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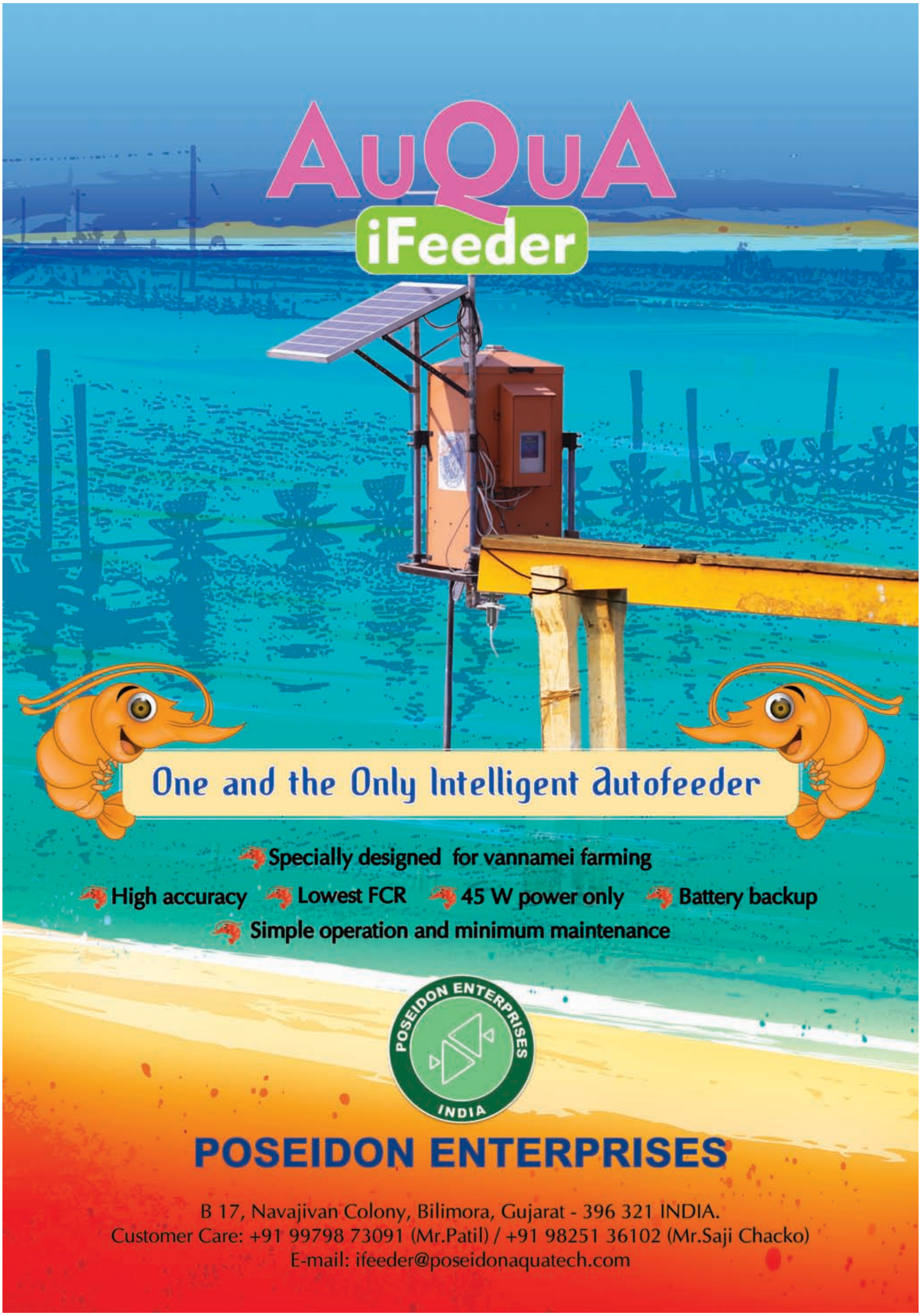
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Articles:

Aqua International wishes you all Happy New Year 2020 !

Dear Readers,

Greetings from Aqua International for a Happy, Prosperous and Peaceful New Year 2020 to the readers, advertisers and the well wishers. The January 2020 issue of Aqua International is in your hands.

In the News section, you may find news about – Ms Rajni Sekhri Sibal, Secretary, Department of Fisheries, Ministry of Fisheries, Animal Husbandry and Dairying, Government of India presented Fisheries Vision 2020 at a National Conference titled "Harnessing the Untapped Potential of Fisheries and Aquaculture" on 13 December 2019 at New Delhi. The Secretary said that Govt is filling the gaps in achieving the vision 2020 by the interventions.

A national seminar on 'Advances in Aquaculture and Biodiversity' was organized at Department of Zoology, Gauhati University, Assam. As a part of this programme, Prof Samir Bhattacharya, Former INSA Golden Jubilee distinguished Professor at School of Life Sciences, Visva-Bharati, West Bengal spoke on 'How fish could overcome the environmental obstacles'; which was the 7th Prof Rajendra Prasad Chaudhuri Endowment Lecture.

A new brood-stock feed is developed by Central Institute of Freshwater Aquaculture (CIFA) led to off-season breeding of Indian major carps in the field conditions. The CIFABROOD, a diet for quality seed production of Indian major carps, has helped break the seasonal barrier and both Rohu and Catla bred successfully in two farms in Tamil Nadu.

Ending a decade's slide in the production of black tiger shrimps, Kerala is experiencing a comeback of the top healthy seafood, thanks to a much-needed initiative of the Marine Products Export Development Authority (MPEDA) launched earlier this year. The MPEDA's efforts to revive the production of black tiger shrimps on a mass sale of its seeds have been receiving encouraging feedback, according to authorities with the statutory body that functions under the Union Government, Ministry of Commerce & Industry.

Mr Imtiyaz Khan and his brothers who started Olpad Aqua in April 2018 have achieved significant progress with in one year and targeted to expand their business into different aspects of Aquaculture sector and working hard to grow.

In the articles section, article titled "Chitosan – derivative from waste to multi-application industry" by Kasturi Chattopadhyay, Sanchita Naskar and K.A. Martin Xavier discussed about Deproteinisation and demineralization of shell wastes containing chitin yields chitosan. Presence of reactive functional groups - amino group at C2 position and hydroxyl groups at the C6 and C3 positions makes chitosan, a versatile component to be used in multi-industries worldwide. Modified chitosan enhances the solubility as well as antimicrobial efficiencies of chitosan. Can be an ideal natural alternative to chemically synthesized antimicrobial agents used in food industries. Can reduce the usage of antibiotics, thereby decreasing rise of antimicrobial resistant microorganism.

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

Our Mission

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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CMFRI calls for community involvement for Vembanad study

Students who are part of CMFRI research project on Vembanad lake engaging in data collection process

Kochi: Following the success of student engagements in the first phase of its research project on Vembanad lake, now the Central Marine Fisheries Research Institute (CMFRI) has sought the support of the general public toensure an extensivecommunity involvement in the second phase of the study. This time people residing along the banks of the Vembanad, fishermen, tourist boat workers, regular commuters and the environmental activists can become part of the research project. Launched last year, the study is aimed at understanding the extent of pathogenic vibrio pollution in the Vembanad lake, identifying their reservoirs in the ecosystem, mapping the distribution of vibrio carriers using remote-sensing techniques and developing forecast models that would serve to anticipate hotspots of microbial infection. Besides CMFRI, National Institute of Oceanography (NIO), Nansen Environmental Research Centre-India (NERCI) and Plymouth Marine Laboratory, UK are also part of the multi-institutional research project that comes under the India-UK Water Quality Initiative of the Department of Science and Technology, Government of India.

A massive extent of community involvement would help enhance the frequency and spatial extent of data collection for the study on the Vembanad and promote scientific awareness among the public, said Dr A. Gopalakrishnan, Director of CMFRI. "The study mainly focuses on mapping the hotspots of vibrio in the lake and developing a forecast model using remote-sensing technology", he said.

"At present around 300 students are part of this project who involve in sharing with researchers the up-to-date data of the various components of the backwater using the 'Secchi disc', a simple hand-held device to measure level of turbidity of water. The student participation has given a boost to the research initiative", he said, and hoped that widening of community engagementinto the general public and those closely watching the Vembanad would give a fillip to the research works.

Vembanad File photo

Technical awareness on use of remote sensing tools in environmental monitoring would benefit those being part of the project. Exposure to this research initiative wouldgive them a chance to interact with reputed scientists from national and international institutions, Dr Gopalakrishnan said.

MPEDA to boost aquaculture in Telangana state

India's Marine Products Export Development Authority (MPEDA) is planning to improve freshwater aquaculture in Telangana state.

An action plan has been prepared to develop water bodies and impart the necessary training to aqua farmers, according to MPEDA chairman K.S. Srinivas. It recently held an event in Hyderabad for more than 100 farmers.

"MPEDA is giving top priority to Andhra Pradesh, which stood top in seafood exports in the country. Still, there is potential to increase seafood as well as cultured fish production in [Telangana]."

It plans to build a regional office in the city of Bhimavaram, which will include a new quality control laboratory.

"Very soon we will request chief minister YS Jagan Mohan Reddy and submit the action plan for development of aquaculture and seafood production in the state."

Prof S. Bhattacharya speaks on 'How fish overcomes environmental obstacles'

The National Seminar on 'Advances in Aquaculture and Biodiversity' was organized at Department of Zoology, Gauhati University, Assam recently. As a part of this programme, on the 2nd day, Prof Samir Bhattacharya, Former INSA Golden Jubilee Distinguished Professor at School of Life Sciences, Visva-Bharati, West Bengal spoke on 'How fish could overcome the environmental obstacles'; which was the 7th Prof Rajendra Prasad Chaudhuri Endowment Lecture.

According to Prof Bhattacharya, many fishes in nature successfully overcome environmental barriers and constraints (changes in pH, salinity, temperature, turbidity, lack of food availability) by developing endogenous mechanisms and their normal growth, survival and reproduction takes place. He discussed about salt barrier and oxygen barrier (hypoxic condition) for fishes; salinity level in freshwater, brackishwater and marine water and their difference; osmoregulatory behaviour of important migratory fishes; mechanism by which amphihaline fish *Hilsa ilisha* crosses the barrier of salt and its migratory route; significance of chloride cells in osmoregulation of fishes; significance of cortisol hormone and prolactin in supporting life of H. *ilisha* in marine water and its adaptation in freshwater respectively, maintenance of the hormones in fish body and helping it to cross salt barrier.

Prof Bhattacharya further discussed about measurement of mobility of snout cells, i.e., cell migration assay; Boyden chamber experiment (having separate sea water and estuarine water salinities) to determine cell (snout cells of *H. ilisha*) migration; mechanism by which *H. ilisha* locate their breeding ground in riverine freshwater; abundance of diatom (phytoplankton) Coscinodiscus sp observed in *H. ilisha* breeding ground in upper stretch of river Hooghly, its role in helping upstream-migrating *H. ilisha* and its attachment over fish nostrils. He highlighted on the chemosensory network associated with this diatom which guides the fish to locate breeding ground; existence of silaffin protein (important as ion and odour receptor) in the diatom; pattern of biosilification in it; his research on extraction of silaffin and generation of anti-silaffin antibody (immunofluorescent in nature).

While discussing on other important barriers, viz., oxygen-depleted condition or hypoxic stress, lowered pH and turbid condition of water bodies, Prof Bhattacharya focused on induction of HIF-1alpha protein; counteraction of stress by certain signals; metabolic sensors SIRT-1 and AMPK used by fishes, which stimulate signaling molecules causing increase in mitochondria bioenergetics ultimately effecting a greater ATP yield; increase in ATP permitting fishes to counteract and overcome afore-mentioned barriers or environmental hazards. ATP level in fishes goes down during hypoxia but it is adapted when mitochondria is increased (so too ATP), he explained. In small turbid ponds, ATP level in catfish Heteropneustes fossilis initially goes down but it produces ATP themselves later on and can recover stress. After initial few days, membrane potential, fatty acid oxidation, cytochrome-C oxidation have been found to increase in H. fossilis and it can combat stress. Molecules SIRT-1 and AMPK sense that ATP is going down and PGC-1alpha regulates increase in ATP, Prof Bhattacharya explained. He is doing research on increasing mitochondrial biogenesis exogenously to overcome hypoxia. Finally Prof Bhattacharya spoke about talent and innovative minds of the Japanese, seriousness in work, gaining interest in doing research, opening of thoughts and inspired MSc Zoology students and PhD researchers present as participants. News communicator Subrato Ghosh was present during this Endowment Lecture of Prof Bhattacharya.

New CIFA feed leads to off-season breeding

The scientifically developed and nutritionally balanced feed enhances egg, sperm and larval quality and hastens early maturation of gonad besides improving breeding performances

Bhubaneswar : In a first, a new brood-stock feed developed by Central Institute of Freshwater Aquaculture (CIFA) led to off-season breeding of Indian major carps in the field conditions.

The CIFABROOD, a diet for quality seed production of Indian major carps, has helped break the seasonal barrier and both rohu and catla bred successfully in two farms in Tamil Nadu.

The scientifically developed and nutritionally balanced feed enhances egg, sperm and larval quality and hastens early maturation of gonad besides improving breeding performances.

Principal Scientist of CIFA Mr Samiran Nandi said though the feed was tested successfully at the research station under controlled condition, it did not yield desired results in field conditions in Odisha.

