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Inside...





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# *Have we achieved basic facilities in our 70 years Independence?*

**Dear Readers,**

The March 2019 issue of *Aqua International* is in your hands. I want to share with you a different topic this month.

Although India completed 70 years of its Independence, the people at Rural and Urban areas of the country are still suffering due to lack of basic infrastructure facilities like good roads with drainage system, pure drinking water, electricity / availability with proper street lights and adequate greenery around. Politicians in ruling the government are always showing interest to take up big big projects perhaps to make through commission from the projects leaving the basic responsibility of providing infrastructure facilities to the people.

The citizens seem to be VIPs to the politicians only during the election time. Once their need of votes is over, they do not care the citizens till the next elections after 5 years. Now in April and May, we have elections for the parliament and some state assemblies in the country. People should choose and vote for the candidates who can work sincerely to provide the above mentioned basic infrastructure facilities in their respective constituencies.

Once infrastructure facilities are developed, people of this nation can develop themselves without much depending on the government and the politicians. I give a simple example of farmers and the stakeholders of poultry and aquaculture sectors in India, --- they developed on their own without much contribution from the government at state and central level. It is the stakeholders of these industries who made these two sectors grow and prosper, and providing employment to lacks of people and nutrition to crores of people in the country.

Government should make investigating agencies effective and take care the borders of the country and eradicate terrorism and unlawful things in the society.

India is a secular country and the rulers should be impartial to the people irrespective of the religion and region of the nation.

The popular leaders like Indira Gandhi, NTR etc failed at times and got defeated in elections as they failed to perform well after coming into power at the government. Although Narendra Modi came into power with huge majority in 2014 as the Prime Minister of India, he is slowly losing popularity due to his own attitude at times and due to his inability in protecting the secular structure of the country. Though he did good at international level and many welfare schemes in India, it is the responsibility of the Prime Minister of the country to ensure peace and supportive to all states and people. The people of different religions, castes, creed, sex and different background should be able to live together in the society with love and peace amongst them. Communal intolerance and hatred are increasing in India in an organised manner which is dangerous to the nation. We need the Administrators from top to bottom such as Prime Minister, Chief Minister, District Collector and Panchayat President to be good hearted, otherwise people cannot live in peace and happiness.

I was not born when the greatest human being Mahatma Gandhi (who brought us Independence) was alive, I saw Mother Teresa, Dr A.P.J. Abdul Kalam, Barack Obama and Atal Bihari Vajpayee and a few others to have done good to the society and Mahatma Gandhi and these leaders lived with values and worked for the well being of all the people.

People should elect good representatives as MPs and MLAs who can take care of the people and the nation in a peaceful and progressive manner. We have to fairly think and act to make good foundation for our children and future generations to live in discipline and with progress and happiness.

Best principle for any leader is to try and do good to the people irrespective of caste, religion and region — and such leaders will remain forever in the hearts of the people, and the God will like them.

No need to remind — Every citizen of India will have love and respect for his / her nation.

M.A.Nazeer
Editor & Publisher
Aqua International

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### *Our Mission*

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

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

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

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

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

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# Workshop held in West Bengal on Fish Nutrition and Feeding Management in Aquaculture

*Dignitaries in inaugural session*

**West Bengal:** A two-day Workshop on Fish Nutrition and Feeding Management in Aquaculture for Sustainable Development was organized by Fisheries Research and Training Centre (FRTC), Department of Zoology (DZ), University of North Bengal (NBU),

WB. The Keynote lecture was given by Prof. A. K. Ray, Retd. Professor of Fish Nutrition, DZ, Viswa-Bharati University on 'Fish feeds: formulation and role in sustained aquaculture development'. He discussed about application of semi-decomposed mustard oil cake (MOC) and poultry droppings in fish pond as sources of N2; oilcakes as alternative protein sources; emphasis on ingredient quality (chemical analyses) and nutritional requirements in feed (nutrient balance) in preparation of on-farm fish feed and diet formulation; non-utilization of excessive amount of protein in feed; durability, acceptability, water stability and safety aspects of feed; different forms of diet like live food, forage materials (for grass carp) and prepared diets; objectives of diet formulation and preparation; pelletized feed for different life stages of fish; anti-nutritional factors (ANFs) and proteolytic enzyme inhibitors in feed ingredients; technical and economic considerations for feed formulation and practical diet; absence of methionine and cysteine in plant ingredients and are supplemented externally; presence of trypsin inhibitors in raw soyabean seeds; aflatoxin contaminant in GNOC; richness of lysine in Azolla; nutrient requirements (recommended values) for major carps; ingredient evaluation and compositional analysis (palatability, digestibility, functionality test, feeding trials); processing techniques (germination, soaking in water, heat treatment) to eliminate ANFs; feeding rate, methods and frequency of feeding.

According to Prof. Ray, feed ingredients must be available in sufficient amount throughout the year, should have high nutrient content, low level of fibre and starch, good amount of essential amino acids, high nutrient digestibility, high bioavailability of nutrients, should contain permissible limit of ANFs and be cost-effective. Factors that limit higher incorporation of plant ingredients are low protein content, amino acid imbalance and presence of ANFs. Sesame oil cake and GNOC in combination can substitute animal protein like fish meal and meat meal in feed. Dr B. N. Paul, Principal Scientist, ICAR-CIFA Rahara Centre spoke on 'Fish feed ingredients

*Participant mixing the ingredients*

*Feed prepared by participants*

and farm-made feed in aquaculture'. He discussed on nutrient composition and merits of different oil cakes, soyabean and fish meal as feed ingredients; carrying capacity of pond; higher protein requirement in early stages of fish; ascorbic acid and tocopherol resists lipid peroxidation in marine fishes; oxygenation of pond water by simple means before application of fish feed and its quick consumption; feeding @ 0.5% of body weight daily during winter in grow-out carp culture. Dr Paul finally highlighted results of demonstration on farm-made fish feed (using locally-available ingredients) conducted at ponds of Samaj Sevak Siksha Mandir and Shilpa Mandir campus at Belur Math, WB.

Dr S. Barat, Retd. Professor of Limnology and Aquaculture, DZ, NBU spoke on 'Fish and its nutrient for sustainability'. He discussed in detail on main water quality parameters for congenial environment in fish ponds; natural live food products for edible and ornamental fishes; artificial, formulated and processed fish feeds; techniques

*Participants preparing feed using pelletizer*

adopted for preparation of natural and formulated feeds; methodology of culture of Paramecium sp, zooplankton Daphnia sp and Moina sp. Dr K. Ghosh, Professor of Fish Nutrition, DZ, Burdwan University spoke on 'Solid state fermentation (SSF) as a function to improve nutrient value of plant feedstuffs'. He discussed about tannins and phytates in oilseeds and plant-based ingredients; condensed and biologically-active hydrolysable tannin that cause precipitation of proteins; enzyme inhibitory effects of tannin in normal and advanced fingerlings;

*Dr B. N. Paul in demonstration class*

presence of tannin-degrading microorganisms that produce tannase in gut of different fishes; SSF enhances digestibility by improving bioavailability of nutrients and reducing ANFs; reduction in tannin level after decomposing Pistia leaf and GNOC; microbial synthesis in SSF cause increase in levels of important amino acids in plant ingredients; functioning of hand and motorized pelletizer; preparation of extruded-cum-floating pelleted feed; degradation of trypsin inhibitors; features of extruded fish feed and processes in a large-scale feed production plant/feed mill.

Dr Ghosh further spoke about utility of decomposed MOC in fish pond; use of Pistia sp and green aquatic weeds as sources of carbohydrate in feed; use of check tray feeding in pond while broadcasting fish feed; decrease and increase in availability of rice bran and DORB respectively in present day markets; formation of Fish Production Group and setting up of fish feed mill in rural areas; indiscriminate use of antibiotics in feed must be stopped; fingerlings produced at the beginning of culture season must be used for production of brood fishes for next season; effect of residue of antibiotics upon probiotics and efficacy of latter is hampered; probiotics in fish feed (10000000 units/100gm feed) inhibit growth of pathogenic bacteria Aeromonas sp, Pseudomonas sp, Klebsiella sp and helps in fish digestion; use of hatched-out Artemia and chopped tubifex as larval feed of indigenous Magur during 3rd to 8th day; non-acceptability of formulated feed from 8th day; experiments on addition of molluscan meat (mussel meal 10%) as attractant and egg custard in feed (mixture of hydrolysed fish meal, soyabean meal, wheat flour and GNOC) that gave more than 70% larval survivability; shifting of Magur advanced larvae/fry to formulated feed later on.

Dr G. H. Pailan, Principal Scientist, ICAR-CIFE Kolkata Centre spoke on 'Formulation of artificial feed for freshwater ornamental fishes'. He discussed about ornamental fish genetic resource in India; presence of dietary essential linoleic acid and linolenic acid in linseed oil; 8% and 3% lipid essential in diet for cultivable carnivorous fishes and herbivorous fishes respectively; maize, wheat, rice or their by-products as carbohydrate source; 20-25% energy source for carnivorous fishes; Spirulina and astaxanthin as source of carotenoids and 2-3% added in ornamental fish feed; pumpkin, carrot, beet, marigold and rose petals as carotenoid source; grinded shrimp head as source of carotenoids and feed attractant; pellet drying upto less than 10% moisture content to avoid fungal contamination; successive steps involved in feed preparation, like selection of ingredients, grinding, mixing, dough preparation, cooking, cooling, mixing of Vit.-Min premix, pelleting, crumbling, pellet drying and storage.


*Fish nutrition experts*

An intensive hands-on training and demonstration on preparation of pelleted fish feed by hand pelletizer was arranged at FRTC, NBU under the guidance of fish nutrition experts Dr Paul, Dr Ghosh, Dr Pailan and Prof. Ray. Participants were introduced with different feed ingredients (oil cakes and its powdered form, expeller MOC, by-product of pulses, oils, ghee residue and others) kept displayed, which are sources of fat, essential amino acids, carbohydrate, essential fatty acids. All of the theoretical aspects were demonstrated with many practical examples. Importance of finely-powdered ingredients in pellet preparation, rice polish as gold mine, use of linseed oil in absence of cod liver oil, use of different protein sources and balance of dietary essential amino acids in feed, were discussed. Experts suggested a catfish larval feed (with 46% protein) comprising a mixture of fish meal 45%, wheat flour 5%, GNOC 15%, soyabean meal 15%, rice polish 10%, Vit-Mineral mix 2% and six percent cod liver oil 8%. Participants were guided for preparation of sample pelleted feed for major carps, comprising lentil flour by-product, maize powder, rice bran, MOC, soyabean meal, ghee residue, Vit-Min mix, linseed sludge and vegetable oil. In this programme, participants included 28 progressive fish farmers and fish breeders from five districts of north Bengal, who could accumulate state-of-the-art knowledge in fish nutrition and practical experience in fish feed preparation. News communicator Subrato Ghosh also participated in this programme.

# Demonstration and Transfer of Rural Technology at Balek, Lower Dibang Valley, Arunachal Pradesh


*Inaugural session in progress*

Central Institute of Fisheries Technology (ICAR), Cochin in collaboration with Krishi Vigyan Kendra, Balek, Lower Dibang Valley, Arunachal Pradesh organized Demonstration of Smoke

*Explaining the COFISKI to the Chief Guest*

Curing Fish in Hygienic Conditions and distributed 15 Community Fish Smoking Kilns (COFISKI) Units. The programme as part of CSR Scheme of Coal India Project "Community Fish Smoking Kilns for better health, hygiene, quality product with longer shelf life, sustainable income generation and lesser carbon foot print for hinterland women fishers belonging to economically under-privileged SC and ST groups" was organized at KVK, Balek recently. Dr M.M. Prasad, Principal Investigator of the Project and HOD, MFB Division, CIFT and Dr T.J. Ramesha, Head, KVK, Balek appraised Ms Mitali Namchoom, IAS, Lower Debang Valley on the developmental programmes undertaken by CIFT in harvest and post harvest fisheries in Lower Debang Valley as a part of NEH programmes of Government of India.

