, mainlyduring the production of exotic species or marine ornamentals listed in the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).Other legal issues such as the use of coastal properties with direct access to the sea, the use of groundwater (either fresh or marine), water discharge and use of exotic species, import and export permits may also be regulated by specific laws that may pose a problem for licensing.

- **Culture systems**

The aquaculture of marine ornamental species can beclassified into two main categories: in situ or ex-situ. This terminology reveals the location site forthe culture with its own set of advantages and disadvantages.

▶ **In Situ Culture**

In situ aquaculture refers to the culture of organisms in the marine environment with the use ofnatural conditions. It is the most commonmethod in the countries which exports marine ornamentals such as cultured live rock, corals, tridacnid clams and less frequently fishes (e.g., seahorses). This practicemainly depends on available natural conditions (e.g., water physical and chemical parameters, water currents and hydrodynamics, light and nutrients) for the production of target species. But the exposure of cultured specimens to a range of lethal factors, namely: extreme weather conditions (e.g., storms and hurricanes), sedimentation (an issue for sessile organisms) and the presence of pathogens, parasites, predators, and competitors are the main drawback of the systemwhich may negatively affectthe survival and growth (Page et al., 2011). Also, the ability to control any parameter that may enhance production is very limited or even absent in in-situ culture. Likewise, the land operated support facilities arerequired for the production of artificial live rocksand the attachment of coral fragments to a suitable substrate in most of these culture practices. While the lower operational costs and less skilled labor force are the advantages of in situ aquaculture over ex situ culture practices.

▶ **Ex Situ Culture**

The another most commonly employed method to culture marine ornamental speciesis ex situ aquaculture.It allows better control over production and the regulation of culture conditions to maximize survival and growth. It is practiced in many countries (both exporting and importing) and requires a more skilled staff than in situaquaculture. Construction and operational costs are also higher in ex-situ than in in-situ aquaculture. Also, the higher risk of introducing exotic species into coastal watersis the major constraint for operating this type of facility (Semmens et al., 2004).Coastal properties in regions with good seawater quality may be too expensive and more difficult to license. Flow-through systemscan also be used for marine ornamental fish culture and need a reliable source of high-quality natural seawater.

Broodstock management

The selection and conditioning of broodstock play a crucial rolein the success of marine ornamental species farming. The management of the broodstock must process by adapting the zootechnical procedures which requireprevious knowledge of biological, physiological and ecological aspects of the species to be cultured.

Broodstock Systems: Design and Planning

The careful planning of systems and infrastructures for broodstock management and reproduction is paramount. So the planning should be based on (i) the biological requirements of cultivated species, (ii) the broodstock infrastructures (location of the operation, broodstock tank design, and technical equipment) and (iii) the operational costs and market value of cultivated species. After collecting all thisinformation, themarket inspection about the land or buildings available should be done by the aquaculturist and should start the preparation of a business plan.

▶ **Biological Requirements of Cultured Species**

In order to guarantee the success of marine ornamental aquaculture, proper knowledge about the biological requirements of the species to be cultivated is essential(Olivotto et al., 2003).It is necessary to study the existing literature about the life history of the chosen species, to ascertainthe difficulties in cultivation and reproduction of the selected species. If the available information is scarce,then field observations can be made if possible or can take other aquaculturists' personal experiences strategies to spawn and rear species for which the life cycle has not been controlled (Pillay and Kutty, 2005; Stickney, 2009). The reproductive strategies in marine ornamental aquaculture species vary considerably such as sexual and asexual reproduction, gonochorism and hermaphroditism (synchronous and sequential) and species with bidirectional sex change habit. Therefore, it is essential to obtain detailed knowledge about all these factors of interest, to reduce the numbers of trial and error required to get things right.Also, the planning for a broodstock facility should anticipate the issues of species with or without parental care to guarantee successful egg collection for incubation.The spawning season (single and multiple) is another critical factor to control in the reproduction process. The steps of aquaculturist interference to control spawning of the target species are again dependent on the knowledge of the biology of the species.The manipulation of environmental and other factorssuch as temperature, photoperiod,nutrition (e.g. the supply of live feeds to stimulate the broodstock and increase gamete quality), water chemical parameters or other particular factors (full and new moon) usually used to induce gonad maturation and spawningcan determine the success and viability of a marine ornamental