"We decided to apply in breeding farms in Tamil Nadu where the climate these days is pleasant with sporadic rainfall activities. Two farms, including one private farm, were selected and both rohu and catla were bred. While 25 lakh

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After a decade, black tiger shrimps stage a comeback in Kerala

Authorities says that MPEDA's efforts to revive the production of black tiger shrimps on a mass sale of its seeds have been receiving encouraging feedback.

Ending a decade's slide in the production of black tiger shrimps, Kerala is experiencing a comeback of the top healthy seafood, thanks to a much-needed initiative of the Marine Products Export Development Authority (MPEDA) launched earlier this year.

The MPEDA's efforts to revive the production of black tiger shrimps on a mass sale of its seeds have been receiving encouraging feedback, according to authorities with the statutory body that functions under the Union Governments Ministry of Commerce & Industry.

The mass sale of seeds since the past 100 days shows a rapidly growing interest among the farmers to raise the disease-free variety, the authorities said.

The Kochi-headquartered MPEDA had on February 18 begun supplying black tiger shrimp seeds from its new multi-species aquaculture complex (MAC) at Vallarpadam.

The inaugural sale was done by MPEDA chairman K.S. Srinivas by handing over one lakh seeds to former Kerala Director-General of Police Hormis Tharakan, a progressive shrimp farmer.

Today, Mr. Srinivas noted, the black tiger prawn supplied from the nine-acre MAC has been showing 'excellent' performance in various parts of the State.

We knew that increased production of the black tiger variety can boost India's shrimp exports in the long run. We are seeing the early signs of it happening, he said.

Recently, I visited some of the aquaculture farms to understand the field performance of the seeds from our facility. Our seeds are doing well. The farmers comments are encouraging," he said.

Mr. Tharakan, buttressing the point, said the seeds showed good performance during the three months of culture period.

"They [seeds] gained an average weight of 38gm, thanks to the quality. I got 260kg of shrimp in the 90 days from an area of 50 cents by stocking 10,000 seeds. Currently, we are rearing another 90,000 seeds, he said.

This is in happy contrast to my facing a continuous crop loss for the last three years, he said.

The ₹7.26-crore MAC, which was inaugurated on December 8 last, features a hatchery with an annual production capacity of 20 million black tiger shrimp seeds, besides nurseries for four varieties of fin fishes.

C.V. Mathew, another farmer who has been into shrimp cultivation for 16 years in his native Kumbalangi suburb, said black tiger seeds from MAC attained 25gm size in the first 50 days.

In 86 days, the animals reached an average size of 40gm, he said.

I have never experienced such a growth rate of my crop. No different has been the feedback from the farmers from down State Kollam and Kannur in north Malabar after culturing the seeds taken from the Vallarpadam hatchery, top MPEDA officials said.

It was from 2010 that the black tiger shrimp, an endemic species to south-east Asia, began to face a slump in its traditional reputation as a major variety of cultivated shrimp item in India. That was after aquaculture farmers in the country began to focus on growing the exotic vannamei species of shrimps in a big way.

New CIFA feed leads to off-season breeding

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spawns were harvested from 23.1 kg female, 11 lakh improved rohu (Jayanti) spawns were recovered from 11.3 kg female," he informed.

Indian major carps - rohu, catla, mrigal are seasonal breeders and they breed only during monsoon (June-August) throughout the country. Though many attempts were made by CIFA to overcome the barrier and breed fish in off season (November-January), it was unaccomplished so far due to constraint of specific ambient condition.

A team of eight scientists led by Nandi has developed the feed that facilitates early spawning and improves spawn recovery. It is also suitable for multiple/repeat breeding in carp and can be given as mass feed.

Nandi said the feed was supplied to Tamil Nadu farms in September under National Fisheries Development Board (NFDB) funded project to observe possibility of maturation. The diet (two per cent of body weight) was fed for 45 days.

"The success has long term implication as Tamil Nadu can be developed into a major seed production centre especially during non-breeding season, which will contribute substantially for the aquaculture production in the country," he hoped.


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Indian shrimp looks to China for demand growth

Globefish reports that during the second half of 2019, international shrimp trade escaped another market crash supported by strong imports by China

Indian shrimp looks at China for growth in demand as US imports is seen slowing. According to a trade report by FAO's Globefish, which is responsible for information and analysis on international fish trade and markets, China is now the world's number one market for shrimp and strong demand from China kept the international shrimp trade stable in 2019.

The report also mentions the likelihood of lower shrimp exports from India in 2019 as overall exports of shrimp declined from most countries in Asia, due to lower import demand, although exports increased to China in large percentages.

However, according to the latest data published by the US agency National Oceanic and Atmospheric Administration (NOAA), India's shrimp exports to the US for the period of January-September 2019 stands at 198,350 tonne as against 175,511 tonne during the same period of 2018.

Since 2018, China has emerged as the rising star in the global shrimp market. During the first half of this year, foreign shrimp supplies in China increased by 186% to 2,85,900 tonne, compared with 1,00,000 tonne in 2018 and 54,100 tonne in 2017, for the corresponding periods. During the review period, Ecuador had a 41% share in these imports, followed by India (21%) and Saudi Arabia (8%).

Earlier in October, the Indian government had reported that the country's marine exports to China are expected to cross $1 billion mark by the end of this year having touched almost $800 million in the first nine months of 2019.

India is the second-largest aquaculture producer and the third-largest fish producer in the world with exports of marine products worth $7 billion. China is a major importer of marine products with imports of around $12 billion. China imported 49,701 tonne of seafood from India in 2017-18 worth $227.39 million and according to the data released by China's customs authority recently it has tripled and touched almost $800 million, in the first nine months of 2019.

Regarding Indian shrimp production from aquaculture ,Globefish reports that in India, where shrimp aquaculture is mainly export-oriented, production forecast for 2019 suggested a 30–40% decrease in comparison to 2018.

"In the main aquaculture region, Andhra, the often unsuccessful price negotiations between farmers and processors/ exporters, resulted in a much lower production this year. In Odisha, cyclone and floods disrupted farmed shrimp production during the second half of the year and the region of Tamil Nadu was affected by the unusual and extreme hot weather this year. Production trend in Gujarat and West Bengal remained moderate but insufficient to offset the falling supplies in the southern farming regions," the report mentions.

Shrimp prices in the international trade remained stable in 2019 albeit with a weaker trend. In view of the falling production in India, export prices have started to improve since August, albeit marginally, the report adds. In US, the average import price of shrimp in 2019 was 8.5 % lower during the first half of 2019, compared with the same period in 2018.

Mrs Vijaya and Mr Ravi Pelluru, CEO, BMR Feeds Pvt Ltd, celebrated the marriage of their younger son Deepak Reddy with Prathyusha Reddy on 15 November 2019 in Hotel Taj Deccan, Hyderabad.


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Secretary Rajni Sekhri addresses conference on "Harnessing the Untapped Potential of Aquaculture in India"

New Delhi: Ms Rajni Sekhri Sibal, Secretary, Department of Fisheries, Ministry of Fisheries, Animal Husbandry and Dairying, Government of India presented Fisheries Vision 2020 at a National Conference titled "Harnessing the Untapped Potential of Fisheries and Aquaculture" on 13 December 2019 at Shangri-La Eros Hotel, New Delhi.

The Secretary said that Govt is filling the gaps in achieving the vision 2020 by the interventions such as:

1. Investments in mariculture, Islands, Tunas, Changes in Leasing policy. Promoting private investments in open sea cage culture, quality brood and seed, hatcheries and nurseries, seaweed and Bivalve.

2. Invesment in Coldwater Aquaculture as Trout cultivation in JK, Uttarkand, Ladakh, Himachal Pradesh and NE states. Govt is keen on Branding and Marketing of Organic Cold water fishes from these regions.

3. In Shrimp culture – SPF Seed and Quarantine Traceability and Compliances and promote Private investments in Markets Deepening and Diversification and Improving Export Logistics.

She said, for consumers perspective – to improve

Rajni Sekhri Sibal, Secretary, Department of Fisheries, Ministry of Fisheries, Animal Husbandry and Dairying, GOI

fish quality and awareness creation on preservatives, testing methodologies in fish markets, e-marketing, value addition by fresh / live fish sales, govt is contemplating introduction of Fish Marks focusing on food safety and quality.

In his welcome address, Mr Arabind Das, Chairman, CII National Committee on Allied Sectors in Agriculture – Dairy, Fisheries and Poultry said that this meeting is conducted on the initiation from the Secretary of Department of Fisheries to bring all the stakeholders of the sector on to a platform to discuss the current issues and address the need to successfully implement Vision 2020 document.

Dr Ramesh Kumar, CEO, Salem Microbes Pvt Ltd moderated the session on "Fisheries & Aquaculture:

P. Anil Kumar and Dr Ramesh Kumar with other speakers in the conference

Policy and Programmes".

Mr P. Anil Kumar, Joint Director, Marketing, The Marine Products Export Development Authority (MPEDA) spoke about MPEDA efforts for the upcoming of this sector.

Mr K Palaniswamy, General Manager, National Bank for Agriculture and Rural Development (NABARD) spoke about Finance and Credit Support to Fisheries sector.

Mr Nitin Puri, President & Country Head, Food & Agri Strategic Advisory & Research, Yes Bank, moderated the session on Infrastructure and Trade.

avail benefits.

Presently hatchery capacity developed is in far excess of requirement of the industry. This sector needs Government support for hatcheries in species diversification. Quarentine system has to be brought on par with other animal imports.

Ramraj underlined the need of representation of stakeholders in policy making bodies to avoid disconnect between policy and its implementation.

Mr Santhana Krishnan, CEO, SK Marine Technologies India Pvt Ltd, moderated the session on Technology, Innovation and its Dissemination.

Mr Ravi Yellanki, Managing Director, Vaisakhi Biomarine Pvt Ltd, spoke on Journey of Vannamei so far and the road ahead.

D. Ramraj with other speakers.

Mr D. Ramraj, President, All India Shrimp Hatcheries Association (AISHA) explained the fundamentals of shrimp hatcheries. The CRZ Act of 1991 and CRZ Act of 2011 exempts hatcheries as an activity requiring water front. But later CAA Act restricted hatchery operations. He wanted CAA act to be amended to restore the original rights to operate hatcheries as per CRZ rules.

States as Odisha and Andhra Pradesh are providing relief in Power tariff. But in Gujarat and Tamil Nadu it treated as commercial entity. We need relief and get listed again as MSME to

Dr Manoj M Sharma, President, Gujarat Aquaculture Feed Dealer Association and Director, Mayank Aquaculture Pvt Ltd, addressed on Blue Revolution - Shrimp Farming Success Story of Gujarat.

Dr B Madhusudana Rao, Principal Scientist, ICAR - Central Institute of Fisheries Technology, spoke on R&D in Fisheries – Status and Future.

Significant Achievements:

- Breeding, seed production and culture technologies of 61 finfish and shellfish species:
- Freshwater (Indian Major Carps, Catfish, Freshwater prawn, etc.)


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Rajni Sekhri Sibal speaking as Arabind Das and others look on.

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- Therapeutics and chemical formulations for disease control (e.g. CIFAX, CIFACURE)
- Implementing Disease monitoring through National Fish Diseases Surveillance Programme
- Description of over 300 new fish species & database developed for 3398 fish species.
- Whole genome sequencing of 3 fish species
- Developed different designs of fishing craft for the country (fuel efficient multipurpose fishing vessel, Solar powered boat) and fishing gears with by-catch reduction devices (Turtle Excluder Devise, Square mesh cod end)
- Developed nutraceutical products from seaweeds and green mussel for pain & arthritis, type-2 diabetes, obesity and Seaweed nutraceutical drink for enhancing micronutrients

- HRD through post-graduate programmes and need-based training

Plans Ahead:

- Harvesting of essential fatty acids from coastal waters of India
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- Development and application of novel vaccines for fish/shellfish pathogens of significance
- Land based RAS for high density farming systems
- Factory fish (Labriculture) production of marine food fish
- Selective breeding of Indian white shrimp
- Genomic Selection and Disease resistant fish
- Genetic selection of Indian catfish, Clarias magur for growth
- Creation of a Centre of Excellence in Inland saline Aquaculture
- Development of climate resilient rainbow trout
- High precision fishing systems
- Development of green aquaculture practices for commercially important freshwater finfish and shellfish species

S. Santhanakrishnan, Ravi Kumar Yellanki and Manoj Sharma with other speakers.

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Indian shrimp production actually increasing in 2019, says MPEDA

BANGKOK, Thailand -- Shrimp production volumes in India have continued to increase in 2019, contrary to some reports and to the surprise of many, including Anil Kumar, joint director of Marine Products Export Development Authority (MPEDA).

"We had anticipated production to drop further down by 20-25%," Kumar said, at Infofish's 2019 shrimp conference, held in Bangkok, Thailand.

"But, surprisingly when we looked at the first-half results of the financial year from April to September, when we looked at the production, it's slightly increased," he said. "Everybody was anticipating that prices have gone down from last year, there were rumors of lots of diseases there, but the good news is that actually the data shows that production has gone up."

At the Global Outlook in Aquaculture Leadership (GOAL) conference, held in October in Chennai, India, the forecast was for Indian production to drop in 2019. The GOAL prediction has India flat at around 600,000t in 2019 and 2020, down from as much as 700,000t in 2018 (see second below).

According to Kumar's data (see first below), Indian shrimp production currently stands at close to 700,000 metric tons for all species, approximately 90% of which is vannamei. Production is being increased by both a certain degree of area expansion as well as a more productive use of the current 172,000 hectares worth of ponds.

"Some states like Gujarat usually go for one crop per year, other states go for two crops or more, so there is a tendency for more and more nurseries coming now, and that is resulting in better productivity."

"Increasing the area is still happening, but not as fast as it used to happen before. The old production of vannamei started in 2009-10, and there was a rapid increase in three or four years. Now the rate of increase in the area has come down, but the yield per hectare year, that's come up," Kumar said.

Manoj M Sharma, director of shrimp farming company Mayank Aquaculture, showed conference members the extent shrimp farms have expanded in Gujarat.

Using satellite photos taken for Google Earth over three shrimp farming areas Dumas, Olpad and Mandroi, he showed how between 2004-2018, small clusters of ponds transformed into large blue patchworks of ponds devoted to shrimp aquaculture (see below).

While India still has room to expand its shrimp production, China does not. Expanding shrimp farms in China is "impossible", said Cui He, president of China's Aquatic Products Processing and Market Alliance, during the Infofish conference. Already a producer of 1.82 million metric tons of farmed shrimp annually (other industry members cite much lower figures), more likely is a decrease, he suggested.

"Perhaps there will be a decrease [in farming area], I think," he said.

India plans network of labs to tackle disease

But India is not just expanding its farming area to increase production, it's also ramping up its approach to combating shrimp disease, Kumar said.

As part of its five-step program to tackle shrimp disease, India will be investing in a network of advisory laboratories, providing research and technical advisory services to shrimp farmers, said the MPEDA executive.

The government is aiming to build around 100 "Aqua One" labs in five key coastal states around the country, created as part of a public-private partnership, Kumar said.

Indian shrimp's biggest threats are whitespot and enterocytozoon hepatopenaei (EHP), he acknowledged, detected in 8% and 6% of annual samples respectively.

"What we observe is, during the winter crop, which is from August to the end of November, we find more of a white spot occurrence; and during the summer crop, which runs from March to July, we find more white feces and EHP problems," Kumar told listeners at the conference.

The government has reportedly established an aquatic quarantine facility at Chennai airport in Tamil Nadu province, the only airport in the country through which foreign broodstock is permitted to enter.

Furthermore, as part of the national disease surveillance program, seven national institutions have begun meeting with shrimp farmers and holding advisory sessions, promoting best management practices — Kumar claimed that 10,000 farmers in Andhra Pradesh, India's largest shrimp-farming state by far, have been addressed in this manner.

"Farmers often accuse hatcheries of giving infected PLs [post-larvaes], but we couldn't find many cases of EHP in hatcheries," Kumar said.

MPEDA also has multiple schemes underway aimed at eliminating the use of antibiotics in the country's shrimp aquaculture system, according to Kumar.

For starters, MPEDA is

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Word Fisheries Day 2019: Highlighting the Importance of Indian Fisheries

Apart from being an important sector of food production providing nutritional security, fisheries give employment to 14 Million Indians and save the bio-diversity of the country.

The fishery resources in India are mainly composed of inland and marine. Inland fisheries are mainly composed of major rivers and their tributaries, ponds, reservoirs, lakes, canals, etc. On 21st November, World Fisheries Day is celebrated worldwide by the fishing communities to recognize the vast and sometimes underappreciated food source for millions of humans i.e.' Sea'.

AP Government Launches Scheme

Moreover, Andhra Pradesh's government has recently launched a number of welfare schemes for fishermen on the occasion of World Fisheries Day. State Fisheries Minister Mopidevi Venkata Ramana said on the occasion, 'The YSRCP government has increased compensation to fishermen, for the mandatory ban period of 45 days, from Rs 4,000 to Rs 10,000.' The state government has also increased the subsidy on diesel for mechanized or unmechanized boats. In case of death of fisherman compensation of 10 lakh will be given within 2 months.

How Indian Fisheries are helping the Livelihood?

Indian fisheries and aquaculture is an important sector of food production providing nutritional security, besides livelihood support and gainful employment to more than 14 million people, and contributing to agricultural exports. With diverse resources ranging from deep seas to lakes in the mountains and more than 10% of the global biodiversity in terms of fish and shellfish species, the country has shown continuous and sustained increments in fish production since independence. The total fish production during 2017-18 is estimated to be 12.60 million metric tonnes, of which nearly 65% is from the inland sector and about 50% of the total production is from culture fisheries and constitutes about 6.3% of the global fish production.

As per the government's reports, "Paradigm shifts in terms of increasing contributions from the inland sector and further from aquaculture have been significant over the years. With high growth rates, the different facets, viz., marine fisheries, coastal aquaculture, inland fisheries, freshwater aquaculture, and coldwater fisheries are contributing to the food basket, health, economy, exports, employment and tourism of the country".

Export of Indian Fisheries (source- http://nfdb.gov.in/about-indian-fisheries.htm)

More than 50 different types of fish and shellfish products are being exported to 75 countries around the world. Fish and fish products have presently emerged as the largest group in agricultural exports from India, with 13.77 lakh tonnes in terms of quantity and Rs. 45,106.89 crore in value. This accounts for around 10% of the total exports and nearly 20% of the agricultural exports, and contribute to about 0.91% of the GDP and 5.23% to the -GVA of the country.

With over 2.4 lakh fishing crafts operating along the coast, 7 major fishing harbours, 75 minor fishing harbours and 1,537 landing centres are functioning to cater to the needs of over 4.0 million fisherfolk. For promoting aquaculture, 429 Fish Farmers Development Agencies (FFDAs) and 39 Brackishwater Fish Farms Development Agencies (BFDAs) were established in the country. The annual carp seed production is to the tune of 40 billion fries and that of shrimp is about 54 billion PLs, with increasing species diversification in the recent past. Besides large-scale freshwater food fish culture, ornamental fish culture and high-value marine fish farming are gaining importance in the recent past.

Indian shrimp production actually increasing in 2019, MPEDA says

Contn from Page 26

planning to introduce a novel certification scheme encouraging hatcheries to use antibiotic-free feed. The organization has already been running a test hatchery with nine tanks this year, attempting to prove to local farmers that it is possible to produce antibiotic-free post larvae (PLs) shrimp, via a combination of bacteriophages and probiotics. The results are due for the end of January, Kumar said.

A pilot version of the shrimp seed certificate, tested with 20 shrimp hatcheries, will then be run from January 2020. Guidelines for producing antibiotic-free PLs will be drawn up from the results of this year's MPEDA tests, Kumar added, which can then be used as an example of best practice by the test hatcheries. Data will then be entered into a secure, transparent blockchain system.

The pilot scheme is expected to run for eight months, with the full certification to be launched in 2021. According to the MPEDA co-director, once hatcheries have begun adopting the new certification successfully, a separate version will be rolled out for shrimp farmers too.

On top of this, state-level police task forces have also begun holding regular inspections of hatcheries and aquatic ingredient suppliers, Kumar said, with sharp fines for suppliers or manufacturers found selling unlabeled products, or ones containing antibiotics.

Since the program started last November, task forces have already inspected 479 hatcheries and 1,029 aquaculture supply shops, according to Kumar.

CIFA in Collaboration with State Fisheries Department, Ganjam Conductes Training Programmes at Ganjam District, Odisha

Bhubaneswar, December 21: ICAR-Central Institute of Freshwater Aquaculture, Bhubaneswar under its DST (TSP) Project (Carp seed production and integrated fish farming technology for livelihood development of Phailin affected tribal farmers of Ganjam District, Odisha) and in collaboration with State Fisheries Department, Ganjam organized a chain of training programmes in Ganjam District of Odisha during 17-18 December 2019.

Training on "Scientific Fish Farming" and fish fingerling release to pond was conducted at Nuapada Village, Kukudakhandi Block on 17 December 2019. It was attended by Dr B. C. Mohapatra, Principal Investigator of DST Project and Principal Scientist, CIFA; Mr Pramod Kumar Rout, District Fisheries Officer, Ganjam; Mr N. K. Maharana, AFO, Digapahandi Block; Ms Suchismita Priyadarsini, AFO (HQ); Mrs Sachitarani Kar, AFO, Kukudakhandi Block and the Mr Ranjan Kumar Patra, Revenue Inspector of Balipada RI circle, Ganjam. It was attended by fifty beneficiaries of the village. Training on "Integrated Fish Farming" was conducted at Ambapur Village, Digapahandi Block on 17 December 2019.

Mr Siba Prasad Bhoi, Dy. Director Fisheries, (Ganjam Zone) was the Chief Guest of the function. He inaugurated the programme and appreciated the endeavor of CIFA for the benefit of tribal farmers of the District. It was attended by the Principal Investigator of DST Project and Principal Scientist, CIFA; DFO, Ganjam; AFO, Digapahandi Block and AFO (HQ). More than one hundred persons participated the programme. Training on "Scientific Fish Farming" was conducted at Sindhikhalli Village, Digapahandi Block on 18 December 2019. It was attended by the Principal Investigator of DST Project and Principal Scientist, CIFA; AFO, Digapahani Block and project personnel from ICAR-CIFA. Thirty beneficiaries participated the programme. One training programme on "Integrated Fish Farming" was conducted at Sujanasahi, Khallikote Block on 12 December 2019 and fifty persons took part in it.

CIFT develops device to analyse freshness of fish

Kochi: The Central Institute of Fisheries Technology here has developed a simple, low-cost and easy-to-operate device to assess the freshness of fish in the market.

The paper-based disc can be used on packed fish and shell fishes. The paper disc is attached inside the pack without coming in contact with the fish. This will absorb the chemical compounds released during the storage period and changes colour.

The colour change indicates the freshness of fish without any elaborate and costly laboratory tests. CO Mohan, senior scientist, Fish Processing Division, CIFT, said the cost of the test is nominal and will not affect the sale price of fish. This freshness indicator can be used on chilled, refrigerated and iced fish.

The use of freshness indicator is beneficial to both producer/ manufacturer and consumer.

The test allows the monitoring of supply chains. The consumers will get better quality fish, Mohan said. There are reports of using adulterants to maintain the freshness of fish, which has affected the business and trust of consumers.

The freshness of fish is either ensured by sensory attributes or by analytical methods, which is time-consuming, costly and not real-time, he said.

In many instances, consumers who buy inferior quality fish come to know of it only while cooking or consuming. The availability of low-cost and easy-to-use device will help consumers get good quality fish, while it is helpful to traders to maintain better conditions to retain the freshness.

CIFT scientists Mr K. Elavarasan, Mr Pankaj Kishore, and Mr S. K. Panda were part of the team that developed the device.


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Aquaculture Expo 2018 helped them in setting up of "Olpad Aqua"

Olpad Aqua expanding

Surat: The family and owners of "Olpad Aqua" are in the business of Hardware and Building raw material trade since 2014 based at Olpad, near Surat. The family was trying to understand aquaculture sector and to enter into business in aquaculture sector.

Mr Imtiyaz Khan, an MBA and Managing Partner of Olpad Hardware visited "Aquaculture Expo 2018" exhibition held in the second week of January 2018 at Surat, which gave him an understanding about aquaculture trade and in April 2018 entered into the sector with Olpad Aqua, the trading activity with all types of Shrimp as well as Fish farming materials and inputs business.

Imtiyaz Khan, Executive Director, Olpad Aqua Pvt Ltd

Olpad Aqua are the dealers of different products manufacturing companies dealing with supply of Shrimp seeds, Health & Nutrition products, Ropes, Aerators, Equipment etc.

Shrimp Raw Material Purchase and Sale

In 2019, Olpad Aqua has become a private limited company and has also taken up Shrimp raw material purchase from farmers and sale with head office at Olpad, and branches at Maroli and Surat. Soon they are opening branches in Gobheni Budiya Chokdi.

"We, at Olpad Aqua Pvt Ltd are working hard to be known as a company with supply of quality products at reasonable price and with prompt service" , said Mr Imtiyaz Khan, Executive Director, Olpad Aqua Pvt Ltd, talking to Aqua International Editor M. A. Nazeer at their Olpad office. The Expo you had organized in January 2018 helped us to understand and take up business in aquaculture, and thank you for visiting us, he said.

We have already achieved purchase of 1500 tons raw material from farmers and our aim is to reach 3,000 tons by 2020 for which we are developing infrastructure. They are taking Shrimp material from Khambhat, Bhavnagar, Rajula, Vapi, Valsad, Billimora, Navsari and Surat areas.

Olpad Aqua was started with an investment of Rs 15 lakhs in 2018 and achieved a business turn over of Rs 20 crore in 2018 – 19, out of which 90% is from shrimp material purchase activity. We targeted to achieve Rs 70 crore business in 2019 – 2020 all including. Over 300 farmers are associated with Olpad Aqua and we have three harvesting teams, and are going to expand the team, he stated.

" We want to maintain good relation with all the stakeholders of aquaculture sector and grow ourself in the industry", said Imtiyaz Khan.

Names of Partners in Olpad Aqua

1. Imtiyaz Khan, MBA, Executive Director
2. Nurul Arefin, M.Sc – Director
3. Farhan Malek, M.Com – Director
4. Hasan Malek, Director

He informed that the company is planning to start export of shrimps initially as Merchant Exporter in 2020 and they want to export atleast one container of shrimps in 2020.

Imtiyaz Khan, top left, with his brothers Farhan Malek, Aarefin Malek and Hasan Malek, Directors of Olpad Aqua Pvt Ltd.

A view of Olpad Aqua counter at Olpad near Surat.


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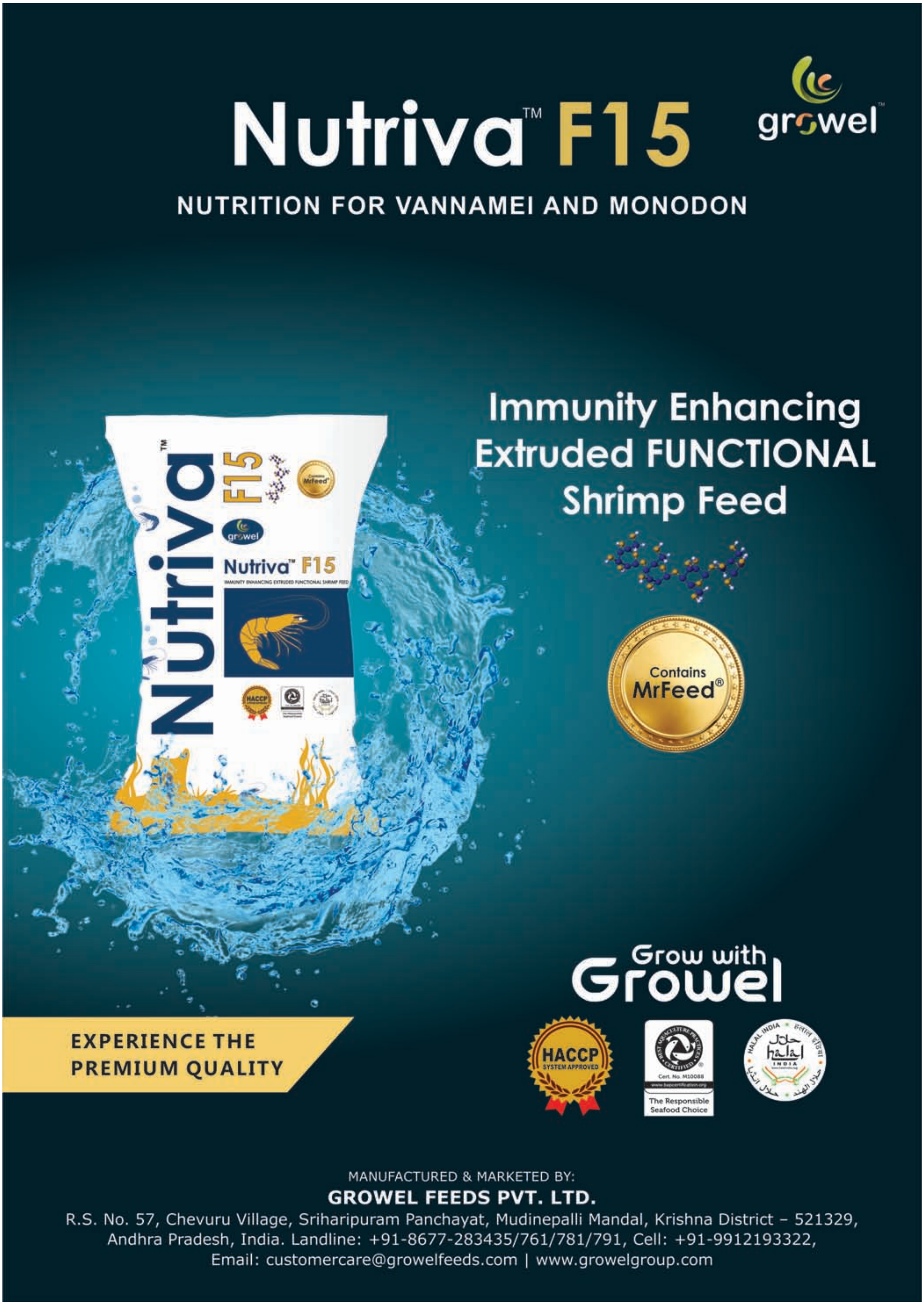
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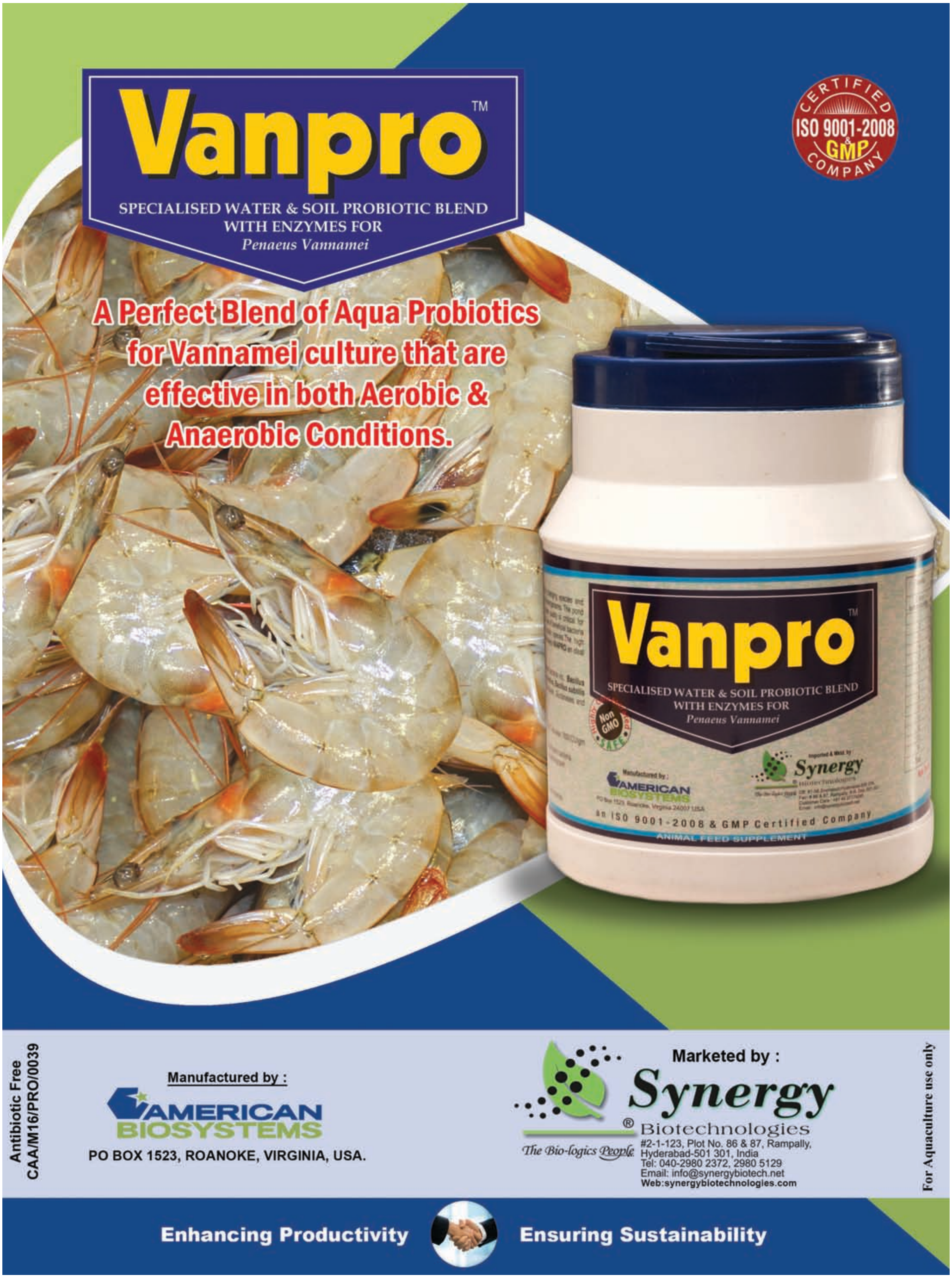
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Vitamin-B6 - 0.62 mg.
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Biotin - 15 mcg.
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L-Lysine - 175 mg.
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Toxin Binders - 200 mg.
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LDLP - 15mg.
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Finfish hatchery planning, concepts, designs & general guidelines

Highlight Points

Appropriate designing of hatchery for the good quality seed production of commonly cultured fin fishes is challenging task for the aquaculturist, biologist, engineers and bio-engineers in India. Concerted efforts in this direction would not only address the issues of stress component involved in the captive breeding but also reduce substantial mortality to boost up the overall production. The established facilities must warrant optimum growth, survival and health of brood stock, larvae and post larvae. A well-operated hatchery must ensure proper inlet and outlet water system and must be free of pathogens and pollutants. Hatchery production schedule, target and scale of operation should be prudently reflected taking into account the reproductive biology of specific species or multispecies. A well-managed hatchery design should also encompass distinct provision for the quarantine facility, brood stock facility, larviculture room, nursery rearing facility and live feed culture unit. The design of the hatchery should be in such a way that it ensure bio-security, efficiency and cost-effectiveness. In the current article, authors have attempted to provide in-depth understanding on the planning, concepts and design of fin fish hatchery along with the general guidelines crucial for the effectual and successful operation.

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The global average per capita consumption of fish is projected as 20.5 kg/annum in 2017 (The State of World Fisheries and Aquaculture, 2018) against the Indian per capita consumption levels lies between 5-10 kg/annum in 2013-15 (MoAFW, PIB, 2019). The current fish production in India is pegged at12.6 million metric tons (2017-2018) in which 8.9 million metric tons is contributed by inland fisheries (capture and culture together) and 3.7 million metric tons is exclusively from marine capture fisheries. The capture fisheries have reached close to the re-estimated fishery potential of the country and there is no further scope to enhance it and also, the availability and utilization of fresh water for aquaculture production is limited. Large scale fish production through mariculture or brackishwater aquaculture is the only alternative to cope up the ever increasing demand for fish proteins. In order to meet the demand-supply gap, marine/ brackishwater finfish production technologies utilizing the vast exclusive economic zone and the brackishwater production area of the country is to be developed.

The open sea cage culture of native marine/brackishwater finfishes such as Lates *calcarifer, Siganus canaliculatus, Trachinotus blochii, Chanos chanos, Rachycentron canadum, Epinephelus fuscoguttatus, Coryphaena hippurus and Scarus ghobban* were demonstrated by the National Institute of Ocean Technology (NIOT). Currently there is no commercial scale mariculture existing in the country apart from a few demonstration programs being carried out by the government research institutions. The Central Institute of Brackishwater Aquaculture (CIBA) pioneered the brackishwater finfish seed production and standardization of hatchery technology for the Asian seabass. The capacity created for the mass production of seabass seed by the Rajiv Gandhi Centre for Aquaculture (RGCA) set up by the Marine Product Export Development Authority (MPEDA). Central Marine Fisheries Research Institute (CMFRI) and the RGCA were successful in brood stock development, breeding and hatchery production of cobia seeds to some extent. The lack of commercial scale hatchery for the consistent periodic seed production of commercial marine finfishes is the major bottleneck in implementing the large-scale marine/brackishwater finfish farming venture in the country. The wild seed availability is often unpredictable & hence farming based on wild caught seeds alone may not be a sustainable approach. The other constraints for the expansion of mariculture are formulated species specific feed availability and culture systems to withstand the country's turbulent sea conditions. Other than the above developments a few more fishes such as pompanos, mullets, milkfish are in various stages of seed propagation technology standardization with the above institutions and there is no private marine/brackishwater finfish hatcheries exists to support the above venture. It is imperative to make

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available good quality seeds all year round to use them for open sea cage culture by exploring the potential of Indian Exclusive Economic Zone for mariculture through state of the art technologies is widely felt as the need of the hour. Therefore, it is essential to understand marine/brackishwater finfish hatchery concepts, designs and general rules, to develop and establish adequate technology for year round production of marine/brackishwaterfinfish seeds uniformly throughout the country.

Hatchery Designing: General considerations

The primary requirements of a hatchery are adequate high altitude seafront land, availability of utilities, access to resources and comforts, transport and good quality sea and fresh water supply. An efficient hatchery system should have of standard facilities for inlet water quality and treatment, waste water treatment, bio-security, Practice of Standard Operating Procedures (SOPs), consideration of the Hazard Analysis Critical Control Point (HACCP) approach, responsible use of chemicals and periodic monitoring of health status of brood stocks through laboratory testing.

Infrastructure

The design of the hatchery should be in such a way to ensure bio-security, efficiency and cost-effectiveness of the system. The tank location and dimensions should be properly positioned to avoid energy wastage and contamination. A degree of design flexibility at each section will have to ensure the future modifications. A well-designed hatchery will have of distinct facilities for quarantine, maturation, brood stock, spawning, hatching, larval and post larval rearing, live feed culture and seed packing units. Besides, there should be supporting infrastructure for water abstraction, filtration, storage, disinfection, aeration, conditioning and distribution, laboratories for disease diagnosis/bacteriology, maintenance area, store rooms, etc.

Maintenance

The established facilities must be maintained regularly so as to warrant optimum growth, survival and health of brood stock, larvae and post larvae to reduce the risks of disease occurrences. The machinery, pipelines (water, aeration and drainage), tanks and filters are properly maintained for good uninterrupted functioning of the hatchery.

Inlet water quality and treatment

The quality of inlet water must be ensured to get high productivity. The inlet water treatment involves mechanical separation of the suspended particles by clarification/filtration, chlorination, de-chlorination and storage under hygienic conditions. Chlorination (10-20 ppm) alone is not sufficient for disinfecting seawater since complete elimination of pathogenic organisms is difficult to accomplish, and also the undesirable residual effect of de-chlorination and production of toxic substances may harm the animals under care. Because of this, an array of filtration systems such as sand filtration, microfiltration, ozonation and UV irradiation is used to ensure the water quality. The important water quality parameters which need to be monitored on continuous basis are ammonia (NH_3< 0.1 ppm), nitrite (NO_2 < 0.1 ppm) and nitrate (NO_3< 10 ppm). Biological nitrification or probiotics usage are generally practiced to attain the preferred water quality. The water quality parameters of hatchery influent water are shown in Table 1.

Table 1. Range for water quality parameters prescribed for hatcheries

Parameter	Preferable range
Salinity	29-34 ppt
pH	7.8-8.2
Temperature	28-32 °C
Oxygen	> 4 ppm
Heavy metals/pesticides	Near Zero
Iron	< 1 ppm
Ammonia (NH_3)	< 0.1 ppm
Nitrite (NO_2)	< 0.1 ppm
Nitrate (NO_3)	< 10 ppm
Hydrogen sulphide (H_2S)	< 0.003 ppm

Waste water treatment

A well-operated hatchery must ensure that all the water discharged from the facility is free of pathogens and pollutants. A wastewater treatment plant should be installed in every hatchery to assure this. The discharge water from hatchery is usually first released into sedimentation tanks. From there it overflows into treatment tanks where the water will be chlorinated and de-chlorinated through proper aeration. Disinfection of discharged water should be treated with hypochlorite solution (>20 ppm active chlorine for >60 min or 50 ppm for >30 min) or any other effective disinfectant and then well aerated to dechlorinate the discharge water prior to discharge. The pollutants such as ammonia, phosphate and other harmful compounds are to be treated by proper means in the treatment plant. It is essential to ensure that drainage pipes, canals and treatment tanks are of adequate capacity to handle the maximum predicted flow of discharge water taking into account the residence time in the treatment tank. Thus issues with water-logging, backflow and inadequate treatment can be eliminated. Apart from discharge water, the hatchery will also produce solid wastes that also require proper disposal according to local regulations and guidelines. All potentially hazardous materials should be properly labeled and stored within the hatchery and disposed or incinerated periodically. The brood stock or larvae that are infected or died should also be disposed properly so as to avoid contamination of the immediate environment with pathogens. This procedure may involve suitable chemical disinfection (i.e. with chlorine at > 50 ppm for 1 h) within the tanks, removal and incineration of dead animal, before discharging the treated water into the drainage system.

Table 2. Effluent Standards - Aquaculture Certification Council

Variable (units/ frequency)	Value
pH (standard units)	6.0 - 9.5
Total suspended solids (mg/l)	< 50
Soluble phosphorus (mg/l)	< 0.3
Total ammonia-nitrogen (mg/l)	< 3
5-day biological oxygen demand (mg/l)	< 30
Dissolved Oxygen (mg/l)	> 5

Hatchery Production Schedule

Fish hatchery operations for induced breeding are expressed as a function of time. The duration of different operational phases from breeding to nursery rearing depends on the reproductive biology of specific species. Time is needed for accustoming the brooders to the ripening temperature (24°C). The time period depends on water temperature difference between the ponds and the brooder tanks, duration of hatching processes (T1 days) and the intervals between the periods (T days). In case of hatching consisting of several periods the total duration can be calculated with the following equation:

Tn = T1 + T (n - 1), days

Tn = total duration of hatching, in case of n hatching periods (day)

T1 = length of one hatching period (day)

T = time period, e.g. interval between two transportations of larvae (day)

n = number of hatching periods

Target and Scale of operation

Establishing a multispecies (cobia and seabass) finfish hatcherycapable of producing 20 million hatchlings/year will subsequently yield 2 million stockable size seeds/year and there by support a total fish production of 3,800 tons (1 million cobia seeds with 80 per cent survival and 4 kg harvest size yielding 3,200 tons and 1 million seabass seeds at 80 per cent survival and 0.75 kg harvest size yielding 600 tons in 8 months). While planning fish hatcheries one has to start from the basic data of reproduction biology, propagation and nursing of the species. This paper is mainly focusing on the estimation of water budget for large scale hatchery production of cobia and seabass seeds. This model facilityis envisaged to produce 2 million seeds/year (1 million seeds of each species), which will realize 0.35 million seed production/cycle through 6 production cycles.

Seabass (Lates calcarifer) is commonly known as Asian seabass and considered as the most important species for fisheries and aquaculture perspectives. Seabass usually migrates into brackishwater environment for spawning (Copland &Grey, 1987). Because of their euryhaline nature, they can be cultured in a range of salinities right from fresh to seawater (FAO, 2019), but must be placed in saltwater (28 to 35 ppt) prior to the breeding season to enable final gonadal maturation (Boeing, 2000). Asian seabass is a hermaphrodite, first matures as male and then undergo sexual inversion to become female later in life (Jesus-Ayson & Ayson, 2013). When they are six to eight years old (85 - 100 cm TL), seabass changes its sex to female and remain female for the rest of their lives (Guiguen et. al., 1994). They are highly fecund; a single female (120 cm of Total Length) may produce 30 - 40 million eggs. Hence, only small numbers of brood stock are necessary to provide adequate numbers of larvae for large hatchery production. Hatching occurs in around 17 hours after fertilization at 27°C. Seabass will grow from a hatchery juvenile stage of between 50 and 100 mm in length, to a table size of 400-600 g within 12 months and to 3 kg within 18-24 months.

Cobia (Rachycentron canadum) is a commercially important species commonly known as black kingfish or black salmon belonging to the family Rachycentridae. Cobia have the capacity for induced and natural tank spawning and high fecundity (Franks et. al., 2001; Arnold et. al., 2002), rapid growth rates (Chou et. al., 2001), disease resistance, acclimation to tank and net pen confinement, and adaptability to commercially available fish feeds (Schwarz et. al., 2004). Cobia is reported to be a solitary fish and grows to a maximum of 2 m TL (Ganga et. al., 2012). The rapid growth rate and the excellent flesh quality of cobia make it one of the top species for large scale mariculture (Chou et. al., 2001). Fecundity was found to be high and variable, with mean fecundity value estimated as 1.2 million eggs with a coefficient of variation (CV) of 16.7 (Ganga et. al., 2012). Fecundity estimates of 1.9 to 5.4 million eggs have been reported in cobia from Atlantic Ocean (Richards, 1967). Joan Holt et al. reported that cobia produce 1.2 to 2.3 million eggs per spawn. The hatch rates are generally 80-90 per cent and egg hatches within 24 to 30 hours (FAO). Cobia is carnivorous fish demanding high dietary protein levels and commercial feed for grow-out systems are reported to contain as high as 45 per cent protein (Chou et. al., 2001). Captive cobia reared in sea cages showed very high growth rates reaching six to eight kilograms in about 8 to 12 months (Liao et. al., 2004; Bennetti et. al., 2010; Gopakumar et. al., 2011).

Considering the minimum average fecundity rates (0.5 million eggs/spawn) and the standard culling factor of 25 per cent and survival rate of 10 per cent, the hatchlings/cycle was estimated to 3.5 million eggs/cycle. The brood stock requirement for 3.5 million eggs/cycle is arrived at 21 Nos/cycle with a female to male ratio of 1:2. The total brood stock requirement is 21 × 6 cycles × 200% production efficiency is 252 Nos.

Table 3. Estimated biological output and brood stock requirement

Particulars	No. of animals	Total animals
Fingerlings/cycle	350000	
25% culling	437500	
Initial juveniles (60% mortality)	730000	
Initial post larvae (70% mortality)	1050000	
Initial larvae (50% mortality)	2100000	
Fertilized eggs (60% mortality)	3500000	
Female fecundity (eggs/fish/spawn)	500000	
No. of female fish	7	84 (200% efficiency)
No. of male fish	14	168 (200% efficiency)
Total brood stock requirement/cycle	21	252 (200% efficiency)
Total brood stock requirement (6 cycles)		

Quarantine facility

The quarantine unit must be isolated from the rest of the hatchery facilities with restricted entry in a covered building with no direct access to outsiders. It should have a series of 2, 5 and 10 ton tanks for quarantine process and 25 ton FRP tanks for acclimatization with central drainage and feet disinfection provision in the entrance. The total water holding capacity of the facility capable of holding 20 - 25 brooders at a time, with a stocking density of 1 kg biomass/ton of water, and for seabass brooder weighing 8 kg in average, the water requirement for stocking 20 brooders was arrived as 160 tons requiring a total of 160 m3 tank capacity. Water requirement for 25 brooders with 6 water exchanges/day: 200 tons × 6 exchanges = 1,200 tons/day i.e. 50 tons/h

Brood stock facility

The total brood stock requirement was estimated to have 1 million seeds/annum with 6 production cycles/year and 200 per cent efficiency is 252 (Table 3). Consider a stocking capacity of 300 brooders in the hatchery in two different sections such as brood stock tanks and brood stock earthen ponds.

Brood stock tanks

The brood stock tank based facility will have provisions for temperature and photo period regulation and water renewal at the rate of 4 complete exchanges /day. The brood stock tank facility can be with 8 concrete tanks under roof with a capacity of 8×100 tons to maintain 1/3 of the total brood stock. At the rate of 1 kg biomass/ton stocking density, it can accommodate 800 kg of brooders at an average size of 8 kg will accomodate100 brooders. The water requirement was calculated as 800 tons with a tank capacity of 800 m3. Water requirement for 100 brooders with 4 water exchanges/day: 800 tons × 4 exchanges = 3,200 tons/day i.e. 133.33 tons/h.

Earthen ponds for Brood stock maintenance

The 2/3 of the brood stock will be stocked in two earthen ponds at the rate of 1 kg biomass/ton stocking density, it can accommodate 1,600 kg of brooders at an average size of 8 kg will have 200 brooders. The water requirement was calculated as 1,600 tons with requirement of 1,600 m3 pond volume. Water requirement for 200 brooders in the pond with 20 per cent water renewal/day: 2,400 tons × 20% renewal = 480 tons/day i.e. 20 tons/h.

Breeding and Larviculture complex

The breeding cum larviculture complex will house two fish breeding units, incubation facilities, larval rearing facilities and a seed packing unit. The animals are stocked in breeding and larviculture complex from 0-27 dph.

Breeding room

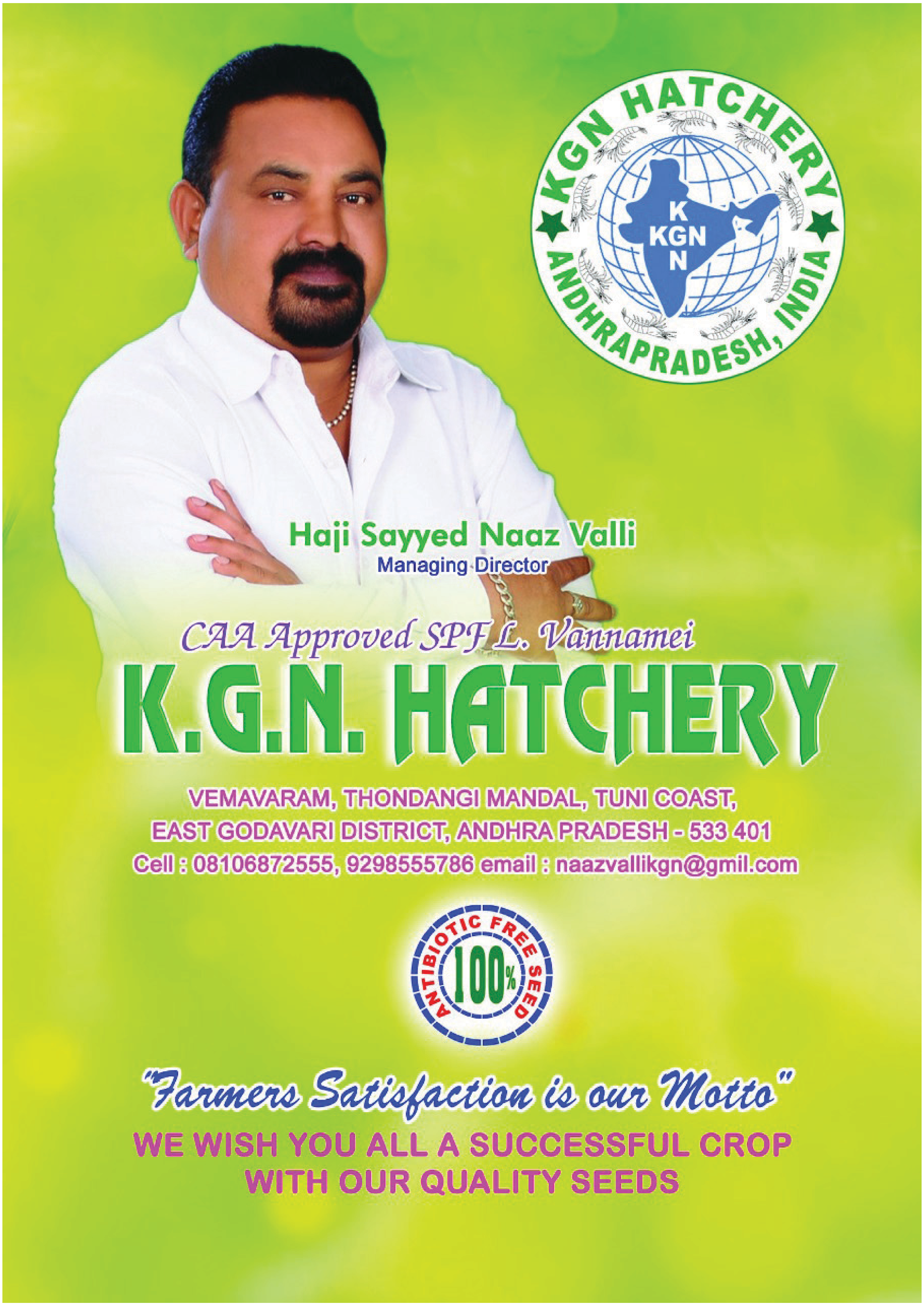
The brood stock requirement/cycle was estimated to be 21 (Table 3). Let 20 animals are stocked in breeding tank for spawning at the stocking density of 1 kg biomass/ton of water. For 20 brooders with an average size of 8 kg, the total biomass in the tank is 160 kg. The water requirement was calculated as 160 tons with a tank capacity of 160 m3. Water requirement for 20 brooders with zero water exchanges/day: 160 tons/day i.e. 6.67 tons/h.

Incubation room

The incubation period lasts for maximum of 3 days. The incubation facility is designed to incubate 4 million eggs at a time. According to Table 3, the no. of hatchlings/cycle to meet the requirement of 0.35 million fingerlings /cycle with 10 per cent survival rate is 3.5 million. Considering a margin for unfertilized eggs the hatchery facility is designed to incubate 4 million eggs. The eggs are stocked in 250 L tanks with the stocking density of 500 eggs /L which requires 32 tanks for incubating 4 million eggs. The total water requirement was calculated as 8 tons with a total tank capacity requirement of 8 m3.Water requirement for 4 million eggs with zero water exchanges/day: 8 tons/day i.e. 0.33 tons/h.

Larviculture room

The initial and post larvae from 3 to 27 dph is going to be stocked in larviculture room. Considering 80 per cent survival on 2nddph the number of hatchlings will be 3.2 million and on 3rddph the number of hatchlings will be 2.56 million. From 3rddph to 27thdph the larvae is stocked at 7-20 Nos/L. Considering 1-3 per cent mortality in every day, 7-20 Nos/L stocking density and 0-240 per cent water exchange/day, the maximum water requirement in the section accounts to be 625 tons on 27thdph. The maximum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tank capacity requirement was estimated to be 300 tons on 20th dph. The maximum water requirement for larviculture section with 240 per cent water exchanges/day: = 625 tons/day i.e. 26 tons/h. The breeding and larviculture complex also should have the facility for seed packing unit and glassware cleaning facility.

Nursery rearing facility

In the nursery rearing facility of hatchery the juveniles are reared from 28 dph till 90 dph. On 28 dph the no. of larvae estimated to be 1.7 million. Considering a stocking density of 1-5 larvae/L and 260-500 per cent water exchanges, the highest water requirement is 3,000 tons in the section which will be on 63 dph. The tank capacity required on this day is for 600 tons. The maximum water requirement for this section with 500% water exchanges/day is: 3000 tons/day i.e. 125 tons/h

Live feed culture unit

The entire live feed culture facility will have separate sections for micro algal innoculum preparation, algal mass culture unit, rotifer culture unit, artemia culture facility, biochemistry lab, micro biology lab, wet labs and feed storage room.

Micro algal culture unit

Nowadays 'green water technique' is practiced for rearing finfish larvae in hatcheries. This is beneficial as the green water larviculture improves the fish larval growth, survival and feed ingestion compared to normal conditions of rearing. It will also help in providing nutrients directly to larvae and diversifying micro flora of larval gut. The larviculture tanks shallprovide with green water at a density of 40,000-50,000 cells/mL from 0-20 dph.

Considering the cell density in the micro algal culture which is about 10^6 cells/mL, and based on the water requirement for larviculture at each day of post hatch, the requirement of green water at a cell density of 40,000-50,000 cells/mL, with triplicates and 120 per cent exchanges is accounts to be maximum at 20th dph was 12,000 L × 3 × 120% = 45,000 L. The maximum water requirement for this section is 45 tons/day i.e. 1.9 tons/hr

Rotifer culture unit

Newly hatched fish larvae normally measures 1.5 mm size and its mouth opens at 3-5 days post hatch. Enriched rotifer is fed to larvae from 3rd to 14th dph atthe rate of 5-15 Nos/mL, two times a day. On the 3rd dph the larvae is fed with 5/mL and gradually can be increased to 15/mL. Rotifers are added to the larviculture tanks, two times a day to maintain the concentrations of 5-15 rotifers/mL. The enrichment is done using essential fatty acids and other nutrients for 12 h prior to feed the larvae. Considering the rotifer culture density of 1,000 Nos/mL, and based on the water requirement for larviculture at each day of post hatch, to maintain a concentration of 5-15 rotifers/mL in the larviculture tanks by feeding with enriched rotifers two times a day and with 150 per cent water exchanges, the water requirement for rotifer culture accounts to 10,500 L at the maximum (3,500 × 150% × 2). The maximum water requirement for this section with 150 per cent water exchanges/day and two times feeding: 10.5 tons/day i.e. 0.44 tons/hr

Artemia culture unit

From 6 to 11 dph, enriched artemia nauplii at instar I stage (24 h post hatch) to be fed to larvae at 0.4/mL. Co-feeding with both enriched rotifers and enriched artemia is continued. Artemia nauplii (12 h post hatch) were enriched for 12 h before feeding the larvae. Enriched artemia is fed from 8 to 28 dph at a rate of 2 Nos/mL. The artemia nauplii density at instar I stage in culture is 200 Nos/mL (24 h post hatch) and that of artemia is 100 Nos/mL considering 50 per cent survival at the later stages of artemia culture. Based on the water requirement for larviculture at each day of post hatch, to maintain the recommended concentration of artemia nauplii and artemia in the larviculture tanks as mentioned, the water requirement for artemia culture accounts to 20,000 L at the maximum (500 L × 120% = 600 L for artemia nauplii and 7,000 L × 260% = 18,200 L). The maximum water requirement for this section is: 20 tons/day i.e. 0.83 tons/hr

Other facilities

The other facilities in the hatchery include 1) pump house for abstraction of seawater, 2) seawater stabilization tanks, 3) electrical, aeration and water distribution plant, 4) seawater and fresh water storage tanks, 5) effluent treatment plant, 6) administrative block and 7) accommodation facility.

Water Budget

Based on the water requirements in each section of hatchery as explained above, the daily water inflow requirements are estimated as in Table 4. The water inflow rates for the continuous flow through system and re-circulation aquaculture system (RAS) are differentiated. When RAS is installed in the brood stock tank and nursery rearing section alone is resulting in saving of 6,400 tons of water/day.

Table 4. Water budget plan and water inflow rate of a hatchery capable of producing 2 million stockable size seeds

Hatchery sections	Flow through system			RAS
	Water ex-change/day	Water re-quire-ment (tons)	24 h	24 h
Quarantine	6	200	1200	1200
Brood stock				
100 brooders in tank	4	800	3200	0
Earthen ponds	20 % renewal	480	480	480
Breeding room	-	160	160	160
Incubation	-	8	8	8

Initial Larvae (0-3 dph)	-	0	0	0
Post Larvae (4-27 dph)	2.4	260	625	625
Initial juveniles (28-37 dph)	-	0	0	0
Juveniles (After 38 dph)	5	600	3000	0
Fingerlings (Till 90 dph)	-	0	0	0
Microalgae culture	-	45	45	45
Rotifer culture	-	10.5	10.5	4
Artemia nauplii culture	-			
Artemia culture	-	20	20	20
Total water requirement	-		8748.5	2548.5
(tons/day)		-	~9000	~2600
L/h		-	364521	106188
L/min		-	6075	1770

The seawater requirement per day is estimated to be 9,000 tons approximately in a continuous flow through system. About half of the seawater required should be filtered for breeding, incubation, larviculture, nursery rearing and live feed units. It accounts to be approximately 4,000 tons/day. Two different sand filters to be installed based on the requirement. The breeding, incubation and initial larvae need 2 micron filters, having 200 tons handling capacity. The rest of 3,800 tons can be filtered with 50 micron filters for post larvae, nursery rearing and live feed units. If RAS is installed, the total seawater requirement per day comes down to 2,600 tons, in which the filtered seawater requirement is only 900 tons/day. The detailed information and flow capacity of each 2 micron and 50 micron sand filters are provided in Table 5 and 6 for flow through and RAS system, respectively.

Table 5. Water inflow rate using continuous flow through system

Sea water requirement						
For 1 day	9000	tons	6250	l/min	104	l/s
For 2 days storage	18000	tons				
Filtered sea water requirement						
For 1 day	4000	tons	2780	l/min	46	l/s
For 2 days storage	8000	tons				
Sand filter requirement						
2 microns	200	tons	140	l/min	2	l/s
50 microns	3800	tons	2640	l/min	44	l/s
Fresh water requirement						
For 1 day	450	tons 5% of total seawater requirement				
For 2 days storage	900	tons	625	l/min	10	l/s

Table 6. Water inflow rate for hatchery using RAS

Sea water requirement						
For 1 day	2600	tons	1800	l/min	30	l/s
For 2 days storage	5200	tons				
Filtered sea water requirement						
For 1 day	900	tons	625	l/min	10	l/s
For 2 days storage	1800	tons				
Sand filter requirement						
2 microns	200	tons	140	l/min	2	l/s
50 microns	700	tons	486	l/min	8	l/s
Fresh water requirement						
For 1 day	450	tons 5% of total seawater requirement				
For 2 days storage	900	tons	625	l/min	10	l/s

RAS uses only a marginal quantity of water for making up the volume of water used. It also eliminates the cost of treating the discharge water from hatchery, thus reducing the cost of effluent treatment plant which is essential nowadays at hatchery due to environmental concerns. RAS consists of a varied set of components that may cause additional cost of installation. However, a cost economic analysis should be done before the installation as the continuous flow through system cause cost of water, pump capacity, power consumption, effluent treatment, etc.

Finally, it is important to make a particular hatchery design to eliminate the issues encountered in hatchery production and health of the species. It's the challenge for the biologists, engineers, and bio-engineers to come up with best out of their efforts to cop up with the stress component involved in captive breeding and culture. The lessons from experienced personnels, true fish culturists must be valued whenever a new hatchery is planned.

References can be provided on request

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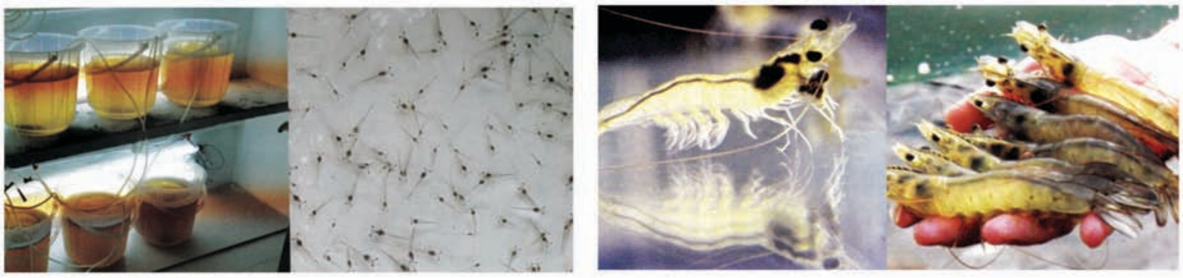

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Chitosan – derivative from waste to multi-application industry

Highlight Points

▶Deproteinisation and demineralization of shell wastes containing chitin yields chitosan. ▶Presence of reactive functional groups - amino group at C2 position and hydroxyl groups at the C6 and C3 positions makes chitosan, a versatile component to be used in multi-industries worldwide. ▶Modified chitosan enhances the solubility as well as antimicrobial efficiencies of chitosan. ▶Can be an ideal natural alternative to chemically synthesized antimicrobial agents used in food industries. ▶Can reduce the usage of antibiotics, thereby decreasing rise of antimicrobial resistant microorganism.

Kasturi Chattopadhyay, Sanchita Naskar and K. A. Martin Xavier

1. Introduction

Marine food processing industries produces large quantities of waste products which causes severe environmental and human health problems. However, proper processing can turned these wastes into high value, useful products. Marine wastes mainly comprise of crustacean exoskeletons of species like shrimp, crab, lobster, krill, cell wall of fungi and insects. These contain a major fraction of a polysaccharide - chitin, the second most abundant bio-polymer after cellulose. Deproteinisation and demineralization of these chitin containing shell wastes causes deacetylation of the chitin resulting into a versatile biopolymer - Chitosan.

Chitin was first discovered in by Prof Henri Braconnot of France in 1811 from mushrooms which he named as "Fungine". Antoine Odier found chitin while studying beetle cuticles and named it "Chitin" after the Greek word "chiton" (means envelope/tunic) in 1823. Chitosan was discovered by Prof C. Rouget in 1859. In 1950's structure of chitin- chitosan was identified by X-ray diffraction and infrared spectra.

Chitosan is known to be the only cationic polymer naturally available. It is also non-toxic, biodegradable and biocompatible in nature. These unique properties make it appropriate for a wide range of applications in foods, cosmetics, and pharmaceuticals. The cationic biopolymer can interact with anionic molecules such as glycosaminoglycans (GAG) and proteoglycans. Many cytokines/growth factors are linked to GAG. A complex of chitosan-GAG may retain and concentrate those substances. Chitosan, due to the D-glucosamine, is insoluble at neutral and alkaline pH in aqueous solution but it is soluble in various weak acids ($pH < 6.5$) such as acetic acid, formic acid, succinic acid, lactic acid, and maleic acid alongside strong hydrochloric acid.

Presence of reactive functional groups - amino group at C2 position and hydroxyl groups at the C6 and C3 positions makes chitosan, a potential antimicrobial agent against a wide array of microorganisms– (bacteria, yeasts and fungi). The antimicrobial property of chitosan comprises of mainly 3 different mode of actions viz., (1) the polycationic nature (positive charge) of chitosan interferes with the bacterial metabolism by electrostatic stacking (negative charge) at the cell surface; (2) low molecular weight chitosan enter the cell's nucleus blocking the transcription of RNA from DNA due to adsorption to DNA molecules; (3) chelation property of chitosan to essential minerals and divalent cations decreases the stability of the bacterial outer membrane.

2. Derivatives of chitosan

Chitosan is able to be synthesized into a variety of derivatives. Amino groups and primary alcohol function gives rise to N- modified chitosan, O- modified chitosan or N,O- modified chitosan. Quaternized chitosan improves the solubility and antimicrobial activity. Phosphorylated chitosan can increase solubility whereas, N- alkyl or N-benzyl chitosan enhances the antimicrobial activity of chitosan. Recently, chitosan is engineered into certain micro and nano particles by cross-linking techniques. The commonly used cross-linkers are- Sodium Tri Polyphosphate (STPP) and Sodium Sulfate (SS). These modified chitosan enhances the solubility as well as antimicrobial efficiencies of chitosan.

Table 1. Different forms of chitosan (Arno et. al, 2017)

Native chitosan based on molecular weight	
Oligo-chitosan	⩽16 kDa
Low molecular weight (LMW) Chitosan	16 kDa to 190 kDa
Medium molecular weight (MMW) Chitosan	190 kDa to 300 kDa
High molecular weight (HMW) Chitosan	> 300 kDa

Modified chitosan	
Phosphorylated Chitosan	Carboxy methyl chitosan
N-alkyl or N-benzyl Chitosan	Trimethyl chitosan
Quaternized Chitosan	Chitosan -12

3.Application of chitosan

The beneficial physico-chemical properties of chitosan has received considerable attention in recent years and its versatile properties are being used in a vast array of industries, ranging from pharmaceutical and cosmetic industry to water treatment and food processing industry. Various applications of chitosan in different industries are summarized in the following table 2.

Table 2 Industrial application of chitosan

Industry	• Properties and their application
Cosmetics	• Polyanions chitosan being the only natural cationic gum that becomes viscous by acid neutralization facilitates its interaction with skin integuments and hair. • Chitosan being compatible with other bioactive components incorporated in cosmetic products composition.
Water engineering	• Polycationic nature of chitosan makes its application as heavy metal trappers (chelating agent) and as flocculating agent, as well as in wastewater and n. • Deacidifying ability of chitin – clarification of beverages. • Membranes made from regenerated chitin and chitosan are used in purification processes like osmosis, reverse osmosis, microfiltration, desalination, dialysis and haemodialysis.
Paper industry	• Hydroxymethyl chitin and other water soluble derivatives are useful components in paper making industries. • Biodegradable packaging material for food wrap and other products.
Textile industry	• Chitin used in Printing and finishing preparations; chitosan removes dyes from dye processing effluents. • Chitin derivates produced are used to impart antistatic and soil repellent characteristics to the textiles. • Both chitin and chitosan both have remarkable contributions to medical related textile sutures, threads and fibres.
Food processing	• Good emulsification ability, superior thickening and gelling agent of microcrystalline chitin (MCC) pave its application for stabilizing food and as a dietary fibre in baked foods.
Agriculture	• Growth enhancing effects in chitin treated seeds and significant reductions in pathogenic infestations in potting mixtures through chitinous additions.
Photography	• Used as a fixing agent for acid dyes in gelatine and as an aid to improve diffusion in colour photography.
Chromatographic separations	• Presence of free amino groups and primary secondary hydroxyl groups in chitosan makes its use in separation of nucleic acids (Thin layer chromatography) and in extraction of phenol and chlorophenols (HPLC)
Tissue engineering	• Biodegradability and biocompatibility of chitosan makes it a candidate species for bone tissue engineering particularly in repair of articular cartilage via biological interactions. • Chitosan and its derivatives extensively used for bone tissue engineering and central nervous system.
Wound healing	• Regenerated chitin fibres, non-woven mats, sponges and films exhibit enhanced wound healing properties when coated upon normal biomedical materials.
Burn treatment	• Forms tough, water absorbent and biocompatible films that allow excellent oxygen permeability properties that prevent oxygen deprivation of injured tissues.
Artificial skin	• Structural similarity with glycosamino glycans can be considered for developing substratum for skin replacement in plastic surgeries and in developing artificial skin.
Opthalmology	• Wound healing and antimicrobial properties of chitosan makes it a candidate material in development of ocular bandage lens and contact lenses.
Drug delivery	• Inexpensive and do not cause any biological hazard, so used in preparation of dosage forms of commercial drugs.

4. CONCLUSION

Research on chitosan has increased in the last few years due to its promising and multiple applications in several industries all around the world. Native antimicrobial properties in chitosan can be enhanced by physical and chemical modifications and its derivatives are gaining a broad potentiality in various fields. Inherent anti-microbial properties and film-forming ability of chitosan makes it an ideal natural polymer that can be an alternative to chemically synthesized antimicrobial agents used in food industries. The in-vivo studies suggested that chitosan, CM and CN may be applied to treat pathogens without causing severe side effects on food quality thus ensuring food safety and enhancing animal and human health. They can reduce the usage of antibiotics and thereby decreasing rise of antimicrobial resistant microorganism. Hence chitosan can be a boon to multi-industries worldwide in improving several properties of industrial products due to its astonishing inherent properties.

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Silvoaquaculture - A forward for sustainable farming in mangrove areas

Highlight Points

▶ Mangroves have a significant value on both ecologically and economically by benefiting the surrounding environment and human populations locally. ▶ Silvoaquaculture is the way of culturing aquatic organisms with non-destructive mangrove friendly aquaculture compatible with the principles of sustainable ecological development. ▶ In India, there is a broad scope for aquasilviculture for practice, one such solution for conserving mangrove forest and offering livelihoods for poor coastal communities.

S. Sangavi and P. Abinaya

Introduction:

Modern brackish water aquaculture operations including culturing of finfish and shellfish species such as milkfish, mullet, mud crab and/ shrimps in traditional pond farming had resulted in environmental degradation. When the culturing of different species gets enlarged in the natural ecosystem, it results in adverse environmental impacts such as habitat destruction, e.g., clearance of mangrove forest (FAO/NACA, 1995). Shrimp aquaculture in/nearby the mangrove areas have been a significant cause for the conversion of mangroves into flat, coastal lands to shrimp ponds. In the year 2015, it was estimated that approximately 1.5 million hectares of global mangrove forests had been converted to shrimp farms (Tenorio et al., 2015). Therefore, one such solution for conserving mangrove forest and offering livelihoods for poor communities is the development of silvoaquaculture.

Importance of mangroves:

Mangroves are one of the primary and unique forest ecosystems that are widely distributed along the intertidal habitat of tropical and subtropical regions. Mangroves have a significant value on both ecologically and economically by benefiting the surrounding environment and human populations locally. They play a vital role by making an ideal nursery ground for fish and shrimp fry, thereby reducing the predation levels. The ecological significance of the mangrove forests includes: efficient at trapping and stabilizing sediment, retarding wave action and water flow, water quality control, erosion control, flood mitigation, and storm protection. It offers an income source for many coastal communities through the biological production of flora and fauna. Apart from these, mangroves also act as carbon sinks (storage of sediments layers in large amounts of organic carbon).

What is Silvoaquaculture?

Silvoaquaculture is a combination of brackishwater aquaculture integrated with mangrove tree culture, and so it is a form of low-input sustainable aquaculture.

According to Primavera et al., 2000, it is "the system of unique aquaculture method that allows to culture both aquatic animals and mangroves trees in the same pond". It is also known as 'tambak tampangsari' in Indonesia, meaning 'brackish pond with multiple crops'. It is the way of culturing aquatic organisms with non-destructive mangrove friendly aquaculture compatible with the principles of sustainable ecological development.

Different models in different countries:

There are many different models followed globally in the concept of silvoaquaculture. The two basic models include: first model consists of 60-80% of mangrove within the pond culture area of about 20-40% and the second model is with same ratio mangrove to pond culture area, where the mangroves are present outside the pond area perpendicular to the coastline. The other models are as follows:

Sl. No.	Name of the models	Name of the countries
1.	Empang parit model	Indonesia
2.	Gei wei model	Hong Kong
3.	Integrated mangrove/ crab pen culture	Malaysia
4.	Shrimp - mangrove model	Vietnam
5.	Integrated silvofisheries with agriculture	Philippines

***Empang parit* model-** It is a traditional silvofisheries practice of integrating aquaculture in the mangrove area. This system involves the culturing of milkfish in the pond area along with reforestation or maintenance of mangroves at a most exceptional level. The stocking density of mangroves in the excavated central platform area ranges from 0.17-2.5 trees per m2 for shrimp and crab culture and 0.2 trees per m2 for milkfishes. The major advantages of this model are sustainable low cost production system and increased efficiency of an integrated system.

***Empang parit* model in Indonesia**

***Gei wei* model-** This model has been widely practiced in the Hong Kong waters. The pond size was found to be length of 1 km by 100 m wide (10 ha), and the mangrove to water ratio was 2:8 to 2:1. This model also reduces the risk of stagnant areas, and the primary management tool used in the culture ponds is the sluice gate. In the modified Gei wei model, the pond fertilization and feeding of fishes (shrimps and other finfishes) were done. The production yield from this system during partial harvesting is 1900kg/10ha/yr.

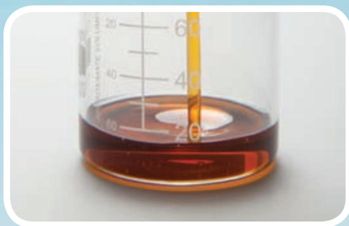
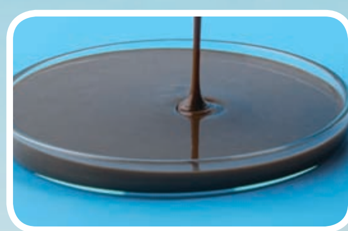
Integrated mangrove/crab pen culture- This Malaysian silvoaquaculture model has the pen structure size of 18×9 m attached with wooden stakes and PVC standpipes in the inlet/outlet. The crab species such as Scylla tranquebarica and S. olivaceous are stocked at a rate of 1000-1500 crabs per pen and fed with trash fish. After the grow-out period of 4-7 months, the crab size of 300g each are harvested, and the production yield is estimated to be 265 kg/pen/cycle.

Integrated mangrove/crab pen culture in Malaysia

Shrimp - mangrove model- In this model, there is a vast farm area of about 3-10 ha with the maintained ratio of mangrove to non-mangrove area as 70:30. The basic type of pond of 5-10 ha are stocked at a rate of 0.5 shrimp/m2 and 1000-2000 trees/ha in 'Mixed Shrimp-Forest', respectively. After 4-5 months of culture period, the production from this model obtained is 200-250 kg/ha/cycle.

Integrated silvofisheries with agriculture- This is a integrated silvofishery model together with agricultural plantations such as banana, cacao, jackfruit, beans and corn are followed in Philippines. The ponds used for the farming purpose as similar to Empang parit model with the mangrove to open water area ratio of 8:2 or 7:3, respectively. Usually, 20% of the pond area are used for stocking of milkfish and tilapia and besides, nippa plantation at the elevated central portion of the pond.

Aquasilviculture in Bangladesh: The Sundarbans in Bangladesh are getting reduced due to the illegal farming activities such as shrimp and/brackishwater finfish culture. So, development measures such as Community Mangrove Aquasilviculture (CMAS) has been taken to increase the density of mangrove forest, which is deteriorating at an alarming rate. CMAS farm is a swampy land area where the mangroves plantations are done in the platform of 1-1.5 feet deep and the cultured species (fish, shrimps, and crab) are stocked in the canals of 2-2.5 feet deep dykes that run along the sides of the farm. This system creates livelihood and employment opportunities for the coastal communities.