Welcoming the gathering, Dr J. Ramesha praised the efforts of the Scientists of ICAR-CIFT who created awareness on the post harvest fisheries and different value added product development. Felicitation were offered by Mr Jatan Pulu, a progressive farmer who appreciated the progress made by women fishers of Lower Debang Valley with the help of CIFT. He also advised women to make sure to work in union for development of Arunachal Pradesh. Ms Oimang Lego of Jiya Village who set an example of success story narrated her experience of journey of success and encouraged the women of Lower Debang Valley to become role models of the country. Delivering the Presidential Address Dr M.M. Prasad said that the team work and toil of women fishers of Lower Dibang Valley is paying dividends in the form of success stories. He said women of Arunachal Pradesh in particular and NE Region states in general are leading in different walks of life. The same thing resulted in the women-centric projects such as Coal India Limited CSR scheme. The Chief Guest of the function Mr Tapik Pertin, ADC, Roing said that CIFT needs all appreciations for the support provided to women fishers of Lower Dibang Valley and opined that women fishers are becoming trainers and are able to train other fisherwoman resulting in better development of the fisheries sector. Later certificates were also issued

*Distribution of COFISKI and kits*

to the beneficiaries when the 15 nos. of COFISKI units worth 8 lakh rupees along with kits to handle smoke cured fish were distributed.

*Demonstration of hygiene and its importance*

The programme came to an end with a vote of thanks by Mr Jimmy Mize (SMS specialist of KVK). More than 70 fishers participated in the function.


*Beneficiaries and resource persons*

# Govt decides to start piloting vannamei shrimp farming

The government has taken a decision to start farming vannamei variety of shrimp on a pilot basis and selected 10-20 acres of land in Cox's Bazar and Khulna districts in this regard.

Initially two entrepreneurs will get permission to launch the farming, before going for commercial production, officials said.

They said the Department of Fisheries (DoF) was formulating the guidelines in this regard while a sub-committee will be formed for feasibility study in Cox's Bazar and Khulna areas.

The DoF will make Standard Operating Procedure (SOP) to operate the hatcheries.

A technical committee on feasibility study and farming of vannamei shrimp at a recent meeting also suggested producing shrimp fry from imported Specific Pathogen Free (SPF) vannamei on a pilot basis side by side the production of vannamei.

The meeting was also told that the entrepreneurs will bear all costs related to production of vannamei and its fry.

Appreciating the latest move, the entrepreneurs argued that the government should provide proper technical supports, including leasing out the land free of cost, to encourage the pilot project.

Currently, the variety is a leading item in the world shrimp market. Because of its cheaper price, consumers prefer this item in Europe and USA, the key markets of frozen shrimp.

As a result, Bangladeshi black tiger species lost its competiveness in these markets.

Exporters said they incurred huge losses in the last five to seven years.

More than 75 per cent of the total world shrimp production is vannamei. Some 32 countries are culturing such category of shrimp.

Wishing anonymity, a senior official at the DoF said they are not against vannamei culture. Rather it should be launched as many countries are now producing the shrimp.

But it is needed to build necessary infrastructures and bio-security system, he said. "So it will take time to launch the project. We don't want to launch it without proper preparation."

He also said the DoF will provide necessary training to the entrepreneurs and an experts' committee will oversee the project. "So, there is no reason the farming will fail."

Bangladesh exports only 2.0 per cent of the international demand for frozen shrimp, according to the Bangladesh Shrimp and Fish Foundation (BSFF).

The country once boasted 110 frozen fish factories holding the second position among the total export-oriented sectors even a decade ago. But the number has come down to as low as 50 now.

Unavailability of exportable fish, especially shrimp, in the local market is the key reason behind this worst situation in the industry, insiders have said. >>

>> According to the Bangladesh Frozen Foods Exporters Association (BFFEA), some 96,265 tonnes of shrimp and fish were exported in fiscal year (FY) 2011-12. The export volume fell by 68,161 tonnes in FY 2016-17.

About 3.5 million people are involved in this sector

# Kerala State Warehousing Corporation gets technology backstopping from ICAR Institutes

*Exchanging the MOA with between ICAR-CIFT and KSWC*

ICAR-Central Institute of Fisheries Technology (ICAR-CIFT), Kochi along with ICAR-Indian Institute of Spices Research (ICAR-IISR), Kozhikode has joined hands with Kerala State Warehousing Corporation (KSWC) for establishing a temperature controlled storage facility at State Warehouse, Vandanmedu, Idukki, Kerala. A tri-partite agreement has been signed between the Institutes and KSWC. The Institutes shall be providing the design and development support to KSWC, for establishing the energy efficient storage facility for dried cardamom and vegetables at their godown at Vandanmedu. Technology backstopping shall be provided through training, and technical guidance to optimize the storage conditions of various produce. The facility is expected to be commissioned and made functional by the end of March 2019, and it shall reduce the quantity of waste, and lengthen the timeframe for marketing of the produce. A Quality Control Laboratory is also being set up along with the storage facility to ensure enhanced shelf life and superior quality of spices and vegetables. By establishing this scientifically advanced preservation system, KSWC is trying to avoid glut and post-harvest losses faced by the farmers and also to arrange easy credit and holding power to them, thereby enabling them to fetch better price for their products.

# CMFRI issues advisory as US ban on wild-caught shrimp hits exports

With export of Indian wild-caught shrimp to the United States being affected for the past seven months due to alleged non-compliance with the US regulations to protect sea turtles, the Central Marine Fisheries Research Institute (CMFRI) has issued an advisory urging the fishing regulators to make the use of turtle excluder devices (TED) mandatory on all trawl nets used by trawl vessels.

Though an expert team from the US Department of State was expected to visit Kerala in January, the visit was postponed in view of the US Government shut down. According to the Marine Products Export Development Authority (MPEDA), the export of wild-caught shrimp has been affected since July, 2018, due to the restrictions imposed by the US State Department. Wild-caught shrimp constitutes around 11 per cent of the Rs.1500-crore shrimp export to the US from India. "The team is expected to visit Kerala by February-end," said a senior officer.

The Department of State had certified 39 nations and one economy, and granted determinations for seven fisheries, as having adequate measures in place to protect sea turtles during commercial shrimp fishing. Only these countries are allowed to export shrimp to the US. However, India does not feature in the list of certified countries.

"The very low intensity of turtle nesting does not warrant the use of TEDs in trawls along the west coast of India. However, as a precautionary measure, trawl fishers may be advised to use them in their trawl nets with adequate state support and incentives," the CMFRI said in its advisory.

To conserve marine turtles in Indian waters, fishery interactions with these animals have to be constantly monitored. This is currently being done through the catch recording and monitoring system by CMFRI which employs nearly 100 observers in all landing ports and beaches of the country. The CMFRI has decided to generate specific annual reports on turtle-fishery every year, said principal scientist Mr K Sunil Mohamed.

The ban came as a blow to the Indian shrimp exporters as the country was the largest exporter of frozen shrimp to the US in 2017, with 32 per cent share. India's exports jumped from 11,000 tonnes in 2016-17 to 25,888 tonnes in 2017-18.

# Proposal of separate fisheries department to lift exports

The government's proposals for the creation of a separate department for fisheries and a 2% interest subvention on loans to fish farmers will help boost shrimp production and exports, expects the seafood industry. India was the top producer of aquaculture shrimps in the world at more than 6 lakh tonnes last fiscal year, when exports of seafood, primarily shrimps, earned the country Rs 45,000 crore in foreign currency. Fisheries is at present clubbed with animal husbandry and dairy under the agriculture ministry, and having a dedicated department will help focus more on the development of the sector.

It will help in quicker decisions at the administrative level for fisheries and seafood, being an exportor iented industry, will definitely benefit," said Mr S. Chandrasekhar, President of the Society of Aquaculture Professionals. This has been a long-pending demand of the industry, he added.

"We hope that there will be a secretary for fisheries under the department whom we will be able to approach directly. For instance, our demands like quarantine facility for aquaculture can be easily settled," said Mr V. Balasubramaniam, General Secretary of the Prawn Farmers Federation of India.

Mr Balasubramaniam said 2% interest subvention proposed for fish farmers and those hit by calamities will help the industry. Recently, the Gaja cyclone had hit shrimp farmers in parts of Tamil Nadu.

Mr Kenny Thomas, Managing Director of Seafoods Exporter, Jinny Marine Traders in Gujarat, sought more clarity on interest subvention. "The announcement says farmers pursuing fisheries and animal husbandry will get interest subvention. But we need to clarify whether it applies to river fisherman or in general including shrimp farmers," he said.

# Fisheries institute to provide technical input for Manipur wetland fishers

Central Inland Fisheries Research Institute (CIFRI), Barrackpore, Kolkata is ready to provide technical knowledge on enclosure fish culture technologies for the benefit of wetland fishers of Manipur.

Director Dr B. K. Das of CIFRI said this while speaking at the on-field training programme on 'Pen aquaculture technology in floodplain wetlands of Manipur' at Sendra near Moirang town in Manipur's Bishnupurdistrict. The training programme attended by around 50 fishers, was conducted by CIFRI in collaboration with fisheries department to train fishers on various aspect of pen aquaculture technology that has immense potential for improving income and livelihoods of wetland fishers.

Director Dr Das said that CIFRI has collaborated with state fisheries department to implement pen aquaculture under the National Mission on Himalayan Studies at Takmu area of Loktak Lake with the main objective of enhancing income through culturing fish in such enclosures installed in the lake.

Urging the fishers to join hands with CIFRI in successfully implementing the project, so that benefits accrued are shared by the fishers themselves, he however emphasized that after one year of the project, fishers have to continue with pen aquaculture using their own savings.

Participating in the training programme,the principal scientist Dr A. K. Das who is in charge of training-extension cell requested all the fisher participants to take full advantage of pen aquaculture technology which can be adopted in parts of LoktakLake for producing higher quantities of fish per unit water area.

Dr SonaYengkokpam discussed about the technical aspects of enclosure fish culture including pen installation, macrophyte clearance, which species to stock and how many to stock per unit area. She emphasized that pens are a low-cost technology and if practiced following scientific guidelines can improve income of the fishers.

Manipur has around 30,171 ha of natural lakes and floodplain wetlands that are largely unexploited and have high potential for increasing fish production through enclosure culture technologies.

# App to update fisherfolk

The city's fishermen can now see real-time threat of high tides and weather conditions across Mumbai and Thane with a click. The Central Marine Fisheries Research Institute (CMFRI) along with Tata Consultancy Services (TCS) has developed a mobile application, m-Krishi, that will give real-time information about length and intensity of the tides and details about rough weather conditions at the sea.

The application will also indicate potential fishing areas in the sea at a particular point of time, to boost the fishing process. It will enable the fishermen to determine when and how deep they can venture into the sea. "This will save their time in searching fish, while also saving fuel consumption in the process," said Mr Ajay Nakhwa, scientist at CMFRI.

Apart from monetary advantage, the initiative also focuses on reducing fatalities among the fishermen by providing details on cyclones, tornados, storms and waves of grave heights. "Information on wind and waves can save lives of fishermen by alerting them beforehand," he added.

It alarms the fishermen about weather information using different colours such as green, yellow, red, orange and white for winds and waves, which will direct them to decide where to carry out fishing activities. It also have micro logging feature, which provides current information on marine fisheries and awareness on the relevant issues.