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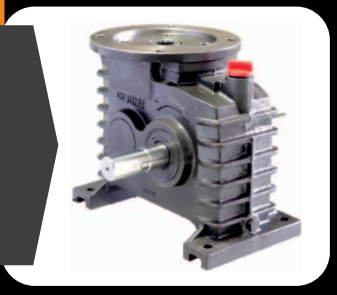

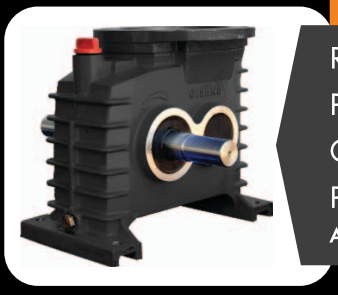

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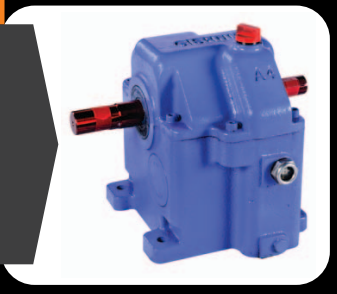

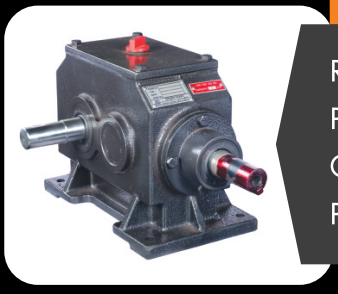

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aquaculture venture. Hence, in order to ensure continuous production of eggs and larvae throughout the year,at least four groups of broodstock should be maintained and then the aquaculturist should precede the manipulation of environmental factors to allow maturation of the gonads in a staggered manner between different broodstock groups.While selecting the broodstock, theaquaculturist should start with wild animals.In the case of captive broodstock, it is important to ensure some diversity so that theanimals chosen to form the broodstock are not siblings, in order to maximize geneticvariability (Cabrita et al., 2006).

Some careful observation swith important vital factorshave to make before buying the animals. Such as choose animals that are accepting a variety of foods and eating well (more important for fishes andcrustaceans); animals should not be pale or free from external injuries or lesions in the skin, fins, shell or exoskeleton or any signs of disease;animals must not show apparent signs of stress and should respond to positive stimuli (e.g. food supply).

- **Broodstock infrastructures**

The infrastructures to maintain a broodstock should be plan in such a way that it includes several factors, such as the operation regime (flow-through or recirculation system), dimension and design of tanks, hydraulic components, technical equipment necessary for water treatment and filtration, photoperiod and lighting systems, and collection of eggs or larvae, depending on the cultivated species (Pillay and Kutty, 2005; Stickney, 2009).The carefulselection of all these components will make sureadequate animal welfare and avoid stressful situations that are usually affectedthe broodstock maturation and reproduction (Pillay and Kutty, 2005; Stickney, 2009).

- **System Operation Management**

The choice of the operatingsystem of an aquaculture facility dependsupon its location (Stickney, 2009). The aquaculturist can choose a flowthrough regimein a place with good water quality which will reduce the implementation and operation costs of the equipment for life support systems (e.g., recirculating water pumps, protein skimmers or mechanical and biological filters). However, the supply of seawater and the success of the production can behinderedbyalteration in water quality due to anthropogenic actions (such as pollution) or biological agents (parasites, pathogenic microorganisms, among others)(Stickney, 2009). The risk may be prevented with the installation of pre-filtration systems for water treatment and disinfection.The decision for the system's operation regime should always include the operational costs and the risks associated with either method. Recirculating systemsare safer and more advantageous as theyallow better control of the physical, chemical and biological parameters in broodstock systemsbut instead, they are more expensive in terms of application due to morecost of the equipment and its operation (Rocha et al., 2015).

