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Inside...

Growel Feeds launches new generation extruded functional shrimp feed 'Nutriva F15'

Indian Seafood Exports set to slow Growth Amid Weaker Shrimp Prices

Enrolment Cards for Aqua Farms, Hatcheries

Aqua Exporters Unaware of Cargo Facility at Gannavaram Airport

Effects of salinity and pH stress on fish

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CONTENTS

ADVERTISERS' INDEX

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From the Editor...

M.A. Nazeer

Dear Readers,

The September 2018 issue of ***Aqua International*** is in your hands.

In the News section, you may find news about - Growel Feeds launches a new generation extruded functional shrimp feed 'Nutriva F15'. It is an immunity enhancing extruded shrimp feed developed in collaboration with Menon Renewable Products, Inc., USA. Nutriva F15 contains 'MrFeed', a patented immunity enhancing nature-derived ingredient developed by Menon Renewable Products, Inc., USA. The company stated that it elicits and enhances the immunity of the shrimp to fight against invading pathogens.

The Marine Products Export Development (MPEDA) has successfully conducted open pond culture of Asian seabass for the time. It was done at the demonstration farm of Rajiv Gandhi Centre of Aquaculture (RGCA), the research & development arm of the MPEDA, at Karaikal in Puducherry.

Farmed Seafood to grow by 40 percent Worldwide: UN – India will promote open sea cage fish farming on a priority basis to boost fish production from marine sector according to federal Agriculture Minister Radha Mohan Singh. Currently fish production in India is estimated at 11.4 million tonnes, out of which 68% is registered from inland fisheries sector and the remaining 32% from marine sector. India's Central Marine Fisheries Research Institute (CMFRI) has recommended the promotion of open sea cage fish farming across the country after the success of pilot projects at 14 locations. India recently introduced a "National Policy on Marine Fisheries - 2017", which will guide the development of marine fisheries sector for the next 10 years in the sub-continent.

Indian seafood exports may show lower growth this fiscal year as shrimp prices continue to remain low and cautious farmers go slow on production. While prices of shrimp, which dominates the Indian seafood export basket, are down by 20% from last year, fear of white spot disease and lower prices forced many farmers to go for partial harvest, resulting in small-sized shrimp, which fetch lower returns compared with the fully grown ones.

The discovery of formalin laced fish across states Goa, Kerala, Assam, Manipur, Nagaland, Meghalaya and the temporary ban on fish imports in Goa and north-east to soothe public anger is a wake-up call for food safety authorities. Formalin is an aqueous solution of formaldehyde, a known carcinogen, and is traditionally used to treat cadavers in morgues and labs to prevent decomposition. In the fish trade it is a cost-effective way to keep fish fresh during transportation to faraway markets in place of ice, which requires maintenance.

To ensure traceability and good quality, MPEDA has decided to issue enrolment cards for export-oriented aquaculture farms and hatcheries.

Veraval Research Centre of ICAR-Central Institute of Fisheries Technology offered a three day Training programme on gear fabrication, net mending and repair to fisherman of Saurashtra region. The programme was funded by National Fisheries Development Board (NFDB), Hyderabad.

In the Articles section, article titled **"Use of Antibiotics in Sustainable Aquaculture - Its Safety and Biological implications"** by Dr Prafull Ranadive, discussed Recently it was observed by National Institute of Oceanography (NIO) that the water hitting the shores of Mumbai's most visited beaches contains bacteria that are resistant to more than 12 types of antibiotics. Indiscriminate use of antibiotics in aquaculture is a matter of concern. Recognition of antibiotics' overuse, which can lead to drug resistance of fish diseases, as well as their cost has further improved farming practices as a solution to disease management.

Another Article "**Effects of Salinity and pH Stress on Fish"** by Banani Mohanta & Pravati Kishan, discussed Now a days there is increasing the number of the industries. The drainage from the industry which increase the pH of the water mainly increases the alkalinity; but fishes require a particular pH 6.5-8.5. If increases more 11 than they will not survive. The use of pesticides in the agriculture field, which after the rain come to the nearest water bodies and changes the water pH. The salinity stress mainly found in the migratory fishes, it may be anadromous (sea to fresh water) or catadromous (fresh water to marine) fish. As they travel in the different salinities area. There is salt imbalance in their body.

Article titled "**Shrimp Toilet: A novel way for disposal of organic waste in Aquaculture systems"** by Md. Idrish Raja Khan, discussed Intensification of aquaculture systems brings problems like accumulation of organic wastes within the systems. Organic wastes invites the various infectious and non-infectious diseases. Shrimp toilet seems as an alternate option as cheap, eco-friendly and sustainable option to overcome the loading of waste material problems.

Readers are invited to send their views and comments on the news 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 industry. Keep reading the magazine regularly and update yourself. Wish you all fruitful results in your efforts.

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Growel Feeds launches a new generation extruded functional shrimp feed 'Nutriva F15'

Growel Feeds Pvt Ltd, India and Menon Renewable Products, Inc., USA exchanging an agreement which makes Growel Feeds to become the exclusive commercial partner for 'MrFeed' in India for Menon Renewable Products, Inc., USA. - at a press conference held at Taj Gateway Hotel, Vijayawada on 12-Aug-2018

Vijayawada: Located 60 km east of Vijayawada, Growel Feeds Pvt Ltd is one of the leading shrimp feed and fish feed producers in India.

P.S. Narendra, Executive Director, Growel Feeds

With an annual production capacity of 2,00,000 ton shrimp feed and 2,00,000 ton fish feed, Growel Feeds Pvt Ltd has its presence in national and international markets. The company's shrimp feed brands Marigold, Nutriva, Nutriva Plus, Sprint LS and Tigeron and fish feed brands Grofin, Growmax, Carpmax, Nutrila, Rainbow are quite popular in aqua farming community. These brands have high demand in national and overseas markets. Growel Feeds currently exports its products to 12 different countries. The company's commitment to quality, innovation and service has been attributed as the main reason for this success.

The well-being of aquaculture community is the major objective of Growel Feeds Pvt Ltd Shrimp disease management is of foremost concern to the aqua farmers. To meet the increasing customer requirements, Growel has been innovating effective feed products through continuous research. They have now introduced a new functional shrimp feed called 'Nutriva F15'. It is an immunity enhancing extruded shrimp feed developed in collaboration with Menon Renewable Products, Inc., USA. Nutriva F15 contains 'MrFeed', a patented immunity enhancing nature-derived ingredient developed by Menon Renewable Products, Inc., USA. MrFeed has been widely tested all over the world and found to be very effective in managing diseases. It elicits and enhances the immunity of the shrimp to fight against invading pathogens. Starting 6-Aug-2018, technical seminars were conducted on the West coast (Surat & Daman) and East coast (Kakinada, Bhimavaram & Kaikaluru) successively to explain the effectiveness of Nutriva F15 to the shrimp farmers and business associates.

M.V.N. Sesha Chary, Executive Director, Growel Feeds

Sandip Ahirrao, Vice President - Sales & Marketing, Growel Feeds

Growel Feeds' Executive Directors, Mr M.V.N. Sesha Chary and Mr P.S. Narendra, Technical Director, Dr Victor Suresh, Vice President – Sales & Marketing, Mr

Dr Suresh Menon, Founder Chairman, Menon Renewable Products, Inc., USA

From left: Dr Sergio Nates, Dr Suresh Menon, M.V.N. Sesha Chary and P.S. Narendra at a press conference held at Taj Gateway Hotel, Vijayawada on 12 August 2018.

Sandip Ahirrao and General Manager – Technical, Mr B. Ravikumar and Menon Renewable Products' Founder Chairman, Dr Suresh Menon and Senior Vice President – Sales, Dr Sergio Nates participated in the seminars and interacted

Dr Sergio Nates, Senior Vice President - Sales, Menon Renewable Products, Inc., USA

with the delegates who turned up in large numbers. Through various presentations, the delegates were explained how Nutriva F15 promotes shrimp health. The aqua farmers were encouraged to follow responsible aquaculture by doing away with antibiotics and resorting to the functional feed, Nutriva F15. The seminars were followed by question & answer sessions.

Several on-farm trials were conducted for 18 months with Nutriva F15 before scaling up the production to commercial level. An agreement was signed between Growel Feeds Pvt Ltd and Menon Renewable Products, Inc., USA at Vijayawada on 12-Aug-2018. This agreement makes Growel Feeds to become the exclusive commercial partner for 'MrFeed' in India for Menon Renewable Products, Inc., USA.

With an history spanning over 25 years, The Growel Group initially started with Growel Formulations in 1994, and later expanded to Growel Feeds, Growel Processors, Growel Labs. Growel Hatcheries is in pipeline. With the vision and mission of well-being

Ravikumar Bangarusamy, General Manager – Technical, Growel Feeds

of the people working in the various professions of aquaculture, the group named itself as 'Growel'.

Dr Victor Suresh, Technical Director, Growel Feeds

The Growel Group currently has an annual turnover of ₹1,500 Crore.

The management said that they are a part of the society and apart from business, they also give importance to their commitment towards the society. One of their corporate social responsibility activities is the supply of drinking water to 12 villages around their company.

Daily 60,000 litres of drinking water produced in their reverse osmosis plant is utilized for this purpose. The company also built a community hall and dedicated it to the public. Growel realizes that 'Today's Children are Tomorrow's Citizens', and hence it is greatly contributing to the development of government schools. The company keeps its premises very clean and lush with greenery in-line with eco-friendly industrial practices.

Delegates comprising of aqua farmers and business associates at the first Technical Seminar on Nutriva F15 held at Courtyard by Marriott, Surat

MPEDA Conducts Open Pond Culture of Seabass for the First Time in the Country

Kochi: The Marine Products Export Development (MPEDA) has successfully conducted open pond culture of Asian seabass for the time.

It was done at the demonstration farm of Rajiv Gandhi Centre of Aquaculture (RGCA), the research & development arm of the MPEDA, at Karaikal in Puducherry. Seabass, which is reared though 'cage culture', fetches a price of more than Rs400 a kg in the domestic market and also has huge export demand. Under the open pond culture method, its yield can go up to 9 tonnes per hectare.

MPEDA chairman A. Jayathilak, who witnessed the first catch of huge sizes of seabass fish (average weight of 1.5 to 2.00 kg) and 1.10 tonnes being caught in a single haul from the farm, said it would be the best alternative species for shrimp which contributes more than 70 per cent of seafood exports.

"Diversified aquaculture is the key for sustainability. This kind of diversified fish has the potential to significantly add to the seafood export basket. The production of up to 9 tonnes per hectare is really encouraging. In the future the production will be scaled up by keeping in mind the sustainability and eco-friendly culture practices,"he said, adding: "The technology for commercial production of these species would be made available to farmers very soon by RGCA."

Jayathilak, who is also president of RGCA, said the cage culture in ponds is a suitable method for growing seabass, but investment costs are high and cannot be afforded by small and marginal farmers. "But the open pond culture method can help these small farmers without much investment," he pointed out.

RGCA is concentrating its research on seed production, nursery rearing and grow-out methods of various species like cobia, artemia, scampi, tilapia, pompano, grouper and red snapper fishes for both brackish and marine waters.