The TCS also continuously upgrades the application to suit the software of common mobile phones in order to cater to more users.

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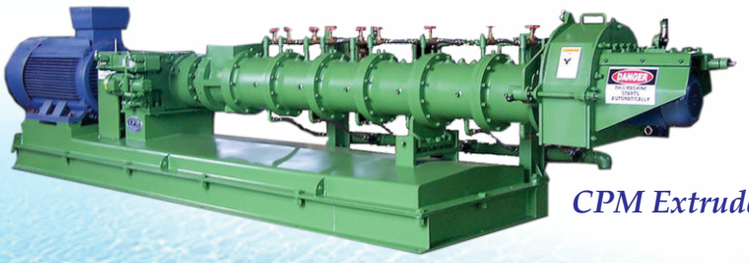

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# Fish Waste to be Utilized as Fish Feed

Under the Swachhta Action Plan, a sanction of Rs.10 lakhs was received by CIFT, Cochin for implementing the "Management and commercial utilization of waste in 20 fish markets (10/ Year) in urban locations" from the Council. Under the programme, it was envisaged to cover 20 fish markets/fish landing centerslocated in six states namely Kerala, Tamil Nadu, Karnataka, Andhra Pradesh, Maharashtra and Gujarat along with two markets at Delhi.

Procurement of model kit consisting of equipment/ tools for a demonstration of the technology on the conversion of fish waste to feed/manure was made. A processing line including meat mincer for preparation of fish silage from fish waste was perfected and tested for field trials.

The inaugural function of the programme was held at Thoppumpady fisheries harbour, Ernakulam. Prof K. V. Thomas the Hon'ble MP of Ernakulam constituency who has agreed to inaugurate the function could not attend due to some unforeseen reasons. The programme started with a welcome address by Dr V. Geetha Lakshmi, Principal Scientist and Nodal officer, Swachh Bharat Mission, CIFT, Cochin. The Chief Guest of the programme was Mr K.K. Kunjachan, Councillor, Kochi Nagar Sabha. In his Presidential address, Dr RavishankarC.N., Director, CIFT elaborated the technology interventions made by CIFT in the fishing and fish processing industry and highlighted the technology developed for fish waste utilization. He added that the Agri-Business Incubation Centre at CIFT supports operations on business projects as a measure of enhancing the foundation for new technology-based industries and establishing a knowledge-based economy.

Dr A. A. Zynudheen, Principal Scientist & I/c QAM Division, CIFT, Cochin explained the technical details of the technology on "fish waste conversion to feed" and how it can be implemented at a larger scale at fishmarkets and harbours where tons of waste gets generated. Mr K. K. Kunjachan inaugurated the programme and stressed the need for proper waste disposal. He lauded the efforts made by CIFT for the initiative in demonstrating a suitable technology for fish waste utilization as fish waste piling up in markets and landing centre are becoming a big challenge for want of suitable disposal mechanism. Mr Noushad, President and Mr Majeed, Secretary, Harbour Management Committee spoke during the occasion and offered their support for the programme. Felicitating the programme, Dr Saju, Joint Director (Fisheries), Govt of Kerala expressed his support for the venture and requested that the Institute should organize similar programmes in other parts of the State. Mr Sudhir, Administrator & Chief Engineer, Cochin Fisheries Harbour also spoke on the occasion and promised full support for the venture and explore possibilities to establish a foolproof waste management system based on the CIFT technology at the harbour. Ms Daisy, Manager, MAYSYAFED also graced the occasion and expressed interest for a demonstration on the technology at MATSYAFED unit at Thoppampady. A formal Vote of Thanks was offered by Dr P.K. Binsi, Scientist, Fish Processing Division, CIFT. The programme was well attended by fishermen, market vendors, representatives from the fish processing industry and the general public.

The inaugural function has followed a demonstration on the technology on conversion of fish waste to feed. Dr Zynudheen and Dr Binsi conducted the demonstration assisted by Mr Ajeesh, Mr N. Sunil, and Mr Rahul Ravindran, Technical Assistants of the Institute. The questions and doubts of the participants were cleared by the scientists of CIFT.

# Meet on tribal aqua farmers begins at CIFA

A national workshop on "Aquaculture as a Livelihood Option for Tribal Farmers of India" began at the Central Institute of Freshwater Aquaculture (CIFA) here. Governor Prof GaneshiLal, inaugurated the programme, besides an exhibition, as the chief guest. The Governor remembered the sacrifice and contribution of tribal community for building the nation.

Deputy Director General (Fisheries and Animal Science), Indian Council of Agricultural Research, Dr J. K. Jena, highlighted the development of strategies, schemes and policies for development of agriculture including aquaculture for livelihood improvement and nutritional security of tribal population of the country.

Director, CIFA Dr Bindu R. Pillai gave the welcome address.

Principal Scientist and Chairman, Tribal Sub Plan Programme of CIFA, Dr B. C.Mohapatra highlighted the contributions of the institute for last three decades for quality seed production, fish culture development and training to tribal farmers.Director, Department of Fisheries Mr P. K. Senapati appreciated the role of CIFA in expansion of freshwater aquaculture technologies.

Two publications namely, a book "Aquaculture as a tool for empowering SC/ST farmers of India: three decades of CIFA's contribution" and e-publication "Souvenir and Extended Abstracts" were released.Around 200 participants from 15 States such as Andhra Pradesh, Telangana, Maharashtra, Assam, Odisha, Manipur, West Bengal, Rajasthan, Karnataka, Uttarakhand, Punjab, Tamil Nadu, Jharkhand, Madhya Pradesh and Chhattisgarh are taking part.

# Odisha Governor Inaugurates TSP National Workshop at ICAR-CIFA

Central Institute of Freshwater Aquaculture, Bhubaneswar is the premier national institute under the administrative control of Indian Council of Agricultural Research, New Delhi. Under the Tribal Sub Plan Scheme of Government of India, the institute is conducting the National Workshop on "Aquaculture as a Livelihood Option for Tribal Farmers of India" at its Kausalyaganga campus. The inaugural function was held in the Auditorium of CIFA.

As Chief Guest of the Inaugural Function, His Excellency the Governor of Odisha, ProfGaneshiLal inaugurated the National Workshop and Exhibition of ICAR Institutes at Kausalyaganga. The Governor remembered the sacrifice and contribution of Tribal community for building the Nation. He stressed that an empowered and prosperous India will not be reality unless the tribes and other down trodden people are brought to the main stream of our society.

Dr J.K. Jena, Deputy Director General (Fisheries & Animal Science), Indian Council of Agricultural Research, New Delhi highlighted the role for development of strategies, schemes and policies for development of agriculture including aquaculture for livelihood improvement and nutritional security of tribal population of the country. He thanked the institute for contributions to aquaculture development in tribal areas of India since 1992. He encouraged the tribal farmers to take up fish culture in their areas as a profitable venture and for availability of cheap animal protein to them in their diet and for economic returns.

DrBindu R. Pillai, Director, CIFA welcomed His Excellency the Governor of Odisha and other dignitaries, delegates, farmers, press and media to the institute and function. She informed that the institute and all are honoured by the visit of His Excellency to the institute after a gap of twelve years. She briefed about the role of CIFA for freshwater aquaculture development in different regions of the country.

Dr B.C. Mohapatra, Principal Scientist and Chairman, Tribal Sub Plan Programme of CIFA highlighted the contributions of the institute for last three decades for quality seed production, fish culture development and training to tribal farmers. The TSP was undertaken by the institute in Gujarat, Kerala, Telengana, Karnataka, Andhra Pradesh, Odisha, Jharkhand, Madhya Pradesh, Maharashtra, Chhattisgarh, West Bengal and all eight north-eastern states of India.

Mr P.K. Senapati, IAS, Director, Department of Fisheries, Govt. of Odisha appreciated the role of CIFA in expansion of freshwater aquaculture technologies to the selected stake holders around the country. He urged to have the linkage among the State Fisheries and CIFA for information sharing in freshwater aquaculture and more collaboration in future.

Two publications namely, Book on "Aquaculture as a tool for empowering SC/ST farmers of India: three decades of CIFA's contribution" and E-publication "Souvenir and Extended Abstracts" were released by His Excellency the Governor of Odisha.

Around 200 participants from 15 states of the country (Andhra Pradesh, Telangana, Maharashtra, Assam, Odisha, Manipur, West Bengal, Rajasthan, Karnataka, Uttarakhand, Punjab, Tamil Nadu, Jharkhand, Madhya Pradesh and Chhattisgarh) participated in the National workshop.

# Fisheries department to join hands with Singapore, Vietnam in aquaculture

*With an aim to further boost the aquaculture sector in Andhra Pradesh, the State government is exploring the possibility of collaborations with various countries to adopt international practices*

**Vijayawada:** With an aim to further boost the aquaculture sector in Andhra Pradesh, the State government is exploring the possibility of collaborations with various countries to adopt international practices. The State Fisheries department has already held discussions in this regard with various organisations from Singapore, Netherlands, Vietnam and a few other countries.

According to information, the collaborations are for knowledge-sharing and technology transfer for better culture of aqua products. "We are looking at collaborations in areas such as farming, hatcheries, processing, value addition, cold-chain development, feed technology and others. The emerging collaborations will not only help in increasing the aquaculture production in the State but also give the farmers more export opportunities," a senior official explained.

The official noted that teams from the said countries have already visited the State in the last four months and held discussions on forging a joint partnership in deep sea fishing as well. While the collaboration with Singapore is expected to be in transfer of technology in aquaculture and in shrimp exportation, the tie-up with Netherlands will be in the fields of feed technology and cold-chain development.

"With Vietnam, we will jointly work mostly on deep sea tuna fishing and value addition products," the official noted. The Fisheries department is likely to enter into agreements to take the collaboration forward. It maybe recalled that the department has already signed an MoU with USA-based Fishin Company for increasing the production of Genetically Improved Farmed Tilapia fish in the State.

For the record, the fisheries sector contributes 7.4 per cent to the State GSDP and has a sector share of 24.24 per cent in the country's fisheries production. AP is also the highest producer of shrimp, occupying about 66 per cent of country's production.


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# The Role of Probiotics in Aquaculture

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**What are Probiotics?**

The term Probiotics was defined by The Food and Agriculture Organization of the United Nations/ World Health Organization as "living microorganisms once administered in the host in appropriate amounts will confer a healthy profit." Once probiotic is administrated, it exerts a significant impact on the host by stimulating or improving its defense system. Gismondo et al. defined the term, probiotic as "for life," originating from the Greek words "pro" and "bios." The probiotics are defined as organisms and substances that exert beneficial effects on the host by balancing its intestinal microbes (Gismondo *et al*., 1999).

**Need for Probiotics in Aquaculture**

There is a tremendous increase in worldwide production of farmed fish and shellfish in the last decenniums (Naylor *et al*., 2000). The needs for fish and fishery products will be expanded by more than 2 million tons by 2020. Due to illegal and over-fishing natural fisheries stocks are maximally deteriorated, and stocks of many fish species are in decline. African catfish (*Clarias garipienis*), Tilapia (*Oreochromis niloticus*), cod (*Gadus morhua*), turbot (*Psetta maxima*), and tuna (*Thunnus sp.*) which are wild fish species became more and more attractive as potential aquaculture species. Hence, farming of such species fulfills the consumer demand. This anticipated demand for fish and fishery products are met by aquaculture, which accounts for 41% of global fish production in 2015. Thus Aquaculture compensates the need for animal protein. The feed for aquaculture exerts threshold on both practical and economic aspects as it plays a vital role in the production cycle. Feed additive sectors, to achieve the better growth and health of fish and shrimp are expanding day by day to meet the potential culturist's requirements. As Probiotic gained its success in human and animal feeding practices, now the attention is on aquaculture. It has many beneficial aspects as it aids in diseases control, competes with various environmental stressors and also promotes the growth of the cultured organisms. Probiotics provide resistance against many pathogenic agents by manipulating the non-specific innate immunity among fishes. Probiotics have been defined in aquaculture, as a major nutritional factor influencing gastrointestinal physiology and function (Diplock *et al*., 1999).

**Modes of action**

Antagonism, a natural phenomenon, comforts the balance between competing for beneficial and potentially pathogenic microorganisms. The presence of other microorganisms can modify the microbiota present in the gastrointestinal tract of aquatic animals. Thus, antagonism reduces or eradicate the presence of opportunist pathogens by 1. Competition for adhesion sites and colonization, 2. Competition for nutrient and energy sources and 3. Competition for iron. Probiotic bacteria colonize and adhere to the intestinal mucosa preventing the place for the establishment of pathogens. Thereby stimulates the removal of pathogens from the infected intestinal tract. Balcazar et al. summarized the three steps of the probiotic establishment as an attraction, association into the surface secreting gel and ended by attachment to animal tissue cells (Balcazar *et al*., 2007).

Competition for nutrient also plays an important role in the composition of the microbiota of the intestinal tract or the surrounding environment of cultured aquatic species. Increasing some strains of probiotic bacteria such as Lactobacillus and Bacillus may decrease the substrate available for other bacterial populations. Siderophores, a bacterial product is low molecular weight (1500), ferric ion-specific chelating agents which has the ability to dissolve the precipitated iron and make it available for microbial growth. They have an affinity for the uptake and transport of ferric ion. As iron serves as a cofactor for various enzymes, siderophores play an important role in bacterial chemical communication. The ultimate competition for iron aggravate the bacteria for siderophore biosynthesis and utilization machinery to overcome siderophore piracy or to enable the use of siderophores for specific inter–strain chemical communication (Seyedsayamdost *et al*., 2012; Traxler *et al*., 2012).

**Types of Probiotics**

Probiotics are mainly of two types namely type 1- gut probiotics and type 2- water probiotics. Gut probiotics are usually blended with feed and can be administrated orally thereby enhancing the beneficial microbial flora of the gut. Water probiotics by consuming all the available nutrients eliminate the pathogenic bacteria through starvation by proliferating in the water medium (Merrifield *et al*., 2010).

**Methods of application of probiotics**

Probiotics are usually

## Highlight Points

1. **Probiotics have the beneficial effects in disease control and also competes with various environmental stressors.**
2. **It promotes the growth of cultured organisms.**
3. **Probiotic usage manipulates the non-specific innate immunity among fishes, hence help them to resist many pathogenic agents and are actively used worldwide.**

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marketed in two different forms Dry and liquid forms. The dry probiotics should be brewed at farm site before application that comes in packets. It can be given along with feed or can be applied to water. Dry probiotic kit contains a packet of dry powder and enzyme catalyst. Brewing is done in clean disinfected water after emptying the packets and should be thoroughly blended. Brewing is done at 27–32°C for 16 to 18 hours with continuous aeration. The brewed probiotic should be used within 72 hours. Liquid forms are live and ready to act. The hatcheries generally use it. The liquid forms can be directly added to hatchery tanks and can also be blended with farm feed. It can be applied any time of the day in indoor hatchery tanks, while either in the morning or evening in outdoor tanks. Liquid forms give positive results than dry form in lesser time (Merrifield *et al*., 2010).

**Properties of probiotics**

It is expected in order for a potential probiotic strain to exert its beneficial effects it should exhibit certain desirable properties like acid and bile tolerance, adhesion to mucosal and epithelial surfaces, antimicrobial activity and bile salt hydrolase activity. The desirable approach is establishing the strain properties such as target population, and target physiologic function specific studies as there are no particular parameters is essential to all probiotic applications. The strains must grow under manufacture and as well as commercial conditions and also should retain viability under normal storage conditions. Viability potentiates adherence, reduction of gut permeability, and immunomodulation which is a prerequisite for probiotic functionality and thereby constituting a technical challenge. Certain studies even proved that viability is not necessary for all probiotic effects. During the initial production steps for certain probiotic strains optimal growth might be sufficient, and therefore during storage, they necessarily don't want to retain good viability (Cahill, 1990; Biswas et al., 2013; Ibrahem, 2015).

**Uses of Probiotics**

Lactic acid bacteria are the most commonly used organisms in probiotic preparations and are accounts large numbers in the gut of healthy animals (Zhang et al., 2009). The alimentary tract of fishes with its complex polymicrobial ecology interacts with the internal and external environment thereby influencing the fish's health and disease. The intestine, a complex multifunctional organ, not only has a major role in digesting and absorbing feedstuff but also plays a critical role in osmotic balance, endocrine regulation of digestion, metabolism, and immunity. The addition of some microorganisms that participate in the digestion processes enhances the digestion processes of aquatic animals. The digestion process can be enhanced by the production of extracellular enzymes- proteases, lipases and by supplying necessary growth factors like fatty acids, vitamins, etc.

The growth enhancement is of premium importance among the various benefits of probiotics in aquaculture. This occurs as a result of bacterial species colonizing the gut of the host and results in bringing about a change in the bacterial composition of the gut thereby in some way benefits the health of the host. Probiotic microorganisms also can inhibit or eliminate some potentially pathogenic bacteria. This can be done by the production of inhibitory biological substances like antibiotics, antibacterial substances, siderophores, bacteriolytic enzymes, proteases, and a protease inhibitor, lactic acid and other organic compounds like bacteriocins, hydrogen peroxide, and butyric acid production.

Bacteriocins produced by certain types of bacteria are proteins that antagonize other species which are related to the producer bacterium. Lactic acid bacteria and Bacillus are the most common one to produce bacteriocins thereby inhibiting the growth of competing bacteria. Bacteriocins are categorized into four classes as class I (antibiotics), class II (small hydrophobic, heat-stable peptides), class III (large heat-stable peptides) and class IV (complex bacteriocins: probiotics with lipid and carbohydrate). Nisin, famous bacteriocins, is a ribosomally synthesized antimicrobial peptide produced by certain strains of Lactococcus lactis. Nisin act against human *Enterococcus faecalis, Streptococcus pneumoniae, Staphylococcus aureus, Staphylococcus epidermidis*, and others (Balcazar *et al*., 2007).

Some probiotic bacteria have antiviral effects, and the inactivation occurs by chemical and biological substances, such as extracts from marine algae and the bacterial extracellular products. The antagonistic compounds production may also be active against the virus as Balcazar et al. reported antiviral activity from *Vibrios sp., Pseudomonas sp., Aeromonas sp*. Obtained from salmon hatcheries against infectious hematopoietic necrosis virus. Some probiotic strains of marine origin also have the affinity to produce bacteriolytic enzymes against *V. parahaemolyticus* (Balcazar *et al*., 2007). Alteromonas sp. strain B-10-31 produces Monastatine (an alkaline protease inhibitor) that showed inhibitory activity against protease from *A. hydrophila and V. anguillarum.*

Vitamins are the valuable output of the probiotics. It is also reported that certain lactic acid bacteria (LAB) could synthesize water-soluble vitamins like folates, riboflavin, and vitamin B12 (Leblanc et al., 2011). They also discussed the use of genetically modified strains to either increase vitamin production or design new vitamin-producing strains.

Fishes have a primitive immune system when compared with higher vertebrates. Two separate compartments were present in higher vertebrates to generate myeloid and lymphoid immune cell types whereas fishes do not possess bone marrow or lymph nodes thereby produce lymphoid and myeloid cells in the same compartments. The adaptive immune of fish shows a slow response to infective pathogens which usually takes a week instead of days as in mammals. Fishes despite its adaptive immune system, it efficiently supports the ecological success of fishes and also against infectious pathogens.

The Fish immune system based on the difference in speed and specificity of response can be subdivided into three categories (Burnett, 2005). The external barriers including the epithelia of the skin, gills, and alimentary canal, which separates the fish from its environment act as the first line of defense mechanism. They work as mechanical barriers to invading pathogens, also containing chemical (antibodies, lysozyme, etc.) and cellular (immune cells) defenses.

The innate immune system forms the second immune category which enables a rapid response to invading pathogens by providing non-specific responses which are activated by pathogen-associated molecular patterns (PAMP) that are common to many pathogens. The humoral factors such as lysozyme or complement factors and phagocytic cells are the main elements of the innate immune system of fishes. The phagocytic cells function by ingesting tissue debris and microorganism's thereby secreting immune response regulating factors and also bridges innate and adaptive immune responses.

The adaptive or acquired immune system, the third line of immune defense, is a set of humoral and cellular components that enable a pathogen-specific response. The probiotic ability to modulate the nonspecific immune responses increases the disease resistance during bacterial infections in aquatic animals. Recently many studies have been focused on the role of probiotics in the immune system. The immune system activation is a costly operation. Probiotics stimulate various immunohematological parameters positively such as mononuclear phagocytic cells (monocytes, macrophages) and polymorphonuclear leukocytes (neutrophils) and NK cells in teleosts (Balcazar, 2003). Probiotics also actively stimulate the B lymphocytes proliferation, thereby elevation of immunoglobulin level in both in vitro and in vivo conditions occurs.

Several in vitro and in vivo studies showed that there is an increase in Respiratory burst activity by numerous probiotics in several aquatic animals. Probiotics have a positive influence on water quality, but the mechanism of actions is still in infancy. To improve water quality in aquaculture, fish raisers relies on the removal of toxic materials from water. Li et al. studied the possible role of probiotic bacteria in improving the shrimp water culture. He found that the addition of photosynthetic bacteria in the water resulted in the elimination of some toxic metabolic and toxic products thereby enhancing the water quality (Li *et al*., 1997).

Harmful algae in water hinder the development of cultured aquatic species, thus by adding suitable controlling agents antagonize the undesirable growths. Some probiotic bacteria possessed the selective ability to antagonize the development of the harmful algae. Fukami et al. showed some probiotic bacterial strains have an algicidal effect on many toxic microalgae, particularly of red tide plankton. The algicidal ability of seawater origin Flavobacterium sp. Moreover, the control of Gymnodinuim mikimotoi algal blooms was recorded by them (Fukami *et al*., 1997).

Aquaculture if appropriately managed, is of high economic yield projects. Reproduction constitutes the backbone for any production yield. Many elements regulate reproduction. Fish species, nutrition, and environment are the master leading elements. Nutrition is closely interlinked with the timed reproductive consequences (from gametes through puberty to adults in both sexes). Ghosh et al. isolated B. subtilis from the intestine of Cirrhinus mrigala and tested the incorporation of it in diets of four species of ornamental fishes in a 1-year feeding experiment. They reported the increase in the gonadosomatic index, fecundity, viability, and production of fry from the females of all tested species. Also suggested that the vitamins B synthesized by the probiotic (especially vitamin B1 and B12) lowers the number of dead or deformed alevins (Ghosh *et al*., 2007).

Lactic acid bacteria are of significance as far as nutrition is concerned, and among them, the ones with the most important properties are Lactococcus and Bifidobacterium. Lactic acid bacteria are Gram-positive and catalase-negative that produces lactic acid as the main end-product of carbohydrate fermentation. Bifidobacterium is phylogenetically listed among them as they use a separate metabolic pathway.

**Table No.1 Microbial Species commonly used as Probiotics**

| Lactobacillus sp. | Bifidobacterium sp. | Other lactic acid Bacteria | Nonlactic acid bacteria |
|---|---|---|---|
| L. acidophilus | B. adolescentis | Enterococcus faecalis | Bacillus cereus |
| L. casei | B. animalis | E. faecium | Escherichia coli strain nissle |
| L. crispatus | B. bifidum | Lactococcus lactis | Propionibacterium freudenreichii |
| L. gallinarum | B. breve | Leuconostoc mesenteroides | Saccharomyces cerevisiae |
| L. gasseri | B. infantis | Pediococcus acidilactici | S. boulardii |
| L. johnsonii | B. lactis | Sporolactobacillus inulinus | |
| L. paracasei | B. longum | Streptococcus thermophilus | |
| L. plantarum | | | |
| L. reuteri | | | |
| L. rhamnosus | | | |

**Conclusion**

Aquaculture is one of the valuable solutions to meet the ongoing globalization of food shortage. Improving the aquaculture practices by innovations is essential. Probiotics usage in aquaculture systems provides high-quality products regarding size, safety, and healthier organisms. It can also increase the aquaculture yield. The probiotics application will become a major field in the development of aquaculture in the future.

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***More Reference can be provided on request.***

# Application of Renewable Energy in Aquaculture

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**Introduction:**

Aquaculture is one of the fastest growing sector which produces fish - a cheap source of protein and nutrition. In the recent past, the growth of aquaculture sector was booming, due to declining catches from wild capture fisheries. So, in future, fish protein is full and full depends on aquaculture only. The annual fish production in 2016 is 171 million tons in this aquaculture contributed 80 million tons (FAO, 2018). The cost of feed, disease, electricity, wages and fuel are major recurring problems in the aquaculture sector. Normally the farmers spend 62,213.33 Rs./ha/crop for electricity and 54,470.5Rs /ha/crop for fuel instead of that if they use eco - friendly renewable energy sources, they can reduce the production cost.

Renewable energy is an energy that is generated from natural processes that are continuously replenished which includes sunlight, geothermal heat, wind, tides, water and various forms of biomass. This energy can't be exhausted and is consistently revived. Renewable energy is also called "clean energy" or "green power" because it doesn't pollute the environment.

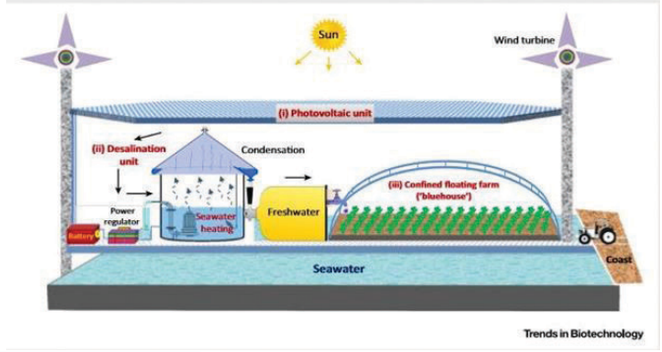
So the use of renewable energy in aquaculture reduces the production cost and increase the sustainability. There are plenty of ways in aquaculture for the use of this renewable energy sources

***Solar Energy***

Solar energy is the energy, in the form of electromagnetic radiation, emitted from the sun. This electromagnetic radiation is converted into usable thermal or electric energy by man power with the aid of mechanical devices. In aquaculture, solar energy can be used indifferent ways.

**a. Solar power generator:**

Aquaculture systems need pumps and aerator to oxygenate the water, to pump the water and purify or filter the water. Solar generated electric power is known as photovoltaic. Solar panels are installed above the pond or cage, which generate the electricity and store in the batteries and then it is used for water exchange, aeration, lighting, automatic feeding, etc.



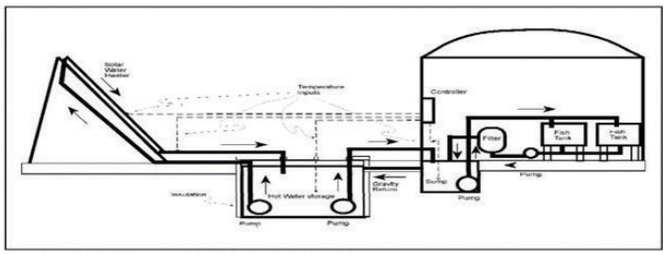

## Highlight Points

- **Use of renewable energy for the production of aquatic organisms is an excellent innovation in sustainable aquaculture.**
- **It is an eco-friendly novel technique in enhancing the aquaculture without compromising natural aquatic ecosystems.**
- **The cost of production can be directly reduced through getting more energy from cheaper cost.**
- **An efficient produced energy can be used for aeration, feed dissension, water pumping, light sources, etc.,**

**b. Solar water heat system:**

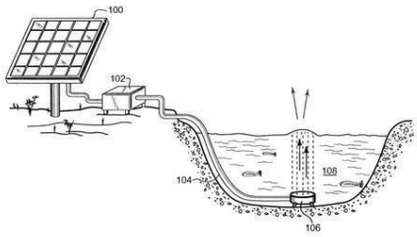
The growth rate of fish is higher in warm water compared to fresh water, because the metabolic rate is higher in warm water. The solar water heater can be used to regulate/maintain the water temperature. At Rosewall Creek salmon hatchery and Smolt unit in Canada, a solar heating plant has been integrated with a conventional

propane heating system. Groundwater is heated with alternative solar energy and stored in two tanks. Here the cool water is heated (12 – 140C) by propane broiler, and then it will go to Salmon tank. For reclaiming the heat, heat exchanger also used. (Source: CanREN, Natural Resources, Canada)



**c. Solar aerator:**

Here Photo Voltaic device is directly connected to the aerators.




**d. Solar feed dispenser:**

**e. Solar pump:**

**Advantages:**

- It is renewable and free.
- It is 100% eco – friendly.
- More energy at cheaper cost.
- Reduce production cost.

**Disadvantages:**

- Need continuous maintenance.
- Only certain places are suitable for solar power installation.
- Solar energy cannot be made at night.
- The batteries can often be large and heavy, taking up space and needs continuous replacement

***Wind Energy***

"Wind energy" or "wind power" indicates thatthe wind is used to create the mechanical energy or electrical energy. Power of the energy depends on the speed of the wind. This mechanical power can be often used for specific tasks (such as grinding grain or pumping water) or a generator will convert this mechanical power into electricity to power homes, businesses, schools, and aquaculture. In aquaculture wind energy is used for power generation, to operate the aerators, wind motor pump systems.

**a. Wind mill or wind power generator:**

When the wind flows between the blades it rotates the blades connected to the shaft. The shaft is connected to the gearbox which used to increase the rotation of the generator. The generator has the magnetic field, due to magnetic field the mechanical energy is converted into electrical energy. The power output goes to a transformer, which converts the electricity from the generator. The regional electricity distribution networks or National Grid transmits the electricity around the country, and on into homes, business, agriculture and aquaculture. Now a day, offshore wind farms are also opened in many places.

**b. Wind based water pump system:**

Wind turbines can be equipped with pump units for pumping, recycling and aerating water reservoirs, particularly in lakes, fishponds and settlement tanks in sewage treatment plants. It is mostly used in agriculture systems as well as aquaculture.

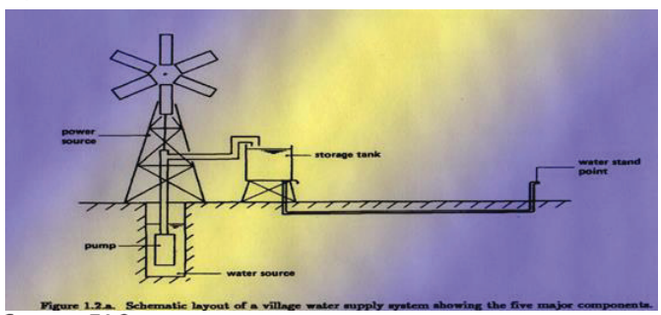



Figure 1.2.a. Schematic layout of a village water supply system showing the five major components.

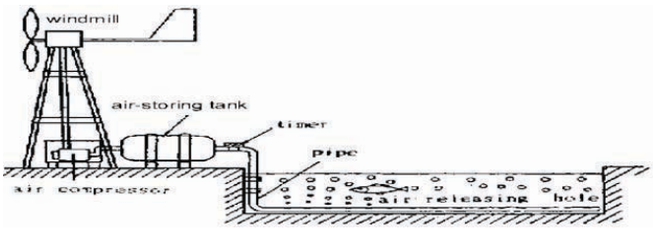
*Source: FAO*

**c. Wind based aerators:**

There are three types of wind based aeration systems used. This fully depends on the wind only.

**1. Air-filling Type:**

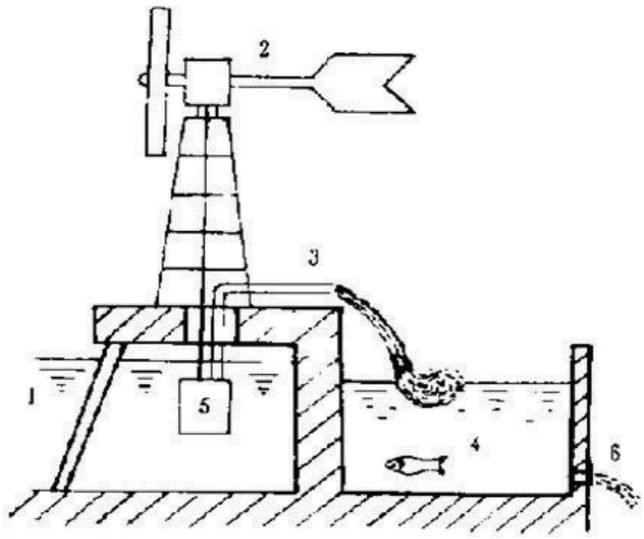
The air-filling type of equipment is used to supply air into the water by using wind power to drive an air compressor. The air compressor is driven by a windmill and the compressed air is stored in the reservoir- an air storing tank, which releases the air through pipes into a fishpond. In the air releasing point, holes are made so small to make the air bubbles in fog shape, which easily dissolve the oxygen from the air into the water




*Source: FAO*

**2. Aeration Type:**

The mechanism of the aeration type of equipment increases the contact area between water and air thereby dissolve the oxygen into the water while the water is in flowing state. Aeration is done by exposing the water into the air using a pump, or lifting the water using a rotating vane wheel, or dropping the water using a steep dam and so on. A pump, which is driven by a windmill, lifts the water from a river and jetting it into a fishpond Therefore, the advantage of this type equipment is that the water in fishpond is continually being replaced by fresh water during the oxygen-enhancing process.

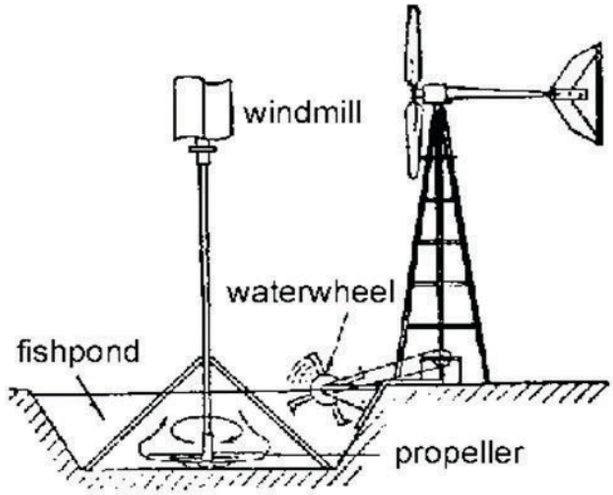



*Source: FAO*

1. Out river water
2. Windmill
3. Outlet pipe
4. Fishpond
5. Pump
6. Drainage outlet

**3. Water-stirring Type:**

A propeller located on the water surface or fishpond bottom is driven by a windmill which increases the DO and also uniformly circulates in the fish pond. In the cold region, this aerator used to prevent the water from freezing.




Source: FAO

**Advantages:**

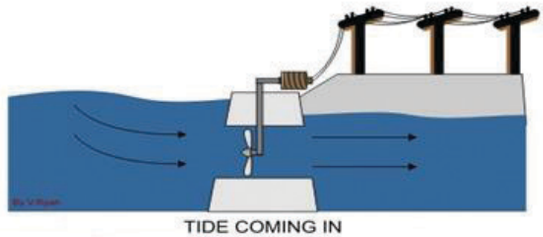
- Wind power does not create greenhouse gases.
- Wind turbines are very safe.
- Although wind turbines can be very tall, each occupies only a small plot of land and an unoccupied land below the wind turbines can be used for other purposes, especially for agricultural activities.
- Remote areas that are not connected to the electricity power grid can use wind turbines to produce their electrical power.

**Disadvantages:**

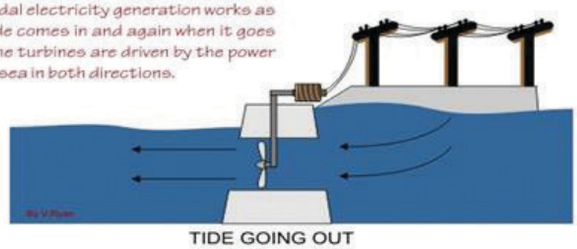
- For most locations, the density of wind power is low.
- Wind velocity must be greater than 7 mph.
- Problem exists in the variation of power density and duration (not reliable).
- Need better ways to store energy.

**Tide Energy**

The tide is created by the gravitational field of sun and moon. Tidal energy is a form of hydropower that converts the energy of tides into electricity or other useful forms of power.




This tidal electricity generation works as the tide comes in and again when it goes out. The turbines are driven by the power of the sea in both directions.



The tide fed farms present in the coastal areas can use this tidal energy. The farms are filled during high tide and drained or water released during low tide. Keeping the paddle wheel fans or turbines in sluice gate produces energy when the water is filled and drained. The produced energy is stored in batteries and used for various aquaculture needs.

**Advantages:**

- Tidal energy is a free and clean energy. There is no waste produced from this energy.
- Less expensive to operate and maintain.
- Low noise pollution.
- It protects against flooding and land damage.
- We can easily predict the high and low tides. But for other energy sources it is not possible.

**Disadvantages:**

- Availability of this energy varies based on the Sun and Moon gravitational forces.
- It requires a suitable site for continuous operation.
- It needs a high investment cost.
- Build-up of silt, sediments and pollutants within the tidal barrage from rivers and streams.
- The blades may be damaged by fishes during operation.

Conclusion:

In recent years, in aquaculture activities, the cost of production is increased due to unavailability of feed ingredients, price fluctuations and others inputs. The shrinkage of energy resources increased the electricity demand which ultimately increased the electricity cost. So wise use of renewable energy resources a cheapest and best energy resource for aquaculture and agriculture farms wouldhelp to reduce the cost of production and increase the sustainable way of farming practices.

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***More Reference can be provided on request.***

# Green Aquaculture: Through Aquaculture Systems Integrated with Phytoremediation Treatment Methods

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## 1. Introduction

The necessary doubling of aquaculture production across the developing world in the next few years will face significant environmental constraints. Recent WRI/World Fish research has examined aquaculture's environmental footprint today and explores various scenarios of aquaculture growth to 2050. On average, fish convert feed to food as efficiently as poultry, making them an attractive option for expanding the global animal protein supply. However, as with all forms of food production, aquaculture isn't without its environmental impacts, and the sector needs to be well prepared for climate change (WRI, 2014).

Increased demand on traditional global fisheries coupled with ocean contamination altered patterns of aquatic species distribution due to climate change, El Nino effects, and altered predator prey relationships has raised international concern about sharp reductions in the stocks of available fish and other aquatic food species. Phytoremediation offers an excellent array of plant–microbe choices that can be matched to a site-specific water quality problem in aquaculture. Matching the appropriate plant or plant community to chemical and biological contaminants can play a major role in conserving and protecting soil and water. Integrating phytoremediation options with various aquaculture systems can serve as a major tool to achieve cost-effective, low energy treatments that can support sustainable aquaculture production on a global scale (Lanzaet al., 2017).

### Highlight Points

**The intensification of aquaculture for global food production has been one of the major reason to the sharp reductions of the stocks of aquatic species used as a source for traditional fishing methods. Phytoremediation offers an environmentally compatible approach that can be quickly integrated into existing aquaculture systems to provide management of contaminants. The scenarios of Integrated Aquaculture-Phytoremediation systems (IAPS) provided in this article are not intended to be all inclusive but rather serve as selected examples of potential applications.**

## 2. Chemical and Biological Contaminants

Sources of water used to supply aquaculture systems are often contaminated with organic and inorganic contaminants and disease causing microorganisms. For example, one major environmental challenge evident in many aquaculture systems in

Southeast Asia and other areas of the world is the presence of freshwater snails that vector human and livestock diseases. Some aquaculture systems follow a polyculture approach that simultaneously produces fish, snails, and other aquatic food species for human consumption. Snails that are intermediate hosts of fish-borne zoonotic trematodes are of special concern in VAC ponds and other types of aquaculture systems. In addition to the human and livestock health threats from aquatic species infected with chemical contaminants, parasites, and other pathogens, reduced marketability of fishes, snails, and other aquaculture products has boring disease organisms warrants control efforts to reduce contamination in aquaculture systems (Dung et al., 2010) .

## 3. Protocol for Integrating Phytoremediation with Aquaculture Systems

### *3.1 Assessing Water Quality*

The first step in the development of an effective integrated aquaculture-phytoremediation system is a local water quality assessment. Major water quality problems resulting from typical freshwater pond and stream aquaculture systems are listed in Table 1. Increased total suspended and dissolved substances, increased biochemical oxygen demand, dissolved oxygen depletion, and increased and excessive phytoplankton which can include toxic blooms are of particular concern (Legaspi et al., 2015).

**Table 1. Water quality problems and selected contaminants in aquaculture systems**

| Water quality problem | Selected contaminants |
|---|---|
| Suspended and dissolved substances | Inorganic and organic materials—TSS, TDS |
| Nutrient loadings | Nitrates, nitrites, phosphorus, unionized ammonia |
| Oxygen depletion—Biochemical Oxygen Demand (BOD) | Dissolved organics, sediment oxygen demand |
| Increased phytoplankton and toxic blooms | Oxygen depletion, organic contaminants, microbial toxins |
| Increased inorganic contaminants | As, Al, Cd, Cu, Pb, Zn) |
| Increased organic contaminants | Malachite green, pesticides, algicides, herbicides, petroleum hydrocarbons |
| Microbial pathogens and parasites | Bacteria, viruses, protozoa, trematodes, cestodes, nematodes |

### *3.2 Selecting Plant Species*

Phytoremediation options designed to control and treat the identified contaminants in aquaculture systems will also be very site specific and must be carefully planned to accommodate the individual characteristics of a particular aquatic system. Design parameters must allow for the integration of phytoremediation processes with the basic operational schemes of common aquaculture systems. Native plants with a relatively rapid growth rate and high biomass production are the most effective candidates for the phyto extraction and phyto stabilization of specific contaminants common in aquaculture operations. Basic knowledge about plants and water quality characteristics may be available from farmers and other local residents involved in IAA activities. Care must be taken to avoid competition between the plant and microbe communities used to treat/remove contaminants and the processes required for cost-efficient aquaculture operations. For example, livestock and crop wastes are typically directed to aquaculture systems to fertilize the biological community that provides food for fish, snails, and other aquatic herbivores under culture (See Fig. 1). The integrated aquaculture-phytoremediation design must provide a good balance that insures both the removal of excess nutrients and an adequate supply of nutrients to support the growth of the aquaculture products (Ansari *et al*., 2015).

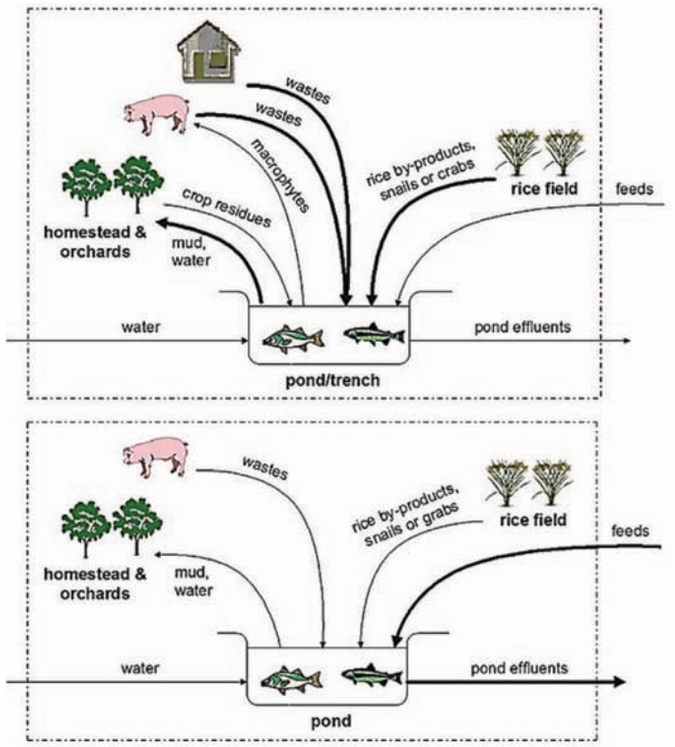


**Fig. 1.** Pond nutrient flows in an integrated aquaculture, crop, and livestock system (IAA-farming) in the Mekong Delta of Vietnam (Nhan *et al*., 2007).

## 4. Design Parameters for Integrated Aquaculture-Phytoremediation Applications

The pond and river areas available for the application of phytoremediation options to control and treat contaminants in aquaculture systems include (1) water supplying the ponds through direct inputs from inflow channels/canals and indirect inputs from non-point source runoff, (2) sediments in the ponds and rivers, (3) bank areas immediately surrounding the ponds and rivers, and (4) water exiting the pond through outflow channels/canals or downstream flow in rivers. Table 2provides selected examples of potential phytoremediation treatment options for aquaculture systems experiencing common contaminants. Food security and water pollution

are of increasing concern, especially in developing countries. Biomass removed from the aquaculture pond or river can be composted, used as fuel, or as food for humans and livestock if the concentration of toxic contaminants is low enough (Lanza, 2002).

**Table 2. Examples of phytoremediation treatment options for aquaculture systems using constructed communities of plants, algae, and bacteria**

| Contaminant removal system | *Plants* |
|---|---|
| Vegetative filter strips (VFS) | |
| Pesticides | *Iris versicolor, Trypsacumdactyloides, Andropogongerardii, Salix nigra* |
| | |
| Petroleum hydrocarbons (TPH) | *Trifoliumsp., Festuasp., Cynodonsp.* |
| Heavy metals/metalloids | |
| | *Vetiveriasp., Chrysopogonsp., Typhasp., Chromolaenasp., Leersiasp., Tagetessp., Acidosasasp.* |
| Natural and constructed wetlands | |
| BOD, TSS, nutrients, heavy metals/ metalloids, organics/malachite green, coliform bacteria, parasites | *Carexsp., Cyperussp., Typhasp., Phragmitessp., Juncussp., Rhizophora sp., Panicumsp., Leersia sp.* |
| Limnocorrals/cages/net pens/hydroponic rafts | |
| BOD, TSS, nutrients, organics/malachite green, metals/metalloid | *Lemnasp., Eichorniasp., Hydrillasp., Ceratophyllumsp., C. indica* |

**5. Vegetative Filter Strips and Natural and Constructed Wetlands**

Vegetative filter strips (VFS) can be applied to areas immediately surrounding IAA/VAC pond shoreline areas (see Fig 1) and to the inflow and outflow areas of the facility. The VFS plant community can be constructed using compatible native plants that are known to be effective in the treatment of specific organic and inorganic contaminant mixtures. In many cases, decorative plants including blue flag iris and marigolds (e.g., *Iris* sp., *Tagetes*sp.) with good phytoremediation potential can provide value-added benefits to farmers as products sold to floral dealers ((Lanza, 2002).

Natural and constructed wetlands can be used to compliment VFS communities specially at the inflow and outflow areas of an aquaculture pond. Plants used in VFS and/or constructed wetlands should be matched to soil or sediment types similar to their normal habitat. For example, *Typha*sp. grows best in wet, saturated soils while *Leersia*sp. favours moist to dry soils. Although erratic phyto extraction patterns may occur over time, both plants can effectively remove small to moderate amounts of heavy metals/metalloids, thus preventing the contaminants from entering the aquaculture system and its food web ((Lanza, 2002).

**6. Limnocorrals, Cages, Net Pens, and Hydroponic Rafts**

Treatment of contaminants in the pond, river basin, or canals can be accomplished with plants housed in containment structures including limnocorrals, cages, net pens, and hydroponic rafts. The site-specific characteristics of the aquaculture operation will determine which type or combination of containment structures is best suited for integration with the aquaculture process. The interaction of different contaminants (e.g., cadmium and zinc) and humic substances are important determinants of contaminant behaviour and removal and should be considered in designing a system. The specific absorption/adsorption characteristics of the plant are also important considerations in the planning and design of integrated aquaculture-phytoremediation systems (Bunluesin et *al*., 2007).

**7. Conclusion and Future Prospects**

Food security and water pollution are of increasing global concern, especially in developing countries. Methods to simultaneously augment food production and decrease water pollution can be valuable additions to current aquaculture operations. Integrated Aquaculture-Phytoremediation Systems (IAPS) offers a new approach to create sustainable aquaculture systems that can provide green, low energy-low technology solutions in developing countries. Using IAPS can great lyenhance the global production of plant and animal food particularly in developing countries with warmer climates and highly diverse plant communities. Research is needed to clarify the possible inclusion of carnivorous plants in phytoremediation communities used in IAPS (Hetland et *al*., 2001).

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***More Reference can be provided on request.***

# Effect of Climate Change on Coral Reef

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## Introduction

The coral reefs are unique ecosystems with includes both biological ("coral" community) and geological components ("reef" structure). These communities are broadly dispersed in the low tropical and subtropical waters across the globe world and are mainly built by the secretion of the limestone as skeletal material by corals and calcareous algae. The reef-building corals are the colonial animals which inhabit the single-celled microalgae, called zooxanthellae within their body tissues. This symbiotic relationship between both the partners benefits by helping the coral to obtains food from the plant photosynthesis while the microalgae to get nutrients released as waste by the coral. The two have complementary effects on carbon dioxide ($CO_2$) exchange which is assumed to account for the rapid rates of their skeletal growth.

The coral reefs offer many values to human society apart from the health of the biosphere. They play a vital role to support fisheries, recycling of nutrients, providing shelter and nursery habitat for many developing organisms, natural breakwaters to protect shorelines and human settlements from waves and storms. Humans widely utilize the products produced by reefs as food, building materials, pharmaceuticals, aquarium trade, and other uses. The reefs have also become the prime tourist destinations and potential economic resources because of their splendid beauty and novelty.

The first biological provinces of reef corals are the Indo-Pacific, Atlantic and Caribbean islands which accounts for about 85% of the world's reefs and a similar proportion of reef biodiversity. The reef communities vary across large-scale environmental gradients as reflected in the diversity gradients across both latitude and longitude. At smaller scales, the makeup of reef communities differs according to the degree of land influence, storm frequency, and the combination of other local and regional factors. The reef communities provide a wealth of information about an organism and ecosystem evolution and earth's environmental changes through time because of the limestone yield by them. The Modern coral reef communities are known to have evolved over the past 40-55 million years while the present day reefs have accumulated during the last 10,000 years of the current interglacial period or Holocene epoch.

## Climate and Environmental Change

The climate system on earth mainly depends on the natural processes which redistribute the sun's energy that is absorbed and re-emitted by the planet. The climate change involves all the variation in the chemical, biological, and geological and physical manifestations—the temperature and movements of the oceans and atmosphere, and the hydrologic cycle that redistributes water across the earth's surface. The Third Intergovernmental Panel on Climate Change (IPCC) found that the average temperature of the earth has risen 0.4–0.8°C since the late 19th century and attributed a substantial part of that change to the concurrent increase in greenhouse gas concentrations; for example, atmospheric $CO_2$ has increased from about 280 parts per million by volume (ppmv) to nearly 370 ppmv. The greenhouse gas concentrations will continue to grow over the next few decades to centuries depending on the future economic and technological developments.

## Climatic Change Stresses to Coral Reefs

The global climate change had imposed a chronic as well as acute stresses on coral reef ecosystems. But due to the absence of the precedents data of modern coral from last 50 million year, it is very challenging to predict the expected change. The gas bubbles preserved in polar ice caps show that atmospheric $CO_2$ concentrations over the past 400,000 years have oscillated between about 180 and 310 parts per million volume or ppmv. Previous temperature and sea-level variations mimic the $CO_2$ fluctuations, with relatively constant minimum (glacial period) and maximum (interglacial) values. The increase in atmospheric $CO_2$ due to anthropogenic factor is the near-vertical line at the present day which has led to the rise in temperature and a decrease in pH of the surface ocean.

## Coral Bleaching

The atmosphere and the ocean have warmed since the end of the 19th century and will continue to heat into the foreseeable future, primarily as a result of increasing greenhouse gas concentrations. The El Niño-Southern Oscillation (ENSO) events have also increased in frequency and intensity over the last few decades. This combination (warming and intense El Niño events) has resulted in a dramatic increase in coral bleaching.

The term 'Bleaching' primarily refers a stress response due to an increase in temperature, light intensity, salinity or other physical means and result in the loss of symbiotic algae by the coral or another host. Most of the pigments in the usually colorful corals depend on the presence of these plant cells. The living tissue of coral animals without algae is translucent, so the white calcium carbonate skeleton

## Highlight Points

1. The coral reefs offer many values to human society and environmet.
2. Coral reef highly suseptible for environmental change.
3. The countries and communities need to enforce laws against coral destruction
4. Conservation policies should ensure natural carbon sequestration by protecting different ecosystem
5. Controlling coastal development through a strategy can help to protect reefs from long-term stresses

shows through, producing a bleached appearance.

The three types of bleaching mechanisms are associated with high temperature and light: animal stress bleaching, algal-stress bleaching, and physiological bleaching. The algal-stress bleaching, acute response to impairment of photosynthesis by high temperature coupled with high light levels while the physiological bleaching reflects the depleted reserves reduced tissue biomass, and less capacity to house algae and disturbance in sexual reproduction as a result of the added energy demands of sustained above-normal temperatures.

The temperature threshold for bleaching is relative to other environmental variables (especially light) and the duration and severity of the departure from the normal temperature conditions of a reef. The coral bleaching events of most significant concern are acute episodes of high mortality and protracted debilitation of survivors in the form of diminished growth and reproductive rates. The corals with branching growth forms, rapid growth rates, and thin tissue layers appear to be most sensitive to bleaching, and usually, die if severely bleached. The slow-growing, thick-tissue, massive corals seem to be less painful and commonly recover from all but the most extreme episodes. Bleaching thus selectively removes certain species from reefs and can lead to significant changes in the geographic distribution of coral species and reef community structures.

**Global Warming and Reef Distribution**

The global distribution of reef-building corals is limited by annual minimum temperatures of ~18°C. Although global warming might extend the range of corals into areas that are now too cold the new area made available by warming will be small, and the countervailing effects of other changes suggest that any geographic expansion of coral reefs will be minor. At present, coral reefs are limited to the tropics and occur only in waters where the temperature remains warmer than 18°C. A 2°C warming of the oceans will expand the range by a few degrees latitude. The locations within this region that have proper depth, substrate, and other environmental conditions could potentially support new coral reefs at the higher temperatures. The coral reefs require shallow, clear water with at least some hard seafloor, and their propagation depends primarily on ocean currents — the west coasts of North and South America, Europe, and Africa experience cool water flowing toward the equator and are thus "upstream" from potential sources; causing restricted distributions of coral reefs. In areas such as the southeastern United States and near the Amazon River, reef expansion along the coast blocked by muddy coastal shelves, river deltas, and turbid water. Only southern China, Japan, Australia, and South Africa present geographically realistic opportunities for reef expansion. Additionally, sea-surface temperature (SST) gradients are very steep in the vicinity of 18°C (the annual minimum temperature threshold for coral reef growth), and ocean model projections which suggests that SST warming associated with doubled $CO_2$ will only move the 18°C contour by a few hundred kilometers, especially in the critical western boundary areas.

**Reduced Calcification Potential**

The oceans currently absorb about a third of the anthropogenic $CO_2$ inputs to the atmosphere, resulting in significant changes in seawater chemistry that affect the ability of reef organisms to calcify. The photosynthesis and respiration by marine microorganisms also affect seawater $CO_2$ concentration, but the overwhelming driver of $CO_2$ levels in shallow seawater is the concentration of $CO_2$ in the overlying atmosphere. The changes in the $CO_2$ level of seawater through public processes of air-sea gas exchange alter the pH and the concentrations of carbonate and bicarbonate ions. The surface seawater chemistry adjusts to changes in atmospheric $CO_2$ concentrations on a time scale of about a year. The projected increases in atmospheric $CO_2$ may drive a reduction in ocean pH to levels not seen for millions of years. Many marine organisms use calcium ($Ca^{2+}$) and carbonate ($CO_3^{2-}$) ions from seawater to secrete $CaCO_3$ skeletons. The reduction in the concentration of either ion affects the rate of skeletal deposition, but the carbonate ion is much less abundant than calcium and appears to play a vital role in coral calcification. The carbonate ion concentration in surface water decreases substantially in response to future atmospheric $CO_2$ increases, reducing the calcification rates of some of the most critical $CaCO_3$ producers. These include corals and calcareous algae on coral reefs and planktonic organisms such as coccolithophores and foraminifera in the open ocean.

The calcification rates of corals also depend on other factors such as temperature. It has been estimated that an average decline of reef calcification rates of 6–14 % as atmospheric $CO_2$ concentration increased from pre-industrial levels (280 ppmv) to present-day values (370 ppmv). The temperature and calcification rates are correlated, and these corals have so far responded more to increases in water temperature (growing faster through increased metabolism and the increased photosynthetic rates of their zooxanthellae) than to decreases in carbonate ion concentration. To boost calcification, however, the temperature increase must remain below the corals' upper thermal limit. A lowered calcification rate means that calcifying organisms extend their skeletons more slowly and form frames of lower density. Lower extension rates reduce the ability of corals to compete for space on a reef. The reduced skeletal mass means less resistance to breakage (analogous to osteoporosis in humans) and higher susceptibility to both physical breakdown and bioerosion.

The reef-building occurs where calcium carbonate precipitation exceeds its removal. The structural components of reefs (skeletons of corals and algae) are glued together and made more resistant to physical breakdown by calcium carbonate cement that precipitates within the reef framework and by the overgrowth of thin layers of calcareous algae. A reduction in $CaCO_3$ precipitation by whatever means (mortality of reef organisms, lowered calcification rates, or decreased cementation rates) reduces a reef's ability to grow and to withstand erosion. Some slow-growing or weakly cemented reefs may stop accumulating or shrink as carbonate deposition declines and erosion increases. The future changes in seawater chemistry will not only lead to decreases in calcification rates but also increases in $CaCO_3$ dissolution.

**Sea Level**

The predicted rise of sea level due to the combined effects of thermal expansion of ocean water and the addition of water from melting ice caps and glaciers is between 0.1 and 0.9 meter by the end of this century. The sea level has remained relatively stable for the last few thousand years,

and many reefs have grown to the point where they are sea-level-limited, with restricted water circulation and little or no potential for upward growth. Modest sea-level rise would, therefore, be beneficial to such reefs. Although sea-level rise might "drown" reefs that are near their lower depth limit by decreasing available light, the projected rate and magnitude of sea-level rise are well within the ability of most reefs to keep up. A more likely source of stress from sea-level rise is the sedimentation due to increased erosion of shorelines.

**Ocean Circulation Changes**

The change in the ocean circulation due to wind-driven upwelling and has led to the global climate change. Virtually all coral reefs at high latitudes occur where boundary currents deliver warm waters from tropical regions (e.g., Bermuda near the Gulf Stream). The changes in the path or strength of these currents impose different temperature regimes on these reefs. There has been concern that present ocean thermohaline circulation (THC) of 0-40% will be severely hampered by the change in ocean temperature and freshwater runoff.

**Precipitation and Storm Patterns**

The tropical precipitation has increased over the past century by 0.2–0.3 % per decade in the 10°S-10°N region and the frequency of intense rainfall events is very likely to increase over most areas. The increases in precipitation can lower salinity and increase sediment discharge and deposition near river mouths, sometimes leading to mass mortalities on nearby coral reefs. The frequency and intensity of droughts are also expected to increase, which may cause changes in vegetation cover and land use that lead to erosion and sediment stress when rains return.

**MEASURES TO PROTECT CORAL REEFS FROM CLIMATE CHANGE?**

1. Establishment of new marine protected areas (MPAs): There is a need to create some new MPAs in the regions that are less prone to bleaching events because of local cold-water currents or upwellings.
2. Reduction of pressures on coral reefs. The countries and communities need to enforce laws against coral destruction, as well as control pollutants, and promote sources of construction material other than coral.
3. Integrated Coastal Zone Management (ICZM) Controlling coastal development through a strategy can help protect reefs from long-term stresses.
4. Identify ways to adapt. The governments of island nations need to assess ways to adapt to these changes in coral reefs and develop a national strategy to deal with these impacts in consultation with local communities and the private sectors.
5. Adopt policies and treaties. Some of the policies drafted by UNFCCC, IPCC, and Kyoto climate change convention is needed to be amended for reducing greenhouse gas emissions and mitigating climate change.
6. Protect and enhance ecosystems. The government should ensure natural carbon sequestration by protecting the ecosystem like forests and wetlands which contributes to control a significant amount of carbon dioxide and other greenhouse gases to the atmosphere.

***Reference can be provided on request.***


## Aqua International

**Statement about ownership and other particulars about newspaper / Journal, Aqua International, to be published every year in March.**

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I, Meer Abdul Nazeer, hereby declare that the particulars given above are true to the best of my knowledge and belief.

Date: 1 March 2019

M.A. NAZEER
Publisher

# Fisheries management through legislative framework in Assam

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## Introduction

Fish is an important constituent in the diet of the people of Assam. The preference for fresh local fish mostly sheds meat items in Assamese households. Interestingly 90% of the population of the state comprises of fish eaters (Chutia et.al, 2018). Similar is the importance of fish catching as numerous traditional gears and traditional fishing methods are employed here. Fishing may be done for recreation or as a major means of livelihood as is done by the Kaibartas, the traditional fishing community of the state (Haque et.al., 2017). The fishing activities are supported by the availability of ample water resources. However the sustainability and maintenance of these resources requires a level of management. This is brought about by legal interventions. Entry 21 of list II of the seventh schedule of the constitution of India lists fisheries within territorial waters as a state subject.

The concept of conservation of fish is not new to India. Through several edicts of king Ashok in 246 B.C. the catching of fish was prohibited by the king during the period of the 3rd Chadurmesi (Jhingran et.al., 1988). However, the regulation and governance of fisheries is a rather complex phenomenon. The inland water resource such as rivers, wetlands and large size community ponds may be subject to the tragedy of the commons as they are having open access and are common property resources.Ownership of inland water bodies other than small ponds vests with the government and the fishing rights of reservoirs and beels are given to individuals, groups and communities according to norms that vary across the states. Rivers are generally fished as a common pool resource with free access, except in a very few States that auction river stretches to individuals(Sugunan et al., 2010).Therefore they require co-managed efforts between legal as well as social and cultural framework. The social framework includes all the customary measures or arrangements and norms established by the society for conservation of such water resources.

Legislations governing fisheries resources and their utilization in the state are under The Assam Fishery Rule 1953 as amended up to The Assam Fishery (Amendment) Rule 1953. Although fisheries legislation covers many aspects including rulings for sale of fish, settlement of disputes etc, the legislations stressing on conservation efforts of fisheries in the state will be described in the present article.

## Highlight Points

- **Regulation and governance of fisheries in the State**
- **Legislations governing fisheries resources and their utilization in the state are under the Assam Fishery Rule 1953**
- **Formation of committee for state fisheries department**
- **Assam private fisheries protection act, 1935**

## Fishing without authority

Under the Assam Fishery Rules, 1953 all fishing without a lease previously

obtained from the Deputy Commissioner of the district concerned or such other officer as he may appoint for the purpose in the fisheries of the province proclaimed under section 16 of the Assam Land and Revenue Regulation, 1886 is prohibited. Any person fishing in the proclaimed waters must carry his/her lease or an authority from the lessee or produce it when called upon to do so by any officer duly authorized.

## The Indian fisheries act, 1897

Provisions: Under sections 8 and 10 of the general clause act, 887, the act shall be read as supplemental to any other enactment for the time in force relating to fisheries in any part of India except Burma.

- Under this act the use of dynamite or other explosives, poison, lime or other noxious substances in any water body with the intent of catching fish is prohibited. In Assam the practice of retting of jute to pollute the water has been banned since 1953. If any person(s) is found adopting such practice will be subject to imprisonment that may extend to two months or to the payment of requisite amount of fine.
- Restrictions are imposed on the use of certain gears and nets. The sizes of gaps in bamboo fencing used for fishing in Assam have been limited. From 1st June – 5th July drag nets of mesh size 2.2 inch is not allowed in any water body in the state
- The use of Berjal/Mahajalor Fasijalor any type of net with meshes less than 7 cm bar/ 14 cm mesh is prohibited during the breeding season.
- The use of net with less than 1 cm bar/ 2 cm mesh Mosaijalin size is prohibited in any Fishery throughout the year.
- No movable Bana with gap less than 7 sq.m shall be used for fishing between 1st May and 15th July in any rivers, Dobas orBeelsor Fisheries.
- The state government may, by notification in the official gazette, declare any specified water body as a sanctuary. This is done to prevent fishing therein for a period not extending two years or declare any period to be closed season for fishing in any Fishery.

Essentially the environment protection act, 1986 is an umbrella act containing provisions for all environment related issues. Also included are the wildlife protection act, 1972 and water (prevention and control of pollution) act, 1974. These acts must be read in conjunction to one another to gain a full picture of the rules that are applicable to aquaculture.

**The Assam fish seed act, 2005**

Provisions: It is under the Assam act no. XIV of 2005. The act is in force to regulate the quality of fish seed to be used for production, marketing and for stocking in the water bodies of the state of Assam. Here the term fish seed includes fish eggs, spawn (up to 8mm), fry (8-40 mm), fingerling (40-80mm), advanced fingerling (80-150mm).

**Formation of committee** - Within three months after the commencement of this act a state level seed committee has been formed chaired by the principal secretary of the state fisheries department. Other members include the director of fisheries, managing director, principal scientist, senior scientist, one nominated fish seed producer and the deputy director of fisheries. The nominated members keep their seats for a period of three years after which they can opt for re-nomination. The functions of the committee include the following:

- Suggest the state department on matters related to fish seed production, marketing, rearing, stocking, transport, import and export
- Support the formation of fish seed producer associations
- Designing and collecting of reports on related matters from the district fishery development officer
- Submission of annual report to the state government

Under this act the production and marketing of fish seeds of species provided in the list is prohibited without registration and grant of license by the state government under section 7.If any persons(s) contraveneany provisions under this act he may be subject to requisite amount of fine in the first instance and fine/imprisonment in the second instance which can extend up to 6 months.

The list of fishes include 27 indigenous species of fish namely Acrossocheilushexagonolepis, Anabustestudineus, Catlacatla, Channamarulius, C.punctatus, C.striatus, Cirrhimusmrigala, Cirrhinusreba, Clariusbatrachus, Heteropneustesfossilis, Labeobata, L.calbasu, L.dero, L.dyocheillus, L.gonius, L.nandina, L.rohita, Mystusaor, M.menoda, M.seenghala, Notopteruschitala, Ompokbimaculatus, O.pabho, Puntius sarana, Rita rita, Tor putitora, T. tor and four species of exotic fishes namelyCtenopharyngodonidella, Cyprinus carpio, Hypothalmichthys molitrix and Puntius javanicus

The Assam private fisheries protection act, 1935

Provision: It is under the Assam act no. I of 1935. It is an act for the protection of the right of fishing in private waters which are properties belonging exclusively to a person(s). The Indian fisheries act, 1897 is to be read as supplemental to this act. Under this act if any person fishes in private waters, uses or puts any fixed engine for the purpose of catching fish or destroys fish without the permission of the permission of the person(s) to whom the right of the fishery therein belongs, shall be guilty of an offence.

Contrivance of the first instance will be charged with the requisite fine followed by imprisonment/ fine in the second instance. The term of imprisonment will not exceed one month. The offences committed under this act are considered as cognizable offences.

Department of Fisheries

The Department of Fisheries was formed in 1948 under the Department of Cottage industries. In 1950 it was attached to the Agriculture Department. In 1963 it was again attached to the Department of Veterinary and Animal Husbandry. Finally, in December 1991 decision was taken regarding the creation of a separate Department of Fisheries. The Department along with the Extension machinery is dedicated to the development of Fisheries and Aquaculture in the state through the adoption of appropriate technology. To secure access to the water bodies by the fisher communities they are given on lease period which has been mentioned as five years. The larger water bodies such as beels are under the fisheries department which the department than leases to the fisheries cooperatives.

**Conclusion**

The major challenges for promotion of inland fisheries have been identified as access to the water bodies and proper management of the fisheries resource for development. Regulation of fisheries resources is under the influence of multiple dimensions such as legal, social, economic and political influences. Therefore to draw a conclusion it can be said that strict adherence to legislation alone cannot be a permanent solution, orientation between legal set-up and sustainable stakeholder practices is necessary to come up with area specific effective solutions. Earlier times have proved that local inhabitants can live in amiable terms with nature. Therefore, the fisher communities in periphery areas need to be organized in order to draw strong co-managed efforts through participatory and community regimes. They may establish community norms towards non-use of destructive fishing methods or prohibiting fishing during breeding period. Furthermore, participatory campaigns can be initiated for effective management of open water bodies such as wetlands, river basins and other inundated areas.

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***More Reference can be provided on request.***

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