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Inside...

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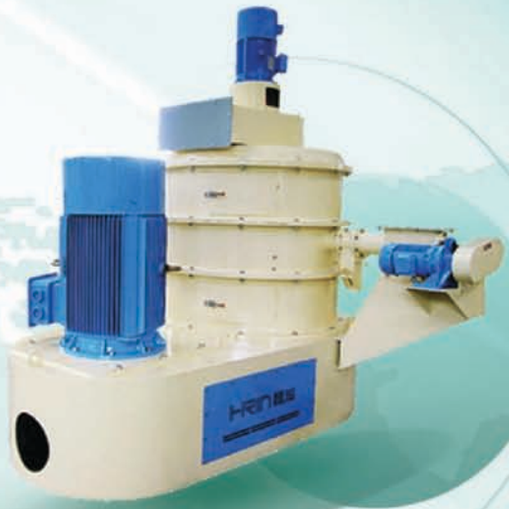

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Fisheries sector has high potential to improve lives of people in African Asian countries

Dear Readers,

The November 2019 issue of ***Aqua International*** is in your hands.

In the News section, you may find news about Dr Manoj Nardeosingh, Secretary General of African Asian Rural Development Organisation (AARDO) advising regional cooperation between African Asian countries is vital to improve the fisheries sector in respective countries. Fisheries sector has high potential to change the lives of the people in many African Asian countries. The sector can play a vital role in the economic development of these nations. He was speaking at the valedictory of an international workshop-cum-training organised by the Central Marine Fisheries Research Institute under the auspices of the AARDO.

The Marine Products Export Development Authority has yet again won the Union government's Rajbhasha Kirti Puraskar for the best in-house implementation of Hindi as the official language.

Aquaculture is one way to meet Asia's growing demand for seafood, but using fish as feed could worsen the problem of declining fish stocks globally. What alternatives has the industry come up with to end this 'fish-eat-fish' world? From conveyor belt sushi to grilled fish stalls on the streets of Bangkok, the popularity of seafood as a source of protein is on the rise globally. This is particularly so in Asia Pacific, which is predicted to account for 70 per cent of global seafood sales in the next 13 years, according to the Food and Agriculture Organization of the United Nations (FAO). Small-scale fisheries are also an important source of income and food in Asia, employing over 30 million people in coastal communities.

In October 2019, the National Marine Fisheries Service (NMFS) published its Draft Outline for a Work Plan for a Federal Aquaculture Regulatory Task Force (Draft Outline) in the Federal Register Notice. The Draft Outline identifies three goals that NMFS intends to use to improve regulatory efficiency for freshwater and marine aquaculture, as well as streamline regulations and management decisions.

Vietnamese officials have announced plans to substantially increase the size of its marine aquaculture sector. The country's marine aquaculture sector has been growing by 20 percent every year since 2010 and produced 431,600 tonnes of fish and shellfish, from an area of 258,000 hectares, in 2018.

Despite this rapid growth the Ministry of Agriculture and Rural Development has drafted a marine aquaculture strategy for the period up to 2030.

In the Articles Section, article titled "Asian Aquaculture: How Far the Rest of the World Are?" by S. S. Rathore, M. A. A. Mamun, S. Nasren, Nitin K. Suyani and M. Junaid Sidiq, discussed about South Asia and Southeast Asian countries are the leading contributors to fish and fishery products in the world fish market. Countries such as China, Indonesia, India, Vietnam and Myanmar contest to be known as the prime fish producer in Asia, though China stands to be the biggest producer and consumer of fish since 2010 as stated in World Fisheries and Aquaculture Report of 2018. This article briefly explained about the recent advances and newly adopted technologies by the different Asian countries for the rapid growth of aquaculture in a sustainable way which make Asia at the top in aquaculture production.

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

M.A.Nazeer
Editor & Publisher
Aqua International

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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.

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Regional cooperation key to boost fisheries in Afro-Asian nations: AARDO Secretary General

Kochi: Regional cooperation between African Asian countries is vital to improve the fisheries sector in respective countries, said Dr Manoj Nardeosingh, Secretary General of African Asian Rural Development Organisation (AARDO).

"Fisheries sector has high potential to change the lives of the people in many African Asian countries. The sector can play a vital role in the economic development these nations", he said.

AARDO Secretary General Dr Manoj Nardeosingh

*His Excellency Dr Manoj Nardeosingh, who hails from Mauritius, took over the charge of office of the **Secretary General** of **AARDO** on 03 September 2019 after having been elected by the Special Session of **AARDO** Executive Committee held in New Delhi, India on 11 June 2019.*

He was speaking at the valedictory of an international workshop-cum-training organised by the Central Marine Fisheries Research Institute (CMFRI) under the auspices of the AARDO.

Urging the scientists and professionals working in the sector to seek regional collaborations for the betterment of the fisheries, he said that focusing on value addition would help transform the lives of coastal communities. "The member countries of AARDO can earn benefits by connecting together, transforming technologies and through exchange schemes", he added.