15 Prawn Units Functioning on Cultivable Land Sealed

Chennai: In a drive against prawn hatcheries contaminating arable lands in Gummidipoondi, about aquaculture farms have been sealed. The development also revealed that six other prawn hatcheries were operating without licence, some encroaching government 'poramboke' land.

According to sources in the revenue department, the action against hatcheries was taken following complaints from villagers about soil contamination by the aquaculture farms. "Farmers from Salai and Elavur hamlets had complained about the adverse impact on their farmlands due to hatcheries functioning amidst cultivable land," a revenue official in Tiruvallur said.

While the 15 hatcheries, functioning over an area of 30 acres in the two villages were shut, six were found to be run without licence from the fisheries department. "Some were also encroaching upon government land," he added.

Aquaculture farms affect the quality of soil in their vicinity. Former director of Zoological Survey of India, K. Venkataraman, said aquaculture farms increase the salinity of farmlands-leaving a direct impact on soil productivity. "Hatcheries pump seawater into the aquaculture farm through channels. Neighbouring ecosystems are affected in the absence of treatment of sourced seawater," he added.

Farmed Seafood to grow by 40 percent Worldwide: UN

The United Nations says that aquaculture (Farmed Seafood) continues to grow faster than any other major food production sector in the world as it helps boost the economies of coastal communities and put affordable protein on the table.

In 2016, 37 countries were producing more farmed than wild-caught fish, according to a new report by the UN Food and Agriculture Organization (FAO).

Aquaculture production is expected to continue its remarkable rise, and volume is projected to reach 109 million metric tons in 2030, with a growth of 37 percent over 2016, said the FAO.

Asia will continue to dominate world aquaculture production, with a share of 89 percent in 2030, said the FAO.

Asia has accounted for about 89 percent of world aquaculture production for over two decades, the report said.

More than 19 million people are engaged in farming fish, and aquaculture production is expected to grow nearly 40% by 2030 said the FAO.

Here is a look at some of what is happening in the world of aquaculture;

Iceland – Iceland's aquaculture sector has seen a dramatic rise in volume output over the past two years, data from the Icelandic Food and Veterinary Authority (Mast) reveals. In 2017 overall volumes climbed to 20,776 metric tons, up from 8,290t in 2015, and 15,061t in 2016 primarily due to salmon farming. The Icelandic Food Administration says salmon and trout remain the two largest species, adding that a number of fish farming companies have expansion of Aquaculture operations in Iceland.

India – India will promote open sea cage fish farming on a priority basis to boost fish production from marine sector according to federal Agriculture Minister Radha Mohan Singh. Currently fish production in India is estimated at 11.4 million tonnes, out of which 68% is registered from inland fisheries sector and the remaining 32% from marine sector. India's Central Marine Fisheries Research Institute (CMFRI) has recommended the promotion of open sea cage fish farming across the country after the success of pilot projects at 14 locations. India recently introduced a "National Policy on Marine Fisheries, 2017", which will guide the development of marine fisheries sector for the next 10 years in the sub-continent.

China – At present, the global aquaculture market is dominated by China, which accounts for nearly three-fourths of the market in terms of both volume and value. China has made expanding mariculture a priority of the government's 13th Five-Year Fisheries Development Plan as the sustainable solution to the overfishing and overexploitation of the oceans.

The demand for fishery products from the region is skyrocketing, and will continue to rise in the future. Given the status of fish stocks, the only way to meet this rising demand will be through aquaculture states a study by the Nanyang Technological University, Singapore.

Greece – Greece has made the aquaculture industry a pillar of its national economy and a critical vehicle to help replenish its wild stocks. The consultancy company McKinsey & Co estimated that in the next 10 years, the aquaculture industry in Greece has the potential to add €1 billion in gross value added exports and create 48,000 new jobs. To realize this potential, the first congress on Hellenic aquaculture took place in Athens in July. Today more than 69 percent of all Greek fisheries production comes from aquaculture and accounts for 11 percent of total Greek agricultural exports. Of the 1,045 aquaculture facilities in Greece, 36 percent are marine fish-farm sites. The main species farmed are sea bass and sea bream (Dorado), particularly in offshore conditions, and mussels, according to Seafood Source.

Norway – Norway will further develop the aquaculture industry to churn its economy, sustain the environment and feed the world according to the country's Prime Minister Erna Solberg. The 2.6 million tons of seafood exported from Norway in 2017 is equivalent of 36 million meals every day, year round. The country seafood worth 94.5 billion Norwegian kroner (11.7 billion U.S. dollars) in 2017, a record high both in value and volume, the Norwegian Seafood Council said. Of the total value of Norway's seafood exports in 2017, 72 percent came from aquaculture and 28 percent from fishing. Salmon is the most important species for Norwegian seafood exports, with over 68 percent of the total export value and 38 percent of the volume, according to the council.

Japan – Inland areas for aquatic farming are limited in Japan so offshore aquaculture is seen as a key step in the industry's development. Aquaculture now accounts for almost half of Japan's coastal fishery production. Japan's Ministry of Agriculture, Forestry and Fisheries in its annual White Paper on Fisheries noted the graying population of Japan's fishermen, with their average age now above60 years old. The paper said that while younger fishers are joining the industry, by and large, they are most interested in aquaculture because it is a growing sector. Projects are currently underway in Japan to raise salmon in large numbers in big offshore pens, by adopting next-generation aquafarming technology.

Indonesia – At 54,716 kilometers, Indonesia's coastline is the longest in the Asia-Pacific, providing huge potential for offshore fish farming. The country's goal is to nearly treble its farmed finfish output by 2019. Indonesia's aquaculture sector yielded more than 4 million tonnes last year, which constituted 5.7 per cent of global aquaculture production. It also contributed roughly 6.7 per cent to Indonesia's national GDP in 2016 and absorbed 4.1 per cent of the country's total workforce.

Scotland – The Scottish government is to work in tandem with the country's fish farmers to address health challenges and help the industry grow sustainably with a 10-year Farmed Fish Health Framework that aims to not only enable growth but also minimize impacts on the environment. The framework has six work streams which will deal with fish health issues and review sea lice protocols. A separate work stream will be set up to cover wild and farmed fish interactions, and will include representatives from both sectors. Aquaculture in Scotland supports 12,000 jobs, many of them well paid, and workers in the sector were the backbone of their Highlands communities, the government said.

Singapore – A self-sustaining 'future food city', featuring a mixed crop cultivation of vegetables, seaweed and fish, is being planned off the coast of Singapore. The "Oceanus Aquapolis" would be a multi-story structure that generates its own solar electricity and harvests rainwater for aquaponics. Singapore imports 90% of its food, making it one of the most food insecure countries in the world.

Philippines – The Philippines is the world's fifth-biggest tilapia producer, behind Bangladesh, Egypt, Indonesia and China. A quarter of fishermen in the Philippines use destructive fishing methods — including explosives, poison and crowbars to pry open coral — even though they are illegal, according to a study by US researchers. The Philippine Government and private sector are currently preparing the Comprehensive National Fisheries Industry Development Plan (CNFIDP). One of its components is Aquaculture Development and Management.

Brunei – The aquaculture sector is fast emerging as a potential source of revenue and job creation in the oil-dependent economy of Brunei. The Sultanate is now considered as one of the largest producers of rostris blue shrimp in the world, thanks to high-technology and computerised farming techniques. Brunei's Fisheries Department has set a target to increase aquaculture revenue from BND9 million in 2015 to BND400 million per year by 2020. Barramundi Asia, a Singaporean fish farming firm, recently signed a deal with the government to invest BND300 million to rear barramundi (sea bass) in Brunei waters.

USA – America's National Marine Fisheries Service (NOAA) is setting a goal to expand marine aquaculture production in the US by at least 50 per cent by the year 2020. The organization recently released its Marine Aquaculture Strategic Plan, which is focusing on the goals of regulatory efficiency, improving tools and technology and keeping the public informed.

Currently, the US imports over 90 per cent of its seafood, about half of which is farmed. Aquaculture production employs about 40,000 people in the US. U.S. Senator Roger Wicker, has introduced a bill that would streamline the permitting process for aquaculture farms in American waters. The bill is similar to calls in Canada for a Federal Aquaculture Act that will provide a modern legal framework for managing the aquaculture sector.

Indian Seafood Exports set to slow Growth Amid Weaker Shrimp Prices

A vannamei shrimp pond in Andhra Pradesh, India.

A vannamei shrimp pond in Andhra Pradesh, India.

Indian seafood exports may show lower growth this fiscal year as shrimp prices continue to remain low and cautious farmers go slow on production.

While prices of shrimp, which dominates the Indian seafood export basket, are down by 20% from last year, fear of white spot disease and lower prices

forced many farmers to go for partial harvest, resulting in small-sized shrimp, which fetch lower returns compared with the fully grown ones.

"Lower prices have discouraged aquaculture farmers from going for more stocking in the farms for the next harvest, which will be done after a few months," said Muthukaruppan, former President of the Indian Society of Aquaculture Professionals.

"Following tightening of quality standards in the European Union [this year], exporters were focusing more on the US market. The oversupply pulled the prices down," said Muthukaruppan. The US is the largest buyer of Indian seafood with about 33% share.

Last month, shrimp prices showed signs of improvement only to go down again. "Farmers are cautious as they lost money in the last harvest. Unless the prices stabilize, they may not stock more," said Balasubramaniam, General Secretary of the Shrimp Farmers Federation of India. Seafood exports had touched a record Rs45,106 crore last year on the back of high prices and good production of shrimps. The shrimp production in the country scaled a new peak of 600,000 tonnes, making India the top shrimp supplier globally.

The Centre's move to raise the import duty on artemia-a small shrimp used as live feed in shrimp farms-to 15% from 5%, may further hit farmers. Artemia is imported from the US.

"We have met the Agriculture and Commerce Ministers, requesting them to keep the duty down, as it would raise the input cost for formers. The Agriculture Ministry is understood to have sent a note to the Commerce Ministry to maintain the current rate," said L. Satyanarain, President of All-India Shrimp Hatcheries Association.

The next big shipment of seafood happens during October-November for the Christmas season. "We hope the prices will improve by then, as the long-term sentiment is good and there are no adverse factors for price decline. Basically, it is a demand-supply mismatch," said Kenny Thomas, MD of Jinny Marine Traders, an exporter based in Gujarat.

Vietnam Poised to Become Top Player in Ocean Aquaculture

Vietnam: Vietnam has set an ambitious goal of becoming a leading country in aquaculture – specifically in the productive development of its coastal marine environment.

Currently ranked as the fourth-largest producer of seafood from aquaculture, behind China, Indonesia, and India, Vietnam produced 3.84 million metric tons (MT) of farmed seafood in 2017. That was more than 53 percent of Vietnam's total seafood production of 7.23 MT, which itself represented an increase of 5.2 percent year-on-year over Vietnam's total from 2016.

Vietnam's government and industry stakeholders have recently taken a more serious interest in the development of Vietnam's aquaculture sector, Tran Dinh Luan, the Deputy Director of Vietnam's Fisheries General Department, told a workshop in Hanoi in early July.

The workshop, co-organized by the Vietnam Seaculture Association, Vietnam's Fisheries General Department, and the U.S. Soybean Export Council (USSEC), centered around Vietnam's draft national strategy for marine aquaculture development through 2030. The strategy, with an addendum that proposes a vision through 2050, was prepared by the Ministry of Agriculture and Rural Development and will be submitted to Vietnam Prime Minister Nguyen Xuan Phuc for final approval.

The plan calls for the country to implement – on a trial basis – several policies designed to encourage industrial sea farming, particularly in offshore areas, by 2020. The plan aims to double the farmed output from the sea by 2020 to 750,000 MT total, comprising 200,000 MT of fish, 400,000 MT of mollusks and 150,000 MT of seaweed, according to the draft strategy.

Luan said while sea farming in Vietnam is still at its early stages of development, the strategy is designed to develop the whole production chain of the sector at larger and more advanced levels. In its latter stages of execution, the plan calls for production to rise to 1.75 million MT by 2030, and to three million MT by 2050.

As a result, Vietnam hopes to gain USD 1.5 billion (EUR 1.29 billion) from exports of its farmed marine products by 2020. That total is estimated to grow by between USD 5 billion and 8 billion (EUR 4.3 billion and 6.9 billion) by 2030 and more than USD 10 billion (EUR 8.6 billion) by 2050. The country aims to become the leading player in the Southeast Asia and Asia in marine aquaculture sector, with the eventual goal of ranking in the top five in the world in terms of output and value of farmed marine products exports by 2050, according to the draft strategy.

The plan also calls for a more intensive focus on developing trading relationships and technology and training partnerships. The country aims to deepen ties with top countries in terms of sea farming, including Norway, Denmark, Japan, the U.S., and Australia. Investors from these countries will be welcomed to transfer modern aquaculture technologies to Vietnam. Vietnam will also look to import high-quality fingerlings from Japan, South Korea, Taiwan and Australia, the draft strategy showed.

Last year, Vietnamese aquaculture produced 2.69 million MT of fish and 723,800 MT of shrimp, data released by Vietnam's Ministry of Agriculture and Rural Development shows. However, output from sea farming remain modest, producing a total of 377,000 MT of farmed marine products, including fish, mollusk, lobster, crab, and seaweed in 2017.

Nguyen Huu Dung, the president of the Vietnam Seaculture Association, told Seafood Source sea farming has not developed much yet in Vietnam, but "it is very promising."

With a coastline of more than 3,260 kilometers (2,026 miles) and numerous islands and bays, Vietnam has huge geographic potential for aquaculture, Luan said. Its exclusive economic zone accounts for nearly 30 percent of the South China Sea. In particular, the waters in the country's west, with fewer storms, and the deep waters in the central region are ideal for large-scale farming of marine fish species.

Pangasius and shrimp are Vietnam's two major aquaculture products. They are mainly raised in Mekong Delta, though other areas across the country are also home to aquaculture development. Developing ocean aquaculture will bring greater diversity and balance to the country's seafood production, especially if Vietnam can apply advanced sea farming technologies in deeper waters, Dung said.

Currently, there are about 50,000 households farming marine products across the country. Most are independent, small-scale farmers using old equipment and outdated practices. But a number of companies – particularly those operating near Phu Quoc Island in the south and Van Phong Bay in the central region – have scaled up industrial farming practices using modern technologies from Norway.

Initial results showed that these sea farming models can be applied in other sea areas of the country, Dung said.

Fishy Business: Formalin in Fish has killed Consumer Confidence. Fix India's Food Inspection Regime

The discovery of formalin laced fish across states – Goa, Kerala, Assam, Manipur, Nagaland, Meghalaya – and the temporary ban on fish imports in Goa and north-east to soothe public anger is a wake-up call for food safety authorities. Formalin is an aqueous solution of formaldehyde, a known carcinogen, and is traditionally used to treat cadavers in morgues and labs to prevent decomposition. In the fish trade it is a cost-effective way to keep fish fresh during transportation to faraway markets in place of ice, which requires maintenance.

Both local markets and dominant fish producers like Andhra Pradesh, Kerala and Tamil Nadu have been hit hard by bans and consumers who have turned off fish. Andhra traders, in particular, have bristled at the bans and blame local politics to benefit local producers. Before the scare, Andhra fish producers were the toast of fish-eating states, with others seeking to replicate its success in aquaculture. India is world's second largest fish producer, inland fish produce has doubled since 2004-05, and exports have quadrupled from Rs 8,400 crore then to Rs 38,000 crore in 2016-17.

The formalin scare highlights the need to keep consumers at the core of business interest, creating cold chain networks for the burgeoning fish trade and ensuring regular food safety inspections. Additionally, consumers can be helped to safeguard themselves. Kochi-based Central Institute of Fisheries Technology has developed a low-cost kit to detect formalin/ammonia presence in fish which will soon hit the market. With media reports of indiscriminate antibiotics use in poultry industry and pesticide presence in vegetables, fruits and foodgrains, consumers could do with more such detection kits that offset the state's failure to set up an effective food safety regime. Food that poisons us is a violation of citizens' fundamental right to food.

Enrolment Cards for Aqua Farms, Hatcheries

To ensure traceability, good quality and meet global norms

Vijaywada: To ensure traceability and good quality, the Marine Products Export Development Authority (MPEDA) has decided to issue enrolment cards for export-oriented aquaculture farms and hatcheries, said P. Anil Kumar, Joint Director, MPEDA. The card is like a Master Card with QR code carrying basic information about the farmer and the farm coordinates. Most farms are geo-tagged and enrolled and the MPEDA is extending a free service. "The digitalisation is aimed at tracing the produce from farm to the plate for the exported farmed shrimp," he said. Important countries in the EU and the U.S. prefer traceability. The Seafood Import Monitoring Programme (SIMP) recently announced by the U.S. government is mandatory from January 1, 2019 and requires traceability. Enrolment will ensure smooth exports of cultured shrimp. In Andhra Pradesh, 34,172 farmers operating in 47,444 hectares have enrolled so far. The officials have asked the remaining farmers to register by August 31.

Aqua Exporters Unaware of Cargo Facility at Gannavaram Airport

Indigo to park four aircraft at airport from September 15 in phases; destinations undecided

Newly introduced AirIndia Express flight from Vijayawada to Mumbai welcomed by water canons at gannavaram airport.

Vijayawada: The 10-tonne capacity cargo service in Gannavaram airport, which has been functional since August 1, is hardly being used by aqua and agricultural exporters, though it happens to be the cheaper way as compared to the one they use for transportation of cargo.

K. Venkata Rama Rao, Founder of Shreepa Logistics, agency in-charge of Gannavaram airport's cargo service, said, "It costs Rs.12 per kg to export goods from Vijayawada to Delhi while it costs Rs.32 per kg to export them from Hyderabad to Delhi. Though this sounds like a no-brainer, some exporters are opting to export from Hyderabad as they are unaware of the cheaper cargo service available from Gannavaram airport despite all the media reports."

Despite direct appeals from Shreepa Logistics, there has been no change

in the situation. "Though we have held several meetings to deal directly with the farmers, the response was not that encouraging. Unfortunately, not even middlemen have approached us till now. However, we want to help the farmers, so we are going to engage with them again. We will conduct seminars and workshops to raise awareness among them," said Rama Rao.

This ignorance is leaving a huge potential untapped, as Delhi's prices of aquaculture and agricultural products are more than triple the prices in Andhra Pradesh.

Shrimp in Delhi is sold at Rs 800 to Rs 1500 per kg while it sells for a mere Rs 250 to Rs 450 in Andhra Pradesh. "When it comes to Guntur G4 chilli, there is a heavy demand in Delhi. It is sold at exorbitant prices as it is very rare there. We want to rope-in Guntur chilli farmers directly. We are going to hold meetings with them soon," Rama Rao said.

He further claimed that Indigo will start operating flights from Gannavaram airport in September and the cargo service's capacity will go up to 12-tonnes.

However, Gannavaram airport's Director, G. Madhu Sudhan Rao, told TNIE that Indigo, which is to park its first aircraft in Gannavaram airport on September 15 and bring in the rest of the three intermittently 'in phases', has not decided the destinations of its flights. "They have taken permission to operate from September 1 but have decided to be prudent and start operating their first aircraft from September 15; they will introduce the rest three in phases based on the passenger traffic."

When asked about the exporters' ignorance of the cargo service by exporters, official sources from Marine Products Exports Development Authority (MPEDA), told TNIE that meetings have been held with exporters and awareness is being created about the cargo service at Gannavaram Airport.

K. Seetharamaraju, Assistant Director, Fisheries, said, "Aquaculture exports will only benefit exporters. It will not benefit aquaculture farmers who sell them to the intermediaries as farmers do not engage in trading even if they are approached directly. They stick to farming."

Ramesh Babu, an exporter of flowers to Malaysia and importer from Bangalore, based in Mylavaram, Krishna District, said, "My uncle and family members are farmers. Since I am educated, I can take care of trading and ensure they get fair returns. However, most other farmers do not have the opportunity and intermediaries fleece them. They are also unaware that there is a cargo service as they do not follow the news and don't keep up."

D. Rajesh, a seafood trader from Ramaypatnam, Prakasam District, said, "I am not aware of the service. Maybe there needs to be more marketing so that we traders come to know about it."

Training Programme on Fabrication of Improved Fishing Gear

Veraval Research Centre of ICAR-Central Institute of Fisheries Technology offered a three day Training programme on gear fabrication, net mending and repair to fisherman of Saurashtra region. The programme was funded by National Fisheries Development Board (NFDB), Hyderabad. In the introductory session, Dr Toms C. Joseph, Scientist in-charge of the Centre reminded the need of training programmes for improving the skill and efficiency of the fishermen and also added that such training programmes will help to introduce the recent technological advancement happening in the sector to the fisherman. Dr K. K. Prajith, Scientist and Course Director for the programme detailed the scope, objective, schedule and structure of the training programme. Dr A.K. Jha, Scientist and Shri Vinay Kumar Vase, Scientist in-charge, Veraval RC of ICAR-CMFRI offered felicitations.

Practical demonstration in progress

Twenty five fishermen from various Fishermen Societies of Veraval participated in the Programme which consisted of sessions on responsible fishing techniques, basics of fishing gear fabrication, bycatch reduction devices, fabrication of improved gillnets, squre mesh codend fabrication etc. handled by experts. Practical demonstrations were done by Shri H.V. Pungera and Shri J.B. Malmadi, Technical Officers. In the concluding ceremony held on 31 July, 2018 the Scientist In-charge of the Centre distributed certificates to the participants.

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Vet Varsity Breeds Pangas Catfish in State

Punjab's climate suitable for pangas culture between March and November

Ludhiana: The Guru Angad Dev Veterinary and Animal Sciences University (GADVASU), Ludhiana, achieved another milestone of breeding pangas catfish successfully in Punjab.

Dr Meera D. Ansal, Head Department of Aquaculture said, "Pangas is an exotic fish without any intramuscular spines having high demand among Punjabis. It is a cold sensitive species, not able to survive below 20 degree Celcius during winters. Hence, it is being reared in coastal states, where the temperature rarely falls to critical levels. At present, iced pangas is transported from Andhra Pradesh to almost all northern states. It sells like a hot cake in the state after covering a distance of about 1,900 km. It is a potential diversification species for enhancing aquaculture productivity (three times), besides doubling farmer's income."

The GADVASU has already standardised pangas culture technology with an average productivity of 17 tons, per hectare and net income of over Rs5 lakh in just 6 months. Climate of Punjab is suitable for pangas culture for a period of 7-8 months from March to November. The major bottle neck in promoting pangas culture in northern states is non-availability of seed. As pangas breeds after attaining three years of age, hatcheries for seed production are developed in regions having no winter season.

The GADVASU not only succeeded in developing four years+ brood stock of pangas through technological interventions, including overwintering under poly house conditions, but also succeeded in breeding the fish in Punjab through induced breeding technology, with progressive fish farmer, Ranjodh Singh of Nanokey village, Patiala.

It is for the first time that breeding of pangas has been successful in non-coastal northern region of the country.

DrS. N. Dutta, who was involved in culture and breeding of pangas catfish said, "Breakthrough has opened new window of possibility of developing pangascatfish hatcheries in Punjab and availability of seed within the state will promote pangas catfish culture on commercial scale."

Dr Meera informed that pangas catfish is an excellent species for developing value added products without much processing hassles and hence, farmers are also motivated to take up pangas catfish culture as a cluster activity, associated with small scale processing units at farmer level.

CLFMA Symposium 2018 to Focus on "GenNXT" aspects for Indian Livestock Sector

"Every industry needs fresh ideas from outside the system to survive and needs next-gen, young and bright minds with the clear vision and traits such as grit and perseverance to make a positive contribution to the society" said B. Soundararajan, Chairman of CLFMA of India, the apex association representing the livestock industry in India on the occasion of International Youth Day (12th August).

CLFMA of India is the apex body representing the dynamic livestock sector in India. The 50-year old industry association is recognized as one among the eldest and highly reputed in India. It currently has over 240 members representing diverse subsectors of animal protein value chain including feed manufacturing; poultry, dairy and aquaculture business; animal nutrition and health, veterinary services, machinery and equipment; processing, distribution and retailing of meat; and ancillary services such as banking.

"It is impossible to achieve the 17 UN Sustainable Development Goals (SDGs) without significant participation and contribution from youth in every aspect. We strongly believe the country's fast-growing livestock sector offers an ocean of opportunities for those who are willing to explore" Soundararajan opined.

Agriculture in India faces a number of important challenges: it needs to become more sustainable and productive, while it must at the same time remain profitable for farmers. This is particularly true for livestock farming. Modern and innovative livestock equipment and technologies are important parts of the solution to address and overcome these challenges. Furthermore, a number of innovations are occurring in plant agriculture to maximize all of the land we can sustainably cultivate. From advanced plant breeding techniques to integrated pest management, to improved varieties, scientists, industry and farmers are working together to ensure food and nutritional security of the country. Livestock is one of the fastest growing agricultural sectors driven mainly by rapid urbanization and higher incomes.

"In the last decade, the world is witnessing how Internet of Things (IoT) and cloud-based technologies are transforming animal-agribusiness sector in unimaginable ways. For example, wearable devices on animals provide real-time data to monitor feed intake, stress levels or disease

symptoms so that these can be addressed promptly not only to enhance productivity but animal welfare as well. Similarly, soil sensors help farmers analyze moisture or nutrient levels to cut down unnecessary irrigation or fertilizer application and contribute greatly to cost savings as well as environmental sustainability. These innovations provide us wealth of information to analyze every process deeper for continuous improvement. It is only a matter of time before we see all these are widely used in India" he added.

This year's theme for CLFMA's annual symposium is 'GenNXT wave: People, Technologies and Innovation' and how this is going to impact the Indian livestock sector

People –perspectives from next-gen managing the business and entrepreneurs

Technologies – perspectives including application of IoT, Blockchain, digital applications

Innovation – in terms of products, marketing, and supply chain on how these innovations can help improve animal welfare, the environmental sustainability and boost farmers' incomes.

Now a days everything in the world has come down to 'one touch', h How the Indian government's full support is needed to unleash the full potential of innovative livestock technologies. Furthermore, innovations like e-commerce through mobile phones, coupled with analytics positively disrupted retailing in India in the recent years. Nowadays, through mobile apps and with just a few clicks, consumers can get their preferred type, preparation, and variety of meat and seafood delivered at their doorsteps at affordable prices year-round without compromising on their two most important needs - convenience and quality.

"It is high time we think about who is going to feed us in future and how to ensure food and nutritional security of the billion-plus population while remaining focused on sustainability of our unique and precious biological ecosystem. It is important to ensure India's animal-agribusiness sector attracts the best talent, sparkling brains and skilled hands from different fields and retains them. Traditional business paradigms; entrenched perceptions and outdated practices must pave way to newer and fresher ideas and concepts that only today's youth can bring in. Only then innovations can sprout and flourish. This industry must be seen as one of the preferred career paths by youngsters, who currently lack awareness about the ocean of opportunities available. Every one of us working in the industry must actively step up to create awareness among students who are aspire to become tomorrow's professionals, entrepreneurs, and leaders and CLFMA's forthcoming symposium would be a great platform for such in-depth deliberations" Soundararajan concluded.□

Senior most dealer for feed and other input in Aquaculture Sector Mr Yarlagadda Prasad, Gudivada in Krishna district, Andhra Pradesh passed away recently. May his soul rest in Peace.

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Better Management Practices for Farming of Rohu

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Introduction:

Rohu *(Labeo rohita)* is the most important cultured species among Indian Major Carps viz. Catla *(Catla catla)* and Mrigal *(Cirrhinus mrigala)* in the Asian countries, especially in the Indian sub-continent. It is the tastiest of all carps and is one of the most preferred species in the country due to higher price in the market. The Indo - Gangetic riverine system is the natural habitat of the major carps from where these fishes have been transplanted to all other water systems in the country. Rohu is a column feeding omnivore and prefers zooplankton, with multitude of food items throughout their various life stages. It is an eurythermal species (does not thrive well below 14˚C). Under normal culture conditions, it grows fast attaining total length of 35-45 cm and weight 700-800 kg in a year.

Best management practices

Management practices refer to the most effective methods/practices implemented in an activity at a particular time that improves the efficiency of the system. The management activities needed to solve the aspects of a resource management. Management of aqua-farms keeps the culture practices profitable without any loss to the farmers or entrepreneurs. Adoption of proper management practices in fish culture brings about the following benefits:

- Improved growth rate
- Minimizes disease occurrences
- Preserves environmental integrity (by reducing impacts on the environment)
- Optimizes utilization of resources, thus enabling sustainability and increased profit
- Attaining food quality standards and improving the marketability of the product

Management Practices in Rohu Culture:

Fish Farm Management:

Management of fish farm is the prerequisite for any of the fish culture practice. Especially farmers with earthern ponds need to improve the pond bottom by draining and dry at least once a year and then applying lime (agricultural, slaked or quick lime) at an appropriate dose to retain pond productivity, fish parasite removal, *etc.* Clearing of aquatic weeds (*Eichhornia, Pistia, etc.*) and predatory fishes by mechanical, chemical or biological process provides an ideal environment for the fishes stocked inside the pond. The natural productivity of ponds can be enhanced by fortnight application of fertilizers (urea, SSP, *etc.*) and manures (cow dung, pig manure, etc.) before stocking of fishes. Periodic monitoring of the physio-chemical parameters is very essential aspect to determine the water quality.

Broodstock Management:

Brood husbandry and brood rearing are two important activities which is less seen in commercial carp hatcheries. Raising of brooders should be done to solve the problem of inbreeding depression and genetic drift in the off springs. For production of brood healthy yearlings from any hatchery should be preferred for rearing purpose. The brood fish pond should be of 0.2-0.5ha, rectangular, with a water depth of 1.5mt. Stocking density should be maintained @ 1500kg/ha for IMCs. Optimum water qualities for brood stock pond detailed in table 1.

Highlight Points

- **Since India is a carp country, it should be cultured widely in a better way to enhance the sustainability of the culture system.**
- **Since carps contribute more than half of the culture system, it should be cultured intensively with following better management practices to enhance the economy of the country through fisheries sector.**
- **Water quality management as well as pond prestocking, stocking, poststocking management should be widely known by all the fish farmers to get the maximum benefit from this profitable culture system.**
- **Moreover there is a need for development of farmer's interest in this sector to know the basic knowledge of pond culture; otherwise it will lead to loss during culture.**
- **Hence the concept of this management practices should reach to the farmers so that they could get benefit from the knowledge and improve their field level experiences.**

Table 1: Water quality parameters of brood stock pond

During brood raising fishes are fed @ 2-3% of the body weight once daily to reduce the feed cost. But soon after the growing period, high protein diet has to be given for the healthy developments of their gonad. Fish, during this period, has to be fed with formulated feed containing 30% protein supplemented

with vitamin, mineral and trace elements. Now-a-days organic feed are used to reduce the cost of fish meal in feed with any leaf meal or insect protein etc used as a replacement to the fish meal.

Parameter	Fresh water
Colour (colour units)	Clear water with greenish hue <100 colour units
Transparency (cm)	20-35
Solids (mgl-1) a)total solids b)suspended solids	<500 30-200
Temperature (oC) a)tropical climate b)temperate climate	25-30 10-12
Clay turbidity (mgl^{-1})	<30
pH	7.5-9.5
Hardness (mgl^{-1})	30-180
Alkalinity (mgl^{-1})	50-300
Salinity (ppt)	<0.5
DO (mgl^{-1})	5-10
Total dissolved free arbon dioxide (mgl^{-1})	<3
Ammonia nitrogen(NH3-N) (mgl^{-1}) a. Unionized (NH_3) b. Ionized ($NH4^+$)	 0-0.1 0-1.0
Nitrite nitrogen(NO_2-N), (mgl^{-1})	0-0.5
Nitrate nitrogen(NO_3-N), (mgl^{-1})	0.1-3
BOD (mgl^{-1})	<10
COD (mgl^{-1})	<50
Hydrogen sulphide (mgl^{-1})	<0.002
Primary productivity (mg C m-3 day^{-1})	1000-3000
Plankton (ml per 100lt)	2
Chlorophyll – a (μgml^{-1})	20-275
Organic carbon in sediment (%)	0.50-2.75

Nursery management:

Normal size of a nursery pond is 0.02-0.05 ha with ideal water depth of 0.5-1 mt. The water depth should be low since less energy will be consumed for feeding in case of spawn. Many steps should be taken care of during the nursery pond preparation like weed clearance, predatory and weed fish clearance, manuring and fertilization, control of aquatic insects etc.

1. Weed clearance

Excessive growth of aquatic weed in the pond leads to competition of the spawn with weed for the available nutrients as well as sunlight and dissolved oxygen. It also hinders their free movement and limits the living space as well. It provides shelter to the predatory and weed fishes and aquatic insects. Sometimes siltation of the pond bottom may also occur due to these weeds. So these weeds have to be eradicated either manually by hand picking or biologically, by use of fishes like Grass carp that used to consume weeds or by using chemicals.

2,4-D is the most common herbicide used @ 4.5-6.7kg/ha. Other chemicals used are Tafficide, Simazine, Paraquat, Endothal etc. For fully submerged weed aquathol (Disodium 3, 6 endosohexa hydrophthalate) can be used instead of 2, 4-D (2,4-Dichlorophennoxy acetic acid).

2. Predatory and weed fish clearance:

IMC breeding season coincides with the south west monsoon, the cat fish or other fish breed prior to the monsoon and hence the control of these predators is necessary in nursery pond. Hence, prior to stocking the desired spawn, poisons like plant derivatives or chlorinated hydrocarbons, organophosphates, urea and bleaching powder can be used to control these predators. Commonly used plant derivatives are Mahua oil cake and derris root powder. Mahua oil cake contains 4-6% saponin which can be used @ 75ppm and for complete removal 200-250ppm at least 2 week prior to stocking to allow complete detoxification. Derris root powder contains 5% rotenone which can be used @ 4ppm for weed fishes and 6-10 ppm for predatory fishes whose toxicity lasts for 4-12 days. Chlorinated hydrocarbons like aldrin, endrin, dieldrin can also be used. But use of these chemicals is not advisable due to its higher toxicity and biomagnifications in the aquatic environment. Organophosphates like Nuvan 100-EC (DDVP), malathion, phosphamidon can also be used. These chemicals inhibit the acetylcholine esterase and thus cause the dysfunction of nervous system that leads to death. Urea and bleaching powder can also be used for the eradication process where urea @ 100-250kg/ha and bleaching powder (30% chlorine) @ 150-250kg/ha has to be used. Urea after applying into the pond dissociates into ammonia which after applying bleaching powder is converted into ammonium chloride that is highly toxic for the fishes.

3. Manuring and fertilization:

Fertilization has to be done prior to 15days with cow dung and GNOC. Normally cow dung is applied @ 10 tones/ha, from which 5 tones is applied 15days before stocking and 5 tones after stocking. Since spawn of Rohu is zooplankton feeder, hence zooplankton production should be maximum prior to stocking in the pond. Liming is also a necessary step in pond fertilization. Liming helps in correcting the pH of the pond water as well as it nullifies the harmful effects of the acids like humic and sulphuric acids. It also helps in decomposition of organic matter. Liming can also be acts as a disinfectant as well as a calcium supplement for the growth of the fish. The N: P and C: N ratios in the pond sediment are the main factors based on which the efficacy of fertilizers and manures for improved natural productivity are selected. N:P

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ratios of 2:1 to 4:1 and C:N ratio of 10:1 to 20:1 are desirable for sustained primary productivity of pond water. Since the freshwater ponds in India usually contain adequate quantities of potassium, potassium fertilizers are generally not applied (Jena and Das, 2006).

Inorganic fertilizers like urea as nitrogen fertilizer, single super phosphate as phosphate fertilizer, mureate of potash as potassium fertilizer are commonly used. Urea contains 46% nitrogen, SSP contains 16-20% P2O5, KCl contains 47-50% K2O.

Productivity of pond	N_2 (mg/100 of soil)	p(mg/100g of soil)	Organic Carbon	Total of water (ppm)	Combination NPK fertilizers
Low	20	3.5	1	50	300-150-0
Medium	20-50	3.5.-6	1.2	50-100	200-100-0
High	50-75	6-12	>2	>100	150-75-0

Dose of some organic manure are as follows.

Cow dung	- 10,000 - 15, 000 kg/ha / yr
Pig Dung	- 5,000 - 12,00 kg/ha./yr
Chicken dung	- 5,000 - 10,000 kg/ha/yr

4. Insect control:

Aquatic insects contribute about 3% of the whole insect population. From them majority of the insects belong to the order Coleoptera, Hemiptera, Odonata. Soap oil emulsion method is mostly used to kill aquatic insects where oil: soap ratio is to be maintained at 56:18 kg/ha. Teepol B 300 can also be used instead of soap with oil. Kerosene, diesel oil can also be used instead of coconut or groundnut oil. These methods are to be applied on a calm day since there is chance of breaking of the oil film due to wind in other days.

Feed management:

Since feed, an important factor for the growth and survivability of fish accounting to 60-70% of the total cost of production; feed management is of prime importance for the farmers. From spawn till marketable size, Rohu fish requires different types as well as different size of feed. Rohu, is an omnivore fish, with the feeding habit varying in different life stages as in the early stages of its lifecycle, it is a zooplankton feeder, but as it grows, it feeds on phytoplankton, and as a juvenile or adult is a herbivorous column feeder, eating mainly phytoplankton and submerged vegetation. So before stocking of spawn the pond should be fertilized properly so that optimum quantity of zooplankton can be available for the spawn. The starter feed for spawn is rotifer followed by Microcladocerans like Daphnia, Moina, Bosmina. Larger copepods like Cyclops should be avoided since these are harmful to the spawn. But soon after 2-3 days supplementary feed should be provided. For Rohu spawn broadcasting method seems to be good for the easy availability of the feed for the spawn. Farmers in Andhra Pradesh give groundnut cake exclusively for the 7-10 days and after 10 days they are gradually replacing the groundnut cake with de-oiled rice bran. In some rohu nurseries the farmers used to give GNOC till the spawn grow to 1.5-2 inch after which they are fed de-oiled rice bran till the completion of the nursery cycle of 15 days. IMC fingerlings and fry require feed with 35 and 40 % protein respectively (Sen et al. 1978) for better growth and survival. The optimum pellet sizes for different size classes of common carp fry has been described by Hasan and Macintosh (1992).

Table 2. Details of carp fry size, total length and preferred pellet size

Fry size (mg)	Total length (mm)	Preferred pellet size (µm)
15–23	13–18	125–300
46–97	17–22	300–500
105–209	20–25	300–790
210–466	24–31	500–1 000

Source: Hasan and Macintosh (1992)

Health and disease management:

Minimizing stress and disease outbreaks in the cultured fish is the principle fish health management. This can be achieved by proper prophylaxis and positive treatment to the epidemics. Due to aquatic ambience, it is difficult to recognize the fish being diseased and so failure of correct diagnosis and timely treatment. This signifies that "Prevention is better than cure".

It is not easy to diagnose diseases in initial stages of fish. Also, due to gregarious nature of fish in water, diseases spread rapidly to other fishes. Hence, effectual preventive measures can reduce the risk of disease occurrence. The most common preventive measures include:

- Selection of healthy fish seed
- Proper stocking density
- Quality feed
- Proper water quality
- Prevention of fish injury

Conclusion:

Therefore, maintenance and judicious management in Rohu farming practices by optimal utilization of available resources correctly and efficiently guarantees a successful production and resulting in a profitable enterprise.

Effects of salinity and p^{H} stress on fish

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INTRODUCTION: -

Stress is any condition that causes physical or mental discomfort that results in the release of stress hormones, this to range in the physiological behaviour of fishes. Stress is present in the lives of all living things and is the force that brings about physical change and adjustment. Sometimes the small amount of stress can be beneficial but it continues for a prolonged time it creates a lot of problems and also many diseases. The overall changes in the stress is the change in the body physiological activity which disturb the metabolic rate of the fish and also increase in the level of stress hormones. This may lead to decrease in the growth rate of the fish and also decrease in the immune system.

Stress can either be-

- short and sudden
- long and chronic.

Symptoms: -

- Gasping: sometimes fish is found on the surface of the water in gasping condition. Thisis mainly due to the lack of oxygen and also due to some environmental parameters.
- Appetite: when fish is in stress condition, it will not accept food.
- Disease: Due to change in environmental parameters the ich disease is commonly happening in fish.
- Strange Swimming: When fish is in stress, its cortisol level is very high and it behaves abnormally like swimming erratically, biting head near the wall of the pond, rubbing its body near the tank etc.

HORMONAL CHANGES DURING STRESS-

When there is stress it may be due to any reasons, its stimulus will come to the hypothalamus which activates the stress-related hormones like cortisol which leads to change in physiological and metabolic changes occurs.

PHYSIOLOGICAL CHANGES DUE TO STRESS-

When there is any stress the concerning primary messenger brain-sympathetic-chromaffin cell axis and brain -pituitary-adrenal axis stimulate the uptake of more oxygen and mobilization of energy-substance, reallocation of energy away from growth and reproduction and mainly suppressive effects on immunity functions.

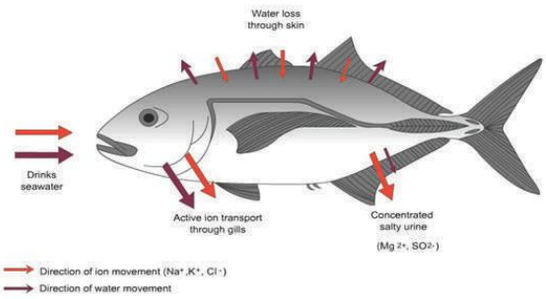
Stress increases the permeability of surface epithelial(e.g-gill) to water and ions. This leads to the higher circulation of catecholamine levels as well as structural damage to gill and skin as they are the main site of damage.

Due to stress the level of cortisol increases then it combines with the glucocorticoid and mineralocorticoid action, as cortisol is essential for the restoration of hydromineral homeostasis, in concern with hormones such as prolactin (in freshwater fish) and growth hormone (in seawater fishes).

SALINITY STRESS: -

- Salinity is a physicochemical property of water which represents a measure of the content of dissolved ionized salt.

Movement of water and ions in saltwater fish



- It influences thermodynamic properties of water (e.g.-density, heat capacity, solvent capacity for solids and gases).

Highlight Points

- **Now a day there is increasing the number of the industries. The drainage from the industry which increase the pH of the water mainly increases the alkalinity; but fishes require a particular pH 6.5-8.5. If increases more 11 than they will not survive.**
- **The use of pesticides in the agriculture field, which after the rain come to the nearest water bodies and changes the water pH.**
- **The salinity stress mainly found in the migratory fishes, it may be anadromous (sea to fresh water) or catadromous (fresh water to marine) fish. As they travel in the different salinities area. There is salt imbalance in their body.**

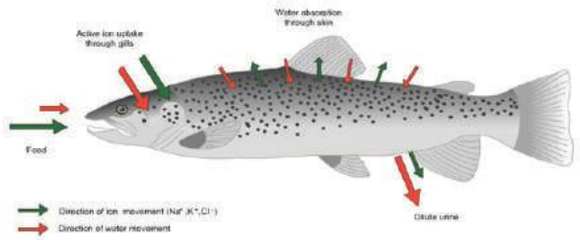
During the time of migration, the salinity stress is more as there is a change in ions concentrations which also changes their physiological activities from the normal fishes. They adapt to this situation by changing some physiology of body processes.

The salinity changes their biochemical processes both inside and outside the cell due to an imbalance in the ions uptake. The salinity of seawater is more than the body fluid of fish. So, the ions move continuously to the fish and water comes out from the fish body. They have to drink water continuously to maintain their body fluid osmolality.

In freshwater fishes, the salinity of fish is more than comparing to the surrounding environment. So, the movements of ions occur from fish to the surrounding environment. The skin has low permeability to water and salt ions; hence very little water is allowed to enter the body or salt to diffuse out through it. To counter the continuous inflow of water through gills, freshwater fishes produce a large amount of dilute urine.

EFFECTS OF STRESS ON OSMOTIC AND IONIC REGULATION: -

Movement of water and ions in freshwater fish



Changes in osmoregulatory mechanisms may not occur immediately in response to a stress and could take many hours, or even years to develop. Similarly, removal of the stress does not mean a rapid return to the normal condition. The immediate response shown by the fish upon transfer to hyperosmotic media are likely to have a subsequent effect on the rest survival and adaptation. There are mainly two categories of stress-

1. Freshwater to seawater transfer
2. Seawater to fresh water transfer

1. Freshwater to seawater transfer: -

When a freshwater fish is a transfer to seawater there is an increase in the drinking rate. In rainbow trout when transferred to seawater increase in drinking rate. Other changes in the rainbow trout seen during this first few hours are dehydration of the whole-body results in weight loss.

During their first 8hr after direct transfer from fresh water to two-thirds sea water, juvenile rainbow trout show significant increases in the Na+ and Cl- concentrationsof the blood plasma, whole body, and muscle tissues. Chloride is most penetrating ions so more amount of chloride ions found in the intracellular compartments. Transfer to sea water is accompanied by a sharp decrease in both the glomerular filtration rate and urine flow. It is reported a decrease in the urine production of rainbow trout

2. Sea water to fresh water transfer: -

When a fish transfer from seawater to fresh water accomplished by a marked reduction in both Na+ and Cl- effluxes. The stenohaline marine fish, Holocanthusciliaris, is able to survive many weeks in fresh water provided that the environment calcium concentration is increased.

PH STRESS: -

Commonly, pH shock occurs when a fish is transferred from one tank to another tank. Their body is very sensitive to the change in pH. Aquatic life is unable to adjust to the sudden change and is unable to maintain acid-base and ion regulation and ammonia excretion. Sudden pH change causes acute stress but if the pH remains for the long term it causes chronic stress.pH values Greater than 10 and lower than 4.5 are unsuitable for most of theaquatic organisms.

Physiological changes due to pH stress: -

- Reproductive failure occurs due to acid stress which is indirectly related to an upset in calcium metabolism and to faulty deposition of protein in developing oocytes. It appears that the 'no effect' in reproduction occurs at the level of pH around 6.5. (Fromm,1979).
- If the acidity of water increases coagulation of gills occurs and mucus formation occurs. This leads to hypoxia.
- Acid stress causes an imbalance of electrolyte homeostasis by decreasing its number.
- When fish are subjected to acid stress blood pH decreases possibly as the result of a flux of H+ ions across gill membranes into the blood. This could change trans-epithelial potential.
- Acidaemia may occur due to the decrease in the excretion of metabolically produced H+ ions and CO_2.
- When pH drops and the capacity of haemoglobin to transport oxygen is decreased. This is called Bohr effect.

Effect on haemoglobin-

Acids liberate protons which shift the oxygen equilibrium curve to the right, toward lower affinity and make the curve more sigmoid. Thus, the cooperativity of oxygen towards haemoglobin decreases, which allows more binding of carbon dioxide with haemoglobin.

CONCLUSION-

Fishes live in an aquatic environment which is a very dynamic environment because of its fluctuation in the water quality parameters. So, stress is a common problem. Our aim must be to reduce the stress in the fish which hamper the fish production. A number of nutraceuticals are developed now a day, which can be used to reduce the stress in fish. It is very difficult to reduce the stress fully, but we can reduce some extent.

NOTES: -

- The salinity stress mainly found in the migratory fishes.
- The pH of the water changes due to the drainage from the different industries.
- The use of the chemicals in the agriculture field which are creating most dangerous environment for the aquatic animals.

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Shrimp Toilet: A novel way for disposal of organic waste in Aquaculture systems

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INTRODUCTION

Global aquaculture production doubled during the last decade, making it one of the fastest growing food production sectors in the world. According to the FAO, aquaculture provides 47% (51 million tons) of the global human fish consumption. In order to keep up with population growth and increasing per capita fish consumption, aquaculture output is set to increase by a further 60–100% over the next 20–30 years. As to achieve the greater level of production the aquaculture systems are now intensified and ponds are the most commonly used aquaculture production system accounting for about 40% of the world production. A vast majority of the farmed freshwater fishes and nearly all farmed crustaceans are cultured in ponds as super-intensive or intensive or semi-intensive aquaculture systems. Intensification of ponds allows accumulation of organic matter during the culture cycle due to the administration of high levels of external inputs (mainly formulated feed and fertilizers). The organic waste material (excretory products) from the target culture organisms is also a considerable source of lodging of organic debris. Uneaten feed and feed derived metabolites accumulate in the sediment where they are decomposed under aerobic or anaerobic conditions. But excess lodging leads to malfunctioning of the decomposition cycle in the pond bottom. Aquaculture ponds are dynamic and complex ecosystems, which will only produce the targeted cultivable production if nutrient cycling and waste decomposition are properly managed.

A number of physical, chemical and biological methods used in treating this kind of problem, management practices influencing the load and decomposition rates in ponds include water exchange, sediment removal, aeration, fallowing period between crop cycles, liming etc. In recent time there is a noble concept of shrimp toilet or central drain applied by aquaculturists

SHRIMP TOILETS

The sludge formation at the pond bottom is the prime cause of the evolution of many infections in shrimp farming. The recent occurrences of severe diseases and downfall in aquaculture production are an excellent example where improper handling of organic waste material may lead to a catastrophic result. The excess feed and the fecal matter released by aquatic organisms ultimately reaches to the center of the pond where most anaerobic conditions exist leading to the formation of ammonia and hydrogen sulphide simultaneously leading to the stress on the animal. This stress gives chance to many opportunistic pathogens for early and easy infection. To avoid this kind of problems farmers in South-east Asian countries, Bangladesh and in India especially in Andhra Pradesh and West Bengal, are showing interest in establishing shrimp pits or shrimp toilets or central drain at the center of the culture pond. For this purpose, they are utilizing about 5- 7% of the total surface area of pond. Ideally, the pond size should be about 1000-5000 m2 for the establishment of shrimp toilet. Establishments include 7-10 feet concrete cement with a smooth slope to the center where there will be a small well of about 2-3 feet depth. Smooth and slope surface (25-300) at center allows fast movement of waste toward the central pit with the additional advantage of lesser requirement of water with concentrated organic waste removal. By the continuous movement of water by intensive aeration all the waste materials will be dragged in to well. This waste can be removed using a siphoning motor or submersible or floating pump (power of about 2 hp) for every week so that there will not be any sludge. Natural gravitational force can also be used for draining the organic waste like in central drain.

In the recent time, there is an addition to shrimp toilet concept is an HDPE and rubber parabola cover (2.5 meters in diameter), placed over the central drain of a pond. The purpose of the keeping parabola is to extend the area of sludge removal. They were kept about 2-3 feet above the pond bottom which allows creation an extra suction force and also preventing some unnecessary losses of target organism through the central drain. Establishment of a parabola in the pond may lead to limited use of manual siphoning.

Scientifically, about 500 gm of organic waste is produced in the production of 1 kg of shrimp. For the production target of 7 tonnes/ hac with the stocking density

Highlight Points

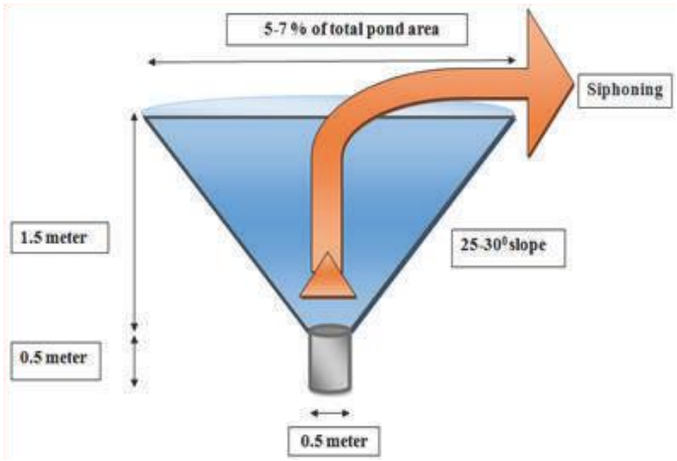
- **Intensification of aquaculture systems brings problems like accumulation of organic wastes within the systems**
- **Organic wastes invites the various infectious and non-infectious diseases**
- **Shrimp toilet seems as an alternate option as cheap, eco-friendly and sustainable option to overcome the loading of waste material problems.**

of 30 pieces/ m2 farmers can accumulate a minimum of 3.5 tonnes of sludge which must be disposed off in an eco-friendly manner. The concentrated sludge if released into the nature untreated has the capability to trigger pathogen which could cause mass mortality in short period of time. Concentrated sludge should not be released directly into the natural resources and instead allowed to settled, treated and then be disposed. The farmer should demarcate 5% of the total culture area as a sludge pit to accumulate the sludge while farming and then dispose it to a safer area after the completion of the culture phase. There should also be a proper design for the pit to facilitate an eco-friendly way for the sludge disposal. Moreover, properly treated sludge could also be used as organic manure for agriculture. This would be beneficial to the agricultural farmers for their farmlands in the surrounding areas.

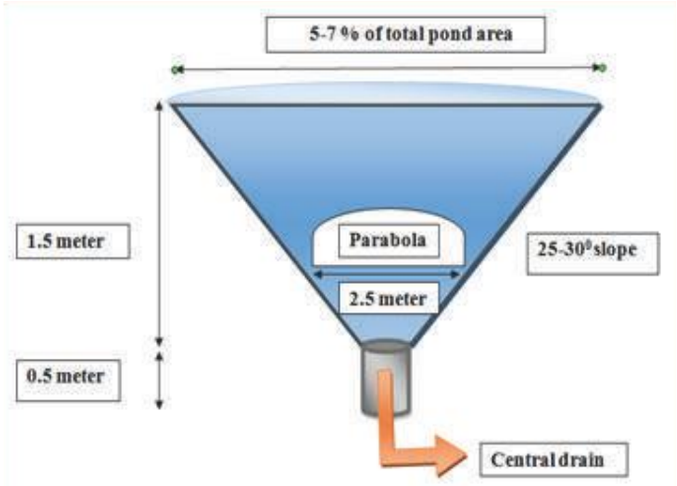
Aquaculture pond with intensive aeration (circular movement)

Dried pond with cental drain at bottom

Central pit of shrimp toilet



Working principle of shrimp toilet



Working principle of central drain

HDPE parabola

Advantages of shrimp pits:

1. Reduces the chance of infections/ infestation- Early mortality syndrome (EMS) or Acute Hepatopancreatic Necrosis Disease (AHPND), Enterocytozoon Hepatopenaei (EHP), White Fecal Disease (WFD), White Muscle Disease (WMD) etc.
2. Animals will be stress-free
3. Avoids usage of chemical at high doses
4. Ammonia and Hydrogen sulphide formation will be very less
5. Controlled/ Improved FCR
6. Pollution free aquatic environment etc

Nanotechnology in Fisheries and Aquaculture

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Introduction

The term "nanotechnology" was created by Professor Norio Taniguchi of Tokyo Science University in 1974 to describe precision manufacturing of materials at the nanometer level, but its origins date back to Rchard Feynman's 1959. Nanoparticles (NPs) are groups of atoms in the size range of 1-100 nm. "Nano" is a Greek word synonymous to dwarf that mean extremely small and used to indicate one billionth of a meter or 1x10-9. On the other hand more elaborately it may be defined as "the design, characterization, creation and application functional materials, devices, and systems through control of matter at the nanometer scale (1-100 nanometers) that is at the atomic and molecular levels and the exploitation of novel phenomenon and properties of matter at that scale". There are several applications of nanotechnology for aquaculture production that are being developed. With a strong history of adopting new technologies, the highly integrated fish farming industry may be among the best to incorporate and commercialize nanotech products.

The different types of nanomaterials like copper, zinc, titanium, magnesium, gold, alginate and silver are available. Among these silver nanoparticles have proved to be most effective having good antimicrobial efficacy against bacteria (Rai et al., 2009). Due to their large surface area to volume ratio, the metallic nanoparticles show good antimicrobial properties that help in the study of growing microbial resistance against metal ions, antibiotics and the development of resistance strains (Mishra et al., 2017).

Nanotechnology in Aquaculture and Fisheries

The fisheries and aquaculture industry can be revolutionized by using nanotechnology with new tools like rapid disease detection, target delivery of drugs, DNA vaccines and nutrients. As per National Science Foundation (USA), the value of the global nanotechnology industry at USD was one trillion in 2015. This is possible due to vast potential of nanotechnology not only in electronic and materials science but also in humans, animal food and agriculture sectors including aquaculture. The application of nanotechnology in biomedical and biological sciences for analysis of biomolecules, cancer therapy, development of non-viral vectors for gene therapy, as transport vehicle for DNA, protein and cells has already received much attention from the scientific fraternities. Although much research and development are needed to enhance the potential use of nanotechnology in aquaculture; there are numerous application of this technology in future i.e. fish health management, water treatment in aquaculture, animal breeding, harvest and postharvest technology.

Fish/Shellfish Health Management and Nano-Vaccines:

Outbreak of disease is one of the major stumbling blocks in the development and sustainability of aquaculture. Numbers of approaches have been applied in an attempt to solve disease problem in aquaculture and vaccination is one of them. But the use of oil emulsion as adjuvant may cause major drawbacks as some fishes and shellfishes show unacceptable levels of side effect. Thus using nanoparticles carrier like chitosan and poly-lactide co-glycolide acid (PLGA) (Rajeshkumar et al., 2009) of vaccine antigens together with mild inflammatory inducers, one may achieve high level of protection to fishes and shellfishes not only against bacterial diseases, but also from certain viral diseases with vaccine induced side effect. Further, the mass vaccination of fish can be done using nanocapsules containing nano-particles. These will be resistant to digestion and degradation. These nanocapsules contain short strand DNA are absorbed into fish cells, when applied to water. The ultrasound mechanism is used to break the capsules which in turn release the DNA thus eliciting an immune response to fish due to the vaccination. The recombinant DNA-chitosan nanoparticles showed effectiveness against white spot syndrome virus (WSSV) that providing protection in shrimp. Similarly, oral administration of these vaccine and site-specific release of the active agent for vaccination will reduce the cost and effort of disease management, application of drug and vaccine delivery leading to sustainable aquaculture.

Nanoparticles have been used as oral drug carriers for several reasons such as improvement of the bioavailability of drugs with poor absorption characteristics, prolongation of the residence time and digestive stabilization of drugs in the intestine, high dispersion at the molecular level and consequently efficient absorption, delivery of vaccine antigens to gut-associated lymphoid tissue and control of the release of the drugs.

Nanoparticles for Enhancement of Fish Growth

Scientists from the Russian Academy of Sciences have reported that young carp and sturgeon exhibited a faster rate of growth (30% and 24% respectively) when they were fed nanoparticles of iron. Research had demonstrated that different Selenium sources (nano-Se and selenomethionine)

Highlight Points

Nanotechnologies are being spoken of as the driving force behind a new industrial revolution in both private and public-sector. It has widespread applications as an enabling technology in various industries. In aquaculture point of view production of more effective fish feed, improving of the physical, chemical and nutritional quality of feed and their respective ingredients, rapid disease diagnosis kits by application of Nanotechnology.

supplemented in basal diet could improve the final weight, relative gain rate, antioxidant status as well as glutathione Peroxidase (GSH-Px) activities and muscle Selenium concentration of crucian carp (Carassius auratus gibelio). Moreover, nano-Se appeared to be more effective than that of organic selenomethionine in increasing muscle selenium content (Zhou et al., 2009).

Nanodelivery of Nutraceuticals

Use of nutraceuticals for health management, value addition and stress mitigation in fish and shellfish is an emerging area of aquaculture research. In spite of their low requirement, incorporation of nutraceuticals involves higher cost. Thus, it needs to be used in such a way that wastage of feeding is minimized and there is efficient utilization of the nutrient. Development of nanodelivery system for these kinds of molecules may address the problems of their application in aquaculture practices at commercial level. There is an immense opportunity to use the nano deliver system of nutraceuticals in fish feed. Moreover, various nanoformulations of feed help to maintain better consistency and taste of feed (FOE, 2008).

Water treatment

Nano-enabled technologies are available today for the removal of contaminants from water. Nanomaterials in the form of activated materials like carbon or alumina, with additives like zeolite and iron containing compounds, can be used in aquaculture application for holding aerobic and anaerobic biofilm for the removal of ammonia, nitrites and nitrate contaminants.

Animal breeding

Management of breeding is an expensive and time consuming problem for culturing animals. One solution that is being studies is a nanotube implanted under the skin to provide real time measurement of changes in the level of estradiol in the blood. The nanotube are used as a means of tracking oestrus in animals (O' Connell et al., 2002) because these tubes have the capacity to bind and detect estradiol antibody at the time of oestrus by near infrared fluorescence. The signal from this sensor will be incorporated as a part of a central monitoring and control system to actuate breeding.

Transgenesis

Microinjection to deliver DNA into mammalian/fish cells is time-consuming and needs to be accurate, using micropipettes and micromanipulators to dispense very small volumes of material pass into the nucleus. Microinjection is the common method for genetic engineering (GE) and marking of GE animal and fish. A novel method of DNA delivery has been recently described by using array of vertically aligned carbon nanofibers (VACNFs) (McKnight et al., 2003). Cells are pressed into the DNA coated VACNFs which then penetrate the cells and introduce the DNA. VACNFs could help to overcome the tedious microinjection involved in genetic manipulation and the temporal expression of genes that are not introduced into inheritable genetic material of embryos but could affect them at crucial times. This temporary expression could improve the concerns that have accompanied GE livestock, including safety of GE animal food and products cross contamination of GE livestock with non-GE varieties and long term effects on animal health and welfare from introduced genes. The use of nanotechnology for DNA delivery could provide benefits to animal health and the safety of animal derived products. However, the safety of the silica nanoparticles and their effects on early embryo development post treatment warrant some investigation, although they have been shown to have little toxicity. Similar nanodelivery system may be attempted for DNA incorporation in fish and shellfish.

Tagging and Nano-Barcoding

Radio frequency ID (Rfid) chip with a radio circuit incorporating nanoscale component with an identification code embedded in it. These tags can hold more information, scanned from a distance and embedded in the product to identify any object anywhere automatically. These tags may be used as a tracking device as well as a device to monitor the metabolism, swimming pattern and feeding behaviour of fish. A nano-barcode is a monitoring device consisting of metallic stripes containing nanoparticles where variations in the striping provide the method of encoding information. By incorporating the nano-barcoding, processing industry and exporters can monitor the source or track the delivery status of their aquaproduct until it reaches the market. Further, coupled with nanosensors and synthetic DNA tagged with colour coded probes, nano-barcode device could detect pathogens and monitor temperature change, leakage etc., thus improving the product quality.

Harvest and Post-Harvest Technology

To catch fish, fishing lures are painted to reflect light to attract the attention of fish. However, these conventional lures reflect light only in one direction. To overcome this problem, the surface of the lure is colored and then nano-coated with a polyimide film which enhances the chance of catching fish 2 to 3 times compared to the case where a lure without a polyimide coating is used.

Devices for Aquatic Environment Management:

Nevada-based Altair Nanotechnologies makes a water-cleaning product for swimming pools and fishponds called "NanoCheck". It uses 40 nm particles of a lanthanum-based compound which absorbs phosphates from the water and prevents growth of algae. NanoCheck is currently undergoing large-scale testing in swimming pools. It also holds promise for its use in thousands of commercial fish farms worldwide where algae and heavy metals removal and prevention are costly at present.

Conclusion

Nanotechnology undoubtedly presents a major opportunity for the economy and sustainable development of aquatic resources in many countries although the application of nanotechnology for animal production is very diverse. But there is a growing concern for possible toxicity of nano particles in biological system. It may have the potential to solve most of the problems in aquaculture and fisheries with better technical innovation at different levels. Careful monitoring and controlled use can help us to maximize benefits and minimize risks.

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Use of Antibiotics in Sustainable Aquaculture - its Safety and Biological implications

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Recently there was shocking news in most of the newspapers. It was about the research study conducted by the National Institute of Oceanography (NIO) and their findings state that the water hitting the shores of Mumbai's most visited beaches contains bacteria that are resistant to more than 12 types of antibiotics. Even worse, the presence of bacteria in the samples was ten times the safe limit, a study has found. There may be many reasons for the cause of this contamination but the alarming signal it gives about the development and spread of antimicrobial resistance in water bodies and its entry into the human food chain.

The capacity of bacteria to adapt to changes in their environment and thus survive is called resistance. It is recognized that a major route of transmission of resistant microorganisms from animals to humans is through the food chain. Antibiotic resistance is a serious clinical and public health problem on a global basis. These uses of antibiotics can also create antibiotic resistance in non-pathogenic bacteria, the resistance genes of which can be transferred to disease-causing bacteria, resulting in antibiotic-resistant infections for humans.

Antibiotic resistance is widespread due in part to clinical overuse and misuse; however, the natural processes of horizontal gene transfer and mutation events that allow genetic exchange within microbial populations have been ongoing since ancient times. By their nature, aquaculture systems contain high numbers of diverse bacteria, which exist in combination with the current and past use of antibiotics, probiotics, prebiotics, and other treatment regimen either alone or in combination. These systems have been designated as "genetic hotspots" for gene transfer.

With the increase in human population, there is an increasing demand for aquaculture to meet the supply of safe, reliable, and economic food rich in proteins. Therefore it is essential that we identify the sources and sinks of antimicrobial resistance, and monitor and analyse the transfer of antimicrobial resistance between the microbial community, the environment, and the farmed product, in order to better understand the implications to human and environmental health.

Antibiotics are drugs of natural or synthetic origin and are used as chemotherapeutic agents in the treatment of infectious diseases of humans, animals and plants. In aquaculture, antibiotics have been used mainly for therapeutic purposes and also as prophylactic agents. Following the discovery of the growth promoting and disease fighting capabilities of antibiotics, fish farmers and livestock producers began using such drugs in animal feeds.

The indiscriminate use of antibiotics has increasingly become a matter of public concern. In the aquaculture farming, the widespread use of antibiotics for treating bacterial diseases has been associated with development of antibiotic resistance in Aeromonas hydrophila, A. salmonicida, Edwardsiella tarda, E. icttaluri, Vibrio anguillarum, V. salmonicida, Pasteurella piscida and Yersinia ruckeri. Very little is actually known about the effects of antibiotic use on the surrounding marine environment. However, studies conducted to date indicate it may carry ecological risks. It was reported that high concentrations of oxytetracycline and florfenicol, both active against furunculosis in salmon, inhibit growth of the wild alga Tetraselmis chuii, an important food source for other marine organisms. With the explosive growth in production and demand for farmed seafood, the question is raised - how can the aquaculture industry lead the charge for responsible use of antibiotics without compromising food safety, the environment and human health, as well as animal health, welfare and productivity?

In the past, antibiotics were used much more liberally in aquaculture. In response to growing awareness of possible ecological and human health risks and stricter regulations on their use, they are now generally used as a last resort. Improvements in farming practices have led to improved animal health and have reduced the need for antibiotics. Recognition of antibiotics' overuse, which can lead to drug resistance of fish diseases, as well as their cost has further incentivised improved farming practices as a solution to disease management. The development and use of vaccines is also a key factor in reducing the need for antibiotics.

An outcome of these higher disease rates in intensive farming is a reliance on antibiotics and other supplements, especially in countries where regulatory limits may not be clearly defined or monitored closely. Antimicrobial use in aquaculture is governed by a variety of factors including

Highlight Points

- **Recently it was observed by National Institute of Oceanography (NIO) that the water hitting the shores of Mumbai's most visited beaches contains bacteria that are resistant to more than 12 types of antibiotics.**
- **Indiscriminate use of antibiotics in aquaculture is a matter of concern. Recognition of antibiotics' overuse, which can lead to drug resistance of fish diseases, as well as their cost has further improved farming practices as a solution to disease management.**

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legislation and regulation by the respective government organization, the particular pathogen present (and its antimicrobial sensitivities), the treatment timing, the disease status of the host, and the system parameters (salinity, temperature, photoperiod, etc.). However, in general, the use of antibiotics in aquaculture depends on local regulations, which vary widely. In some countries (specifically Europe, North America, and Japan), regulations on the use of antibiotics are strict and only a few antibiotics are licensed for use in aquaculture. In Europe, for example, the practice of non-therapeutic prophylactic use of antibiotics was banned in 2001 by the EU Veterinary Medicinal Products Directive, as amended and codified in Directive 2001/82/EC. In Norway, stricter regulatory oversight of antimicrobial use, combined with increased vaccinations and excellent stewardship has been credited, in part, for a 99% fall in antimicrobial use between 1987 and 2013, despite output growing more than 20-fold . However, 90% of the world aquaculture production is carried out in developing countries, which lack regulations and enforcement on the use of antibiotics, leading to high variability in antibiotic use.

The genetic plasticity of the microbial community enables resistance genes to move quickly throughout different environmental bacterial populations and communities. It has been estimated that 90% of bacteria originating in seawater are resistant to one or more antibiotics and up to 20% of the bacteria are resistant to at least five. Once bacteria have acquired resistance genes, they may exist in the environment for a long time, even after the selection pressure ceases. The prolonged use of antibiotics in aquaculture increases the selective pressure on bacterial populations, even at concentrations of antibiotics well below the minimum inhibitory concentration of the susceptible wild type population, and also increases resistance gene transfer rates, including human and fish pathogens.

Due to antibiotics being relatively stable and non-biodegradable, residual antibiotics can remain in commercialised fish and shellfish for consumption. In addition to the use of antibiotics, other pharmaceuticals and metal-containing products are often used in aquaculture to prevent fouling, and to feed and treat fish, in order to limit the spread of infections. Therefore, the exposure of bacterial communities in and around aquaculture operations to the combination of heavy metals, antibiotics, and other co-selecting factors may further increase the likelihood of selection and co-selection of antibiotic resistance.

Not only can residues of antimicrobials remain in fish products, but undigested food and fish faeces containing unabsorbed antimicrobials and secreted antimicrobial metabolites can remain in the water and sediment around fish farms for an extensive period of time, depending on their concentrations and biodegradability

Probiotics are microbes or substances that improve intestinal balance of a host animal. It is considered as a live microorganisms which, when administered in adequate amounts, confer a health benefit on the host. The first application of probiotics in aquaculture, using Bacillus toyoi spores as an additive in feed for yellowtail. The high doses of bacteria often added daily, could cause major shifts in the microbial community present, possibly leading to an excess of AMR species within the aquaculture system. The antibacterial effect exhibited by probiotics is due to a variety of factors including the production of antibiotics, iron-scavenging siderophores, enzymes (e.g., proteases, amylases, and lysozyme), hydrogen peroxide, organic acids (which in mammals may alter the host's intestinal pH), and bacteriocins. Bacteriocins are proteinaceous toxins produced by a wide range of bacteria and archaea and have a number of properties similar to antimicrobials that make them ideal candidates for pathogen control. Probiotics may offer alternatives to antimicrobial compounds, however, microbes used as probiotics are not exempt from acquiring antibiotic resistance genes. Given their shared microbial environment in the gastrointestinal tract, there is a risk of probiotic microbes acquiring antibiotic resistance genes from pathogenic microbes, and vice versa. It was reported the presence of several antibiotic resistance genes in lactic acid bacteria of aquatic animal origin that were intended for use as probiotics in aquaculture.

A consistent approach to antimicrobial resistance control and food safety is required in order to reduce the threat of worldwide resistance. Although considerable studies have been performed in other intensive food production areas such as pig and poultry farming, there is currently a lack of extensive studies in aquaculture systems.

Since the use of antibiotics for disease inhibition and as growth promoters have been prohibited in Europe and regulated in other countries, alternative strategies have been used to alleviate pathogen activity that includes vaccination ; immune stimulation using eco-based nutritional factors derived from plant, bacterial, algae, or animal sources; phage therapy ; and quorum sensing disruption (affecting virulence). In addition, the disinfection of system water may be managed with UV application or, as is often the case for intensive systems, via ozone treatment. These alternative strategies combined with a better understanding of the effects on the microbiome of the farmed host may provide alternative solutions to improve aquaculture health and function, while reducing the potential for the spread of antimicrobial resistance.

Biofloc technology could also help in reducing the antibiotic usage, which is mainly based on the principle of waste nutrients recycling, in particular nitrogen, into microbial biomass that can be used in situ by the cultured animals or be harvested and processed into feed ingredients. Heterotrophic microbiota is stimulated to grow by steering the C/N ratio in the water through the modification of the carbohydrate content in the feed or by the addition of an external carbon source in the water, so that the bacteria can assimilate the waste ammonium for new biomass production. While maintaining ammonia at a low and non-toxic concentration, the water quality improves. The microbial biomass flocs then become important part of food chain and also impart disease protection.

Another market-based approach to address these issues is provided by farm level certification schemes that address antibiotic use within their frameworks for responsible aquaculture. It aims at raising awareness within the aquatic veterinary community about "the use of medically important antimicrobial drugs in food-animal production, and the public health risks associated with antibiotic resistance."

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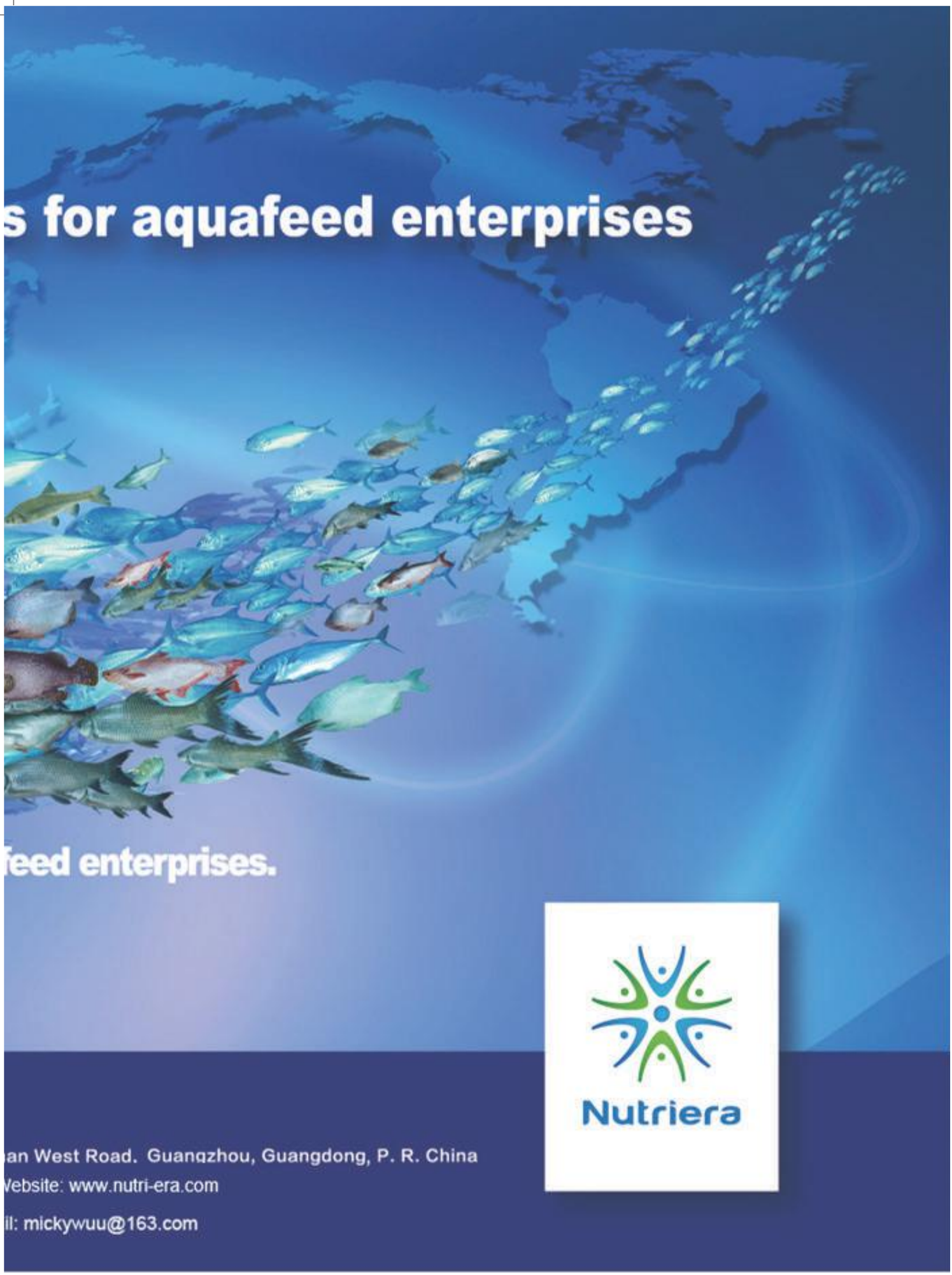

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