Besides the operating system, aquaculture of marine ornamental organisms depends on natural or synthetic seawater. Prior to use, the natural seawater must be mechanicallyfiltered (e.g. 1–10 µm cartridge filter) and UV irradiated or ozonized to remove any particlesand eliminate potential pathogens (Rocha et al., 2015). Another option to sterilize the water is the use of chlorine bleach which can be neutralizedwith sodium thiosulfate after 24 hours and strongly aerate before adding to broodstock systems (Stickney, 2009). The synthetic seawater can also be used as analternative of natural seawater due to unavailability of good quality natural seawater. But it is expensive because ofthe purchase of salt and requires large volumes of freshwater.

- **Broodstock Tank Design and Dimensions**

The selection of tanks mainly design, size and volume to maintain the broodstock are crucial when planning an aquaculture facility. Because if the broodstock is confined in a tank with an inappropriate design or size, it can affecttheir normal behavior or physiological needs; as a result, the process of maturation, mating andspawning can be delayed or even risked due to tank associated stress (Olivotto et al., 2003). The tanks can be constructed from different materials like glass, plastic, acrylic, or fiberglass depending on the species (Stickney, 2009).

Glass is inexpensive material and can be commonly employed to build stocking tanks for the broodstock of marine organism of relatively small size (Olivotto et al., 2011; Rocha et al., 2015). Glass has the advantage of full observation of the broodstock but has a wide variability in strength and weak in tension (Phillips, 1972).It will bend to a certain point and then break. Because of this characteristic gives it will be complicatedto build a cylindrical tank design with glass.Despite all the limitations, glass remains a material of choice for construction of small and medium tanks (e.g., average volumes 50–500 L) with a reasonable price.

Acrylic (brand names-Plexiglas or Perspex) also termed as polymethyl methacrylate (PMMA), a hard clear plastic, can be used as an alternative to glass tanks. It can be used to build large-sized broodstock tanks due to the advantageous characteristics oflightweight (up to 50% lighterthan glass tanks) and more crack resistant (up to 17 times stronger than glass tanks) (Adey et al., 2011). Additionally, acrylic can be transformed to more unusual shapes and also provide unique stocking conditions forsome ornamental marine organisms with specific tank design requirements through thermal forming construction process (e.g.acrylic tanks are most commonlyused to stock delicate jellyfish) (Lange andKaiser, 1995).

Similarly, the fiberglass (also called glass-reinforced plastic, glass fiber-reinforced plastic, or GFRP) tanks can be used for the species that need ample space. The acceptable characteristics of fiberglass such as lightweight, firm, robust and resistant to corrosion material allow the design of a variety of tank shapes. One of the main disadvantages of fiberglass tanks is that the animals may only be viewed from above since the tank walls are opaque.

The aspects of water dynamics in the broodstock tanks, inlet and outlet points,are fundamentalas it not only influencesthe water renewal and organic matter removal butalso influencesthe collection process of eggs or larvae

(Lekang, 2008).The egg collector for successful collection and transfer of the fertilized and viable eggs must install in the tank design of the species that broadcast gametes in the water column. The egg collector can be placed insidethe broodstock tank or outside in the outlet pipe.

Airlift egg collectorsconsist of a screened recipient (a bucket or a box) equipped with floats andsurrounded with small airliftsusually placed inside the broodstock tanks. The airliftsallow the transfer of surface water fromthe broodstock tank into the collector and useair flow to lift the floating eggs without any mechanical stress gently.

Overflow egg collectors consist of a screened container (a PVC cylinder with large lateral and bottom openings screened by mesh nylon net with a size adequate to retain the eggs) should place outside the tankwhen broodstock tank volume or surface area issmall.The overflow collector receives the water of the broodstock tank by overflow and should be placed inside another container (a bucket or a plastic box). During the spawning season,the surfacewater from the spawning tank allowsflowinginto the egg collector by connecting the broodstock tank outletpipe with the open top of the collector. The water level inside thecontainer that holds the collector should be maintained by another outlet overflowconnected to the filtration system. The screen helps the eggs to retained in the collector andkept floating by water flow and gentle aeration.

The ornamental species like clownfishes ofthe genus Amphiprion or firefishes needs a substrate(e.g., a clay pot or a tile) that can be easily removed to place in the hatchery tanks due to their nature of laying adhesive eggs on solid substrates (Madhu and Madhu, 2011).

The species that release the larvae (e.g., shrimp of thegenus Lysmata) usually require a rectangular-base glass or acrylic tank that depends on the size of the broodstock. The tank should be provided with water inlet either ontop or bottom of the tank in an opposite wall to the outlet that protected with a mesh filter (to prevent the escape of the larvae to the filtration system). Also, the rectangular-base tank should be divided with a net in such a way that it avoids the entryof broodstock into other areas.The largerdivision (in the inlet wall side) mustbe elected for the broodstock and the smaller division (in the outlet wall side) should be illuminated with a blue LED spot for larvaeusually released during the night. The light attracts the larvaeand helps to remain confined in the small compartmentand are entrained by the current. This allows the more accessible collection of larvae and also avoids the possible cannibalism by the broodstock.

▶ Operational Costs and Market demand of Cultivated Species

The sustainability of theculture is also dependent on its economic viability. After gathering all the information aboutspecies biology, implementation and operational costs, the market survey should be conducted to evaluate the demand of the species, the possible threats and economic development. The aquaculturist must consider the below-given points before investing in thecultivationof certain species, in order to address all the costs involved, and to assessthe feasibility of the project.

- **Costs factors associated with implementation and operation of an ornamental aquaculture facility**

Fixed costs	Equipment	Variable costs
-Land or building (cost of purchase or value if already owned) -Facility construction or adaptation -Material and installation of sewer systems -Plumbing for fresh and salt water -Reservoirs for fresh and salt water -Pumps to deliver water to the broodstock systems -Office, laboratory, storage, maintenance and reparation workshop -Salaries -Food storage and preparation (e.g. freezer, fridge)	-Laboratory equipment (e.g. microscope, water quality analysis equipment) -Office equipment (e.g. computer, furniture, fax machine, copy machine) -Maintenance and reparation workshop (e.g. drill press, mechanicstools,-carpenters' tools, cutting torch, etc.) -Hatchery tanks and associated plumbing and aeration equipment -Emergency equipment (back-up generator) -Feeding systems (e.g. automatic feeders) -Miscellaneous supplies (e.g. plumbing supplies, spare parts, buckets, fish catch nets, etc.)	-Fringe benefits -Animals for broodstock (purchase or production) -Consumables (e.g. feed, salt, water analyses reagents, replacement of filtration systems components, etc.) -Repairs and maintenance of facilities and equipment -Energy (electricity, natural gas, petrol, diesel fuel) -Chemicals (disease treatment drugs, supplies associated with water qualitydeterminations) -Interest paid -Depreciation -Taxes -Insurance

Source:Calado, R., Olivotto, I., Oliver, M.P. and Holt, G.J. ed., 2017. *Marine ornamental species aquaculture*. New Jersey: John Wiley and Sons.

Larviculture Systems

Larviculture systems are designed and organized to maximize production and minimizespace and cost. In the last decades, most of the advances related to larval rearingmethodologies (zootechnics, feeding, nutrition, diseases among others) and larviculture systemsare achieved to improve performance and efficiency. The advances in larviculture system involve thedevelopment of new and more efficient equipment and also the use of small or large volumes systems (microcosm and mesocosm, respectively).