The AARDO Secretary General appreciated CMFRI for the smooth conduct of the training programme for the member countries for the third consecutive year and he expressed his willingness to cooperate with the CMFRI in the coming years too.

The workshop was aimed at imparting training on a range of topics such as marine fisheries assessment, fish stock estimation, marine fisheries environment, impact of climate change on fisheries, responsible fisheries and mariculture activities.

Fisheries officials from Lebanon, Jordan, Iraq, Oman, Morocco, Zambia, Malawi, Mauritius, Malaysia and Sri Lanka attended the 15-day workshop at the CMFRI. The programme was part of an international collaboration between the Ministry of Rural Development, Government of India and the AARDO, which is an inter-governmental organisation in the field of agricultural and rural development with its headquarters in New Delhi.

Dr A Gopalakrishnan, Director of CMFRI presided over the function. Dr C N Ravi Shankar, Director of Central Institute of Fisheries Technology was the chief guest at the function. Dr Imelda Joseph and Somi Kuriakose spoke on the occasion.

MPEDA wins top Rajbhasha Kirti Puraskar for in-house Hindi promotion

Kochi: The Marine Products Export Development Authority (MPEDA) has yet again won the Union government's Rajbhasha Kirti Puraskar for the best in-house implementation of Hindi as the official language.

At a function in Delhi last month, Home Minister Mr Amit Shah gave away the 2018-19 award to Mr K S Srinivas, chairman of the Kochi-headquartered MPEDA which is a statutory body under the Union Government's Ministry of Commerce & Industry.

Last year too, the MPEDA had bagged the top prize of this award given to the country's departmental establishments and central public-sector undertakings.

Tasked with coordinating with different central and state government establishments engaged in fishery production and allied activities, the 1972-founded MPEDA works for increasing the exports of fisheries, specifying their standards, processing, marketing, extension and training in various aspects of the industry.

Fisheries officials from Afro-Asian countries visit Munambam harbour

A team of foreign fisheries officials observing a bull shark during their visit to the Munambam fishing harbour, as part of an international workshop being held by CMFRI.

Kochi: A team of fisheries officials from 10 member countries of African Asian Rural Development Organisation (AARDO) paid a visit to the Munambam fishing harbour to get a glimpse of the operational structure of marine fisheries sector of India. Aimed at having an awareness on commonly caught fish varieties and their market chains, the visit was part of an international 15-day workshop being organised by the Central Marine Fisheries Research Institute (CMFRI) under the auspices of the AARDO.

Diversified fish varieties, heaps of fishes for fish feed mills, a giant-sized bull shark accidently caught in a trawl net and active auctioneers doing brisk business drew their attention at the harbour.

The team, whichincluded officials from Lebanon, Jordan, Iraq, Oman, Morocco, Zambia, Malawi, Mauritius, Malaysia and Sri Lanka, was keen to understand the entire market chain of the fishes connecting fishermen to consumers. Surprised by the huge quantity of fishes going for the fish meal plants, the team was equally amazed to find a huge diversity of fishes being landed in the harbour, from small varieties like anchovy and sardine to large sized carangids and tuna. They also showed interest in identifying the most sought after fish varieties for domestic and overseas markets differently. The team was excited to understand the role being played by fish auctioneers in the fish market value chain.

Eager to understandthe scientific methods of estimation of fish landings, the overseas officials keenly observed the CMFRI officials while the latter taking landing samples using the stratified multi-stage random sampling method. A team of CMFRI researchers and fisher folks in the harbour helped them to learn in detail about the activities in the harbour and the fishes landed there.

The workshop is aimed at imparting training on a range of topics such as marine fisheries assessment, fish stock estimation, marine fisheries environment, impact of climate change on fisheries, responsible fisheries and mariculture activities like cage farming, along with practical sessions. They will be provided with an opportunity to visit the regional research centres of the CMFRI located at Mandapam and Vizhinjam.

The programme is part of an international collaboration between the Ministry of Rural Development, Government of India and the AARDO, which is an inter-governmental organisation in the field of agricultural and rural development with its headquarters in New Delhi.

New species of fish discovered in a well in Kozhikode

A research team led by the Kerala University of Fisheries and Ocean Studies (Kufos) has discovered a new species of miniature well-dwelling subterranean fish from Kozhikode.

The new species which has been named Pangio bhujia is the first species of eel-loach in the world that has been discovered to be living in subterranean environments. Eel-loaches are generally found in fast flowing streams in South and South East Asia.

A team comprising scientists from Kufos, IISER (Pune), Malabar Awareness and Rescue Centre for Wildlife (MARC), Kannur and Natural History Museum, NHM (London) discovered this fish living in a six-meter-deep homestead well used for drinking and irrigation, as well as from a channel connecting a pond to an adjacent paddy field in the village of Cherinjal in Kozhikode in April. Subsequent studies on its anatomy and genetic structure revealed that this fish represents a never-before known species of eel-loach.