Aquasilviculture in Tamilnadu: The traditional way of canal cultivation or aquasilviculture in the region of TamilNadu is "vaaikal meenpedippu," and it is commonly practiced in the Muthupet mangrove wetland area. These canals are having the length of 1.5-2 km and the width of 1.5-2 m. The mangroves are entirely submerged with the water during the North-West monsoon, and so the fishes and shrimps are trapped inside the canals. It is a cost-benefit and eco-friendly way of farming; besides, it has a positive impact on the mangrove vegetation habitats.

Merits and demerits of Silvoaquaculture:

The silvoaquaculture has several advantages and disadvantages as compared to the modern brackishwater aquaculture that must be considered in planning, developing, and utilizing the mangrove forest sustainably for the culturing activities. The major advantages include: a) low inputs sustainable aquaculture, b) litter production, c) conservation and rehabilitation of mangroves, d) utilization of resources, e) avoidance of chemical use, f) provide livelihood for coastal communities, g) employment opportunities, and h) low capitalization and operational cost. The disadvantages are: a) reduced water circulation, b) low oxygen level, c) greater construction cost per unit of culture, d) low primary productivity, e) potential toxicity from mangroves, and f) limitation on species culture.

Challenges in implementing aquasilviculture:

There are few challenges to be faced during the time of culture are poor culturing techniques and water management; lack of capital and mono-cultures make the farms prone to calamities; subsequent loss of profit, while at the same time having a negative impact on the surrounding ecosystems; to supplement their income, farmers therefore often collect natural resources from adjacent mangroves, causing further degradation and climate change and extreme weather events as well as coastal erosion.

Conclusion:

In India, there is a broad scope for aquasilviculture for practice, because there is a plenty of mangrove regions situated in the states of West Bengal, Gujarat, Andaman and Nicobar Islands, Tamil Nadu, and Karnataka covering 2016, 1107, 617, 47, and 3 km2, respectively. Hence, culturing of fish species in an environmentally sustainable way along with mangroves can help in conservation of the natural habitat and promote the livelihood opportunities for poor communities.

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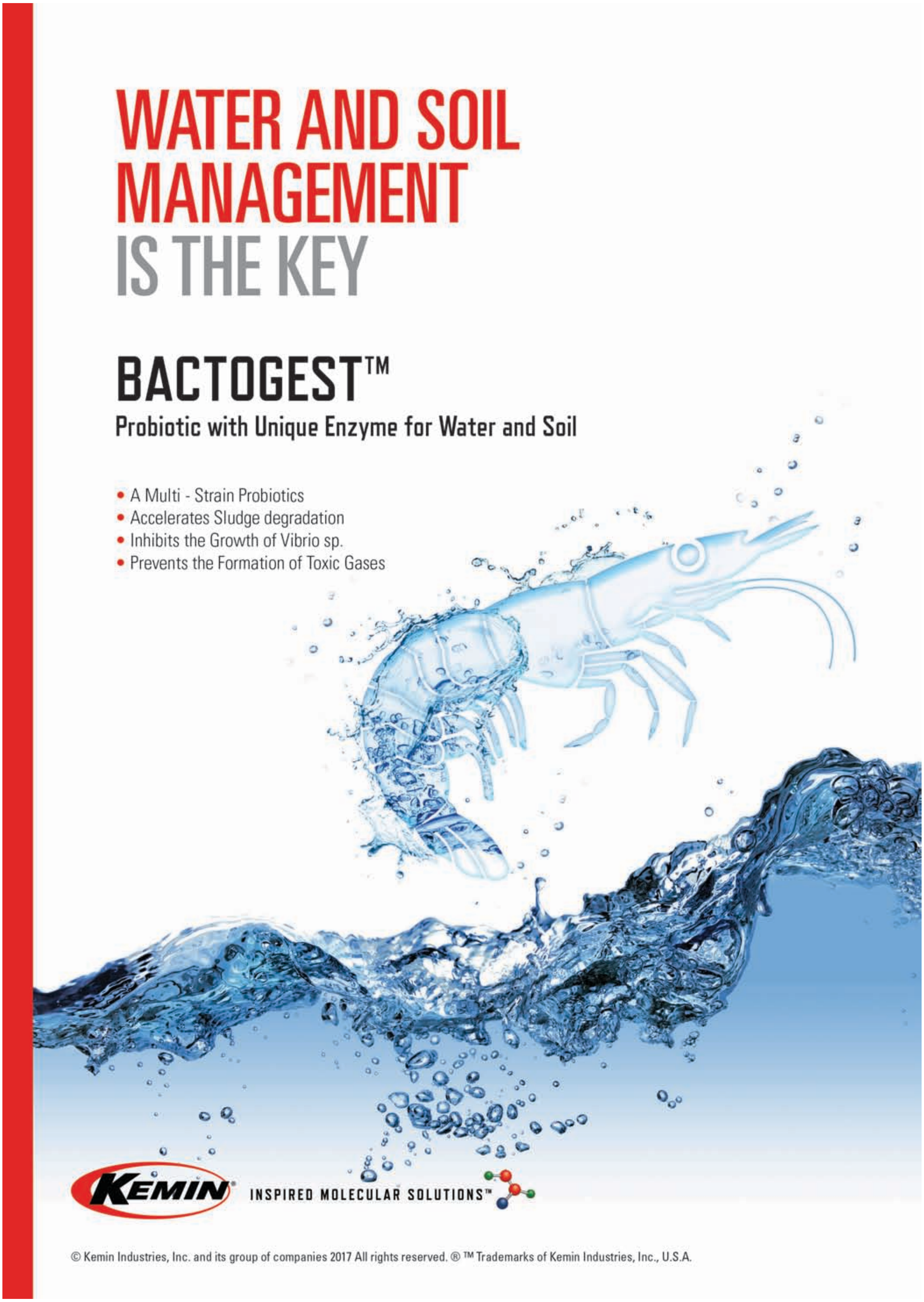
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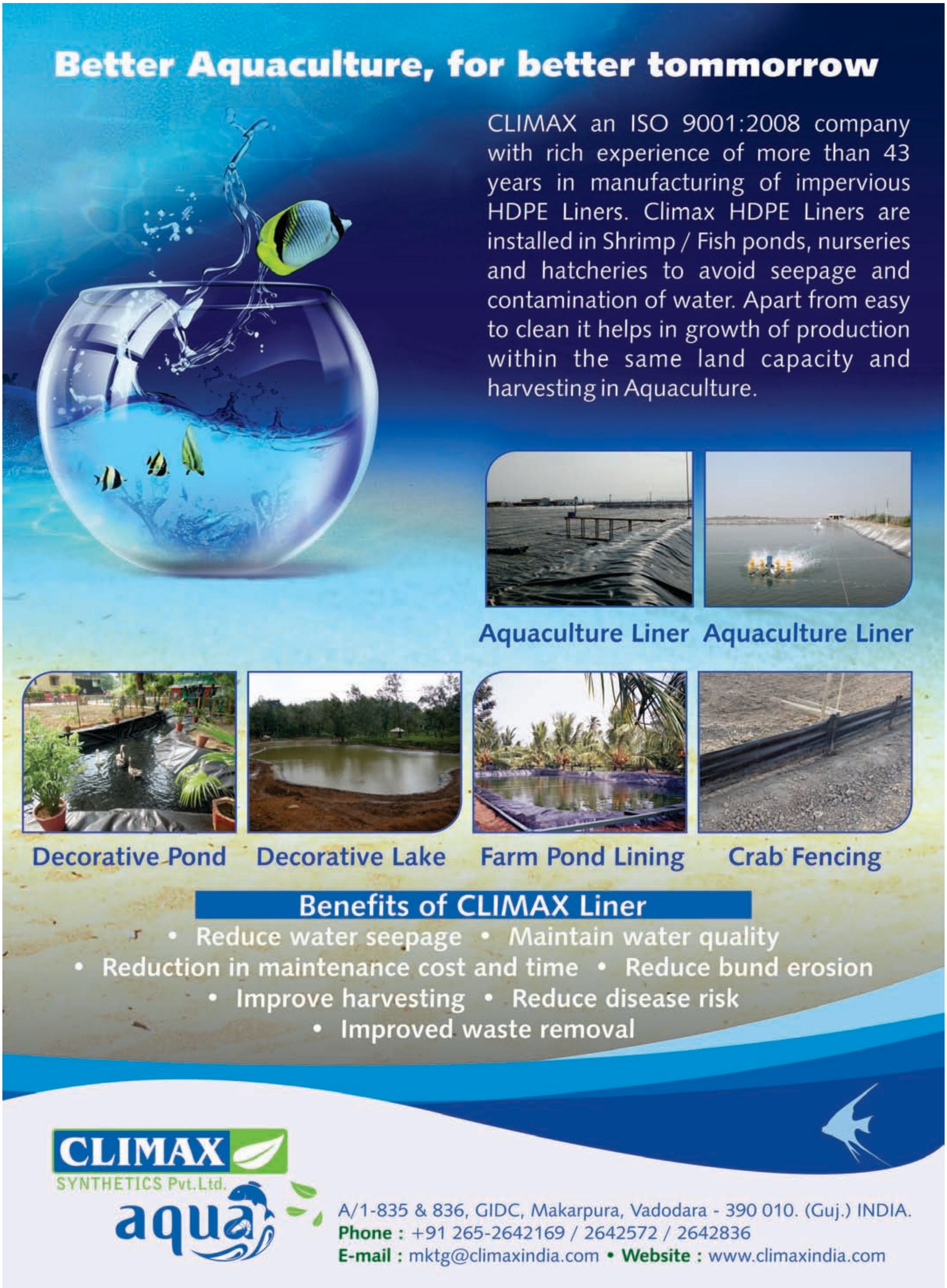
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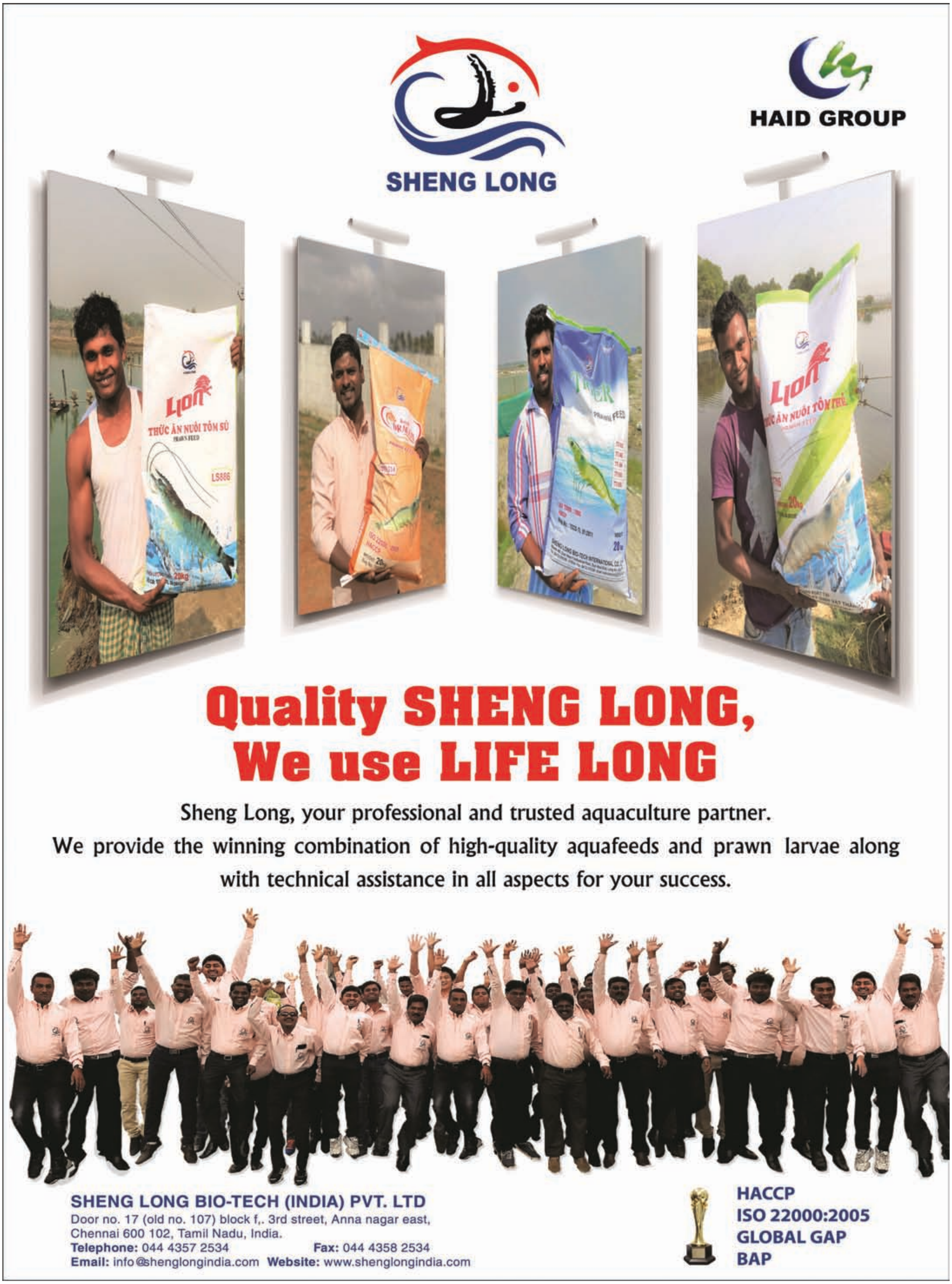
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