► **Mesocosms**

The complex designs, named mesocosms,is an artificial aquatic system that can be useful in ecological studiesand in the assessment of environmental factors and biological features (Adey andLoveland, 2007). Mesocosm consists of large volume tanks and also basins and ponds, wherea short food chain can be artificially induced. Itlies in between the microcosm andthe level of natural ecosystems.It is a semi-intensive system that allows rearing and experimental study of aquatic organisms (Papandroulakis et al., 2004) in which diverse groups of organismssupported by a given physico-chemical environment, energyand nutrients in food webs (Adey and Loveland, 2007). The system maintains the ecologically relevant components of the natural environment under controlledconditionswhich makes it helpful for therearing of delicate larvae of invertebrates, mollusks, crustacean and fishes.Mesocosms are useful for larval rearing but also for breeders, depending on the species.This style is most suitable for professionals, industrial hatcheries or aquarium exhibitions.

In a mesocosm approach, the food supply is based on endogenous sources or by maintaining the monoculture of microalgae and zooplankton externally (Calado, 2008). The food chain can be enhancedthrough the external supplies of food periodically (rotifers, copepods and different developmental stages ofArtemia)during the period of overeating, depending on both the density of larvae in the system and the availability of microalgae to prey.

Mesocosm can be constructed from glass and acrylic materials (40% the density of glass) which are less convenient for large volume units (>1000 L) and require more maintenance labor, especially for wall cleaning while the fiberglass and concrete units can be recommended for mid-size units beyond 1000 L volume (Adey and Loveland, 2007).

► **Microcosm**

Microcosmis the simplified version of mesocosmwithvolumes ranging from a few dozen liters to 1–2 hundred cubic meters. The rearing unitsgenerally used in microcosms are rather conventionaland easily affordable to ornamental hobbyists. Microcosms can be made of 20-L glass tanks with acheaper solutions such as small fiberglass tanks, plastic trash cans, plastic utility sinkswhich have been successfully used in the culture of some marine ornamental fisheslike clownfishes (Amphiprion spp.), gobies (Gobiosoma spp.), dottybacks (Pseudochromis spp.) and some blennies (Meiacanthus spp.) (Olivotto et al., 2005, 2009, 2011).

In microcosm system, the sides of the tank should be dark (black) or covered with black panels to reduce light reflection and facilitate prey recognition and the bottom should be white to simplifythe bottom cleaning. Lighting should be provided at the upper part of the tank because lateral lighting can cause confusion in larval orientation. Usually for small tanks (up to 50 L), an 18 W fluorescent lamp can be provided at theheight of 30 cm above the water surface.

In addition to tank volume, larval rearing success may also depend on tank shape.Round or tanks with rounded corners can be considered ideal as they support not onlythe uniform distributionof larvae and preybut alsohelpful in increasing water flow and concentratingwaste on the tank bottom.The exampleincluded in small larval tanks aresmall 50 L mesh baskets (rearing chambers) which can be placed inlarge tanks (400–1000 L) andfound useful for both demersal andpelagic spawners (Holt, 2003). These rearing chambers promote the concentrationof larvae and food, increases food consumption, provides shelter and decreasespotential physical damage.

Other requirements

Food is also an essentialrequirement in the culture of marine ornamental species. In the case of marine organisms,the feeding requirements are considered as restrictive due to the non-acceptance of inert diets, particularly in larval stages. Likewise, it is difficult to satisfy the food requirements of ornamental speciesinrearing systems by providing the naturally available prey. Hence, it is necessary to manage the live prey production system based on typicalzooplanktonic species during the culture process. Microalgae, rotifers, Artemia and copepods are considered as the most importantlive prey in the rearing ofmarine ornamentals. The adequate knowledge and good practices in the production techniques of live preycan contribute a great success in ornamental species cultivation.

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****More References can be provided on request***

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