"This is an exceptional discovery," said Rajeev Raghavan, Assistant Professor at the Department of Fisheries Resource Management, Kufos who led the study. The new species has several unique characters including the absence of dorsal fin, which has never been encountered in the genus Pangio to which this new species belongs to, and is also unique among the order Cypriniformes and highly unusual even among teleost or bony fishes generally, he said.

Training on Shrimp Disease Diagnosis organized at Kolkata

Dr Aranguren taking a class

A five-days training programme on shrimp disease diagnosis was organized by Department of Fisheries, Government of West Bengal during October 21-25, 2019. It was held at the Office of the Dy. Director of Fisheries (Microbiology & Parasitology), Pailan Research Centre, Kolkata and Departmental officers (FEOs and AROs) participated in it. Dr Luis Fernando Aranguren Caro, Research Scientist and crustacean pathologist from Aquaculture Pathology Laboratory, University of Arizona, USA was the resource person. He discussed about shrimp diseases worldwide; histological (HIS) preparations of previously-important and emerging diseases in economically-important farmed shrimps in Asia, SE Asia and Latin America; diagnostic procedure based on HIS studies and such techniques (preparations); ability to detect a potential pathogen in diagnostic laboratory as the skeleton of disease diagnosis; Enterocytozoon hepatopenaei (EHP) as the major pathogen with White Faeces Syndrome in shrimp farms in Andhra Pradesh and Tamil Nadu; PCR and histopathology as main tools for pathogen detection; importance of reliable positive control and non-detectable control for PCR studies; use of clean (SPF) shrimp stocks; gross anatomy and normal histology of shrimps; economic implication of White Spot Disease outbreaks in shrimp industry.

Dr Aranguren also explained different concepts like tolerant and resistant shrimps to different pathogens, acute and chronic infection, enteric and systemic viral pathogen in shrimps; different diagnostic methods (hazard identification), viz., histopathology, microbiology, molecular biology, bioassays, pond history and fresh mounts; wet mounts and direct microscopy in tissues; EHP as most important pathogen after WSSV and shrimps die due to chronic infection; use of greenhouse nets over and around shrimp ponds to increase water temperature (T) by 3-4°C and prevention of WSSV outbreak. Pathogenicity of WSSV increases when water T is low and shrimps do not die when they are WSSV-infected in summer. Viral copies of WSSV observed to be more in haemolymph of L. vannamei than in P. monodon. WSSV-infected ponds are dewatered and sun-dried as UV radiation can inactivate WSSV. Reddish body discolouration observed in infected L. vannamei but white spots in cuticle not found. Acute mortality due to IHHNV is more in P. stylirostris than in L. vannamei and the latter preferred for commercial culture. EHP-infected shrimps exhibit white faeces (observed in GI tract and pond periphery) and soft shell in later stages.

Dr Aranguren explained improved shrimp farming techniques in different countries; studies on pond behaviour and gross clinical signs {melanization, erosive areas due to white spots, reddish discolouration in stressed shrimps and expansion of chromatophores, soft shell not related to moulting, colour of GI tract and hepatopancreas (HP) of shrimp} association of microscopic ciliated protozoa with brownish discolouration in gill lamellae; white discolouration of HP during EMS acute phase infection; prevalence of Vibrio sp in shrimp ponds and its control by using molasses @ 20kg/ha that will encourage growth of harmless sucrose positive Vibrios. He also discussed about biosecurity in shrimp industry and

Dr Aranguren at shrimp farm wih participants

Dr Aranguren speaking at Faculty of Fishery Sciences

explained in detail the characteristic features, host shrimp infected, target tissues of infection, manifestations of infections and lesions (as observed in histological slides) and control (preventive) measures of different viral pathogens WSSV, IHHNV, HPV, BP, MBV (DNA viruses), YHV, TSV (RNA viruses), microsporidian parasite EHP, bacterial diseases AHPND and Vibriosis.

At the shrimp farm located at Nafarganj, P.S Basanti, South 24 Parganas, Dr Aranguren demonstrated sampling of sick and weak L. vannamei, P. monodon and giant prawn for HIS analysis; noted condition of ponds, days of culture, their stocking density, body weight; demonstrated body features of healthy and sick specimens of sub-adult shrimp; preparation of Davidsons' fixative, its injection into HP and abdominal segments and whole body fixation in polystyrene bottles; collection of pleopods and HP for detection of systemic and enteric pathogens respectively in 95% ethanol for PCR analysis. At laboratory, he demonstrated presence of intranuclear inclusion bodies and occlusion bodies in different prepared slides, focalized melanization, cowdry type A inclusion bodies (for IHHNV), lipid droplets in HP, pyknotic nuclei, EHP spores & plasmodial stage and other specific observations under microscope; drawing out haemolymph from base of 1st pair of pleopods for wet mounts, determination of its clotting time, its inoculation on TSA and TCBS media for observation of Vibrio colonies; dissecting out HP, GI tract content and gill filaments on glass slides and their microscopic observation; explained features of grown green and yellow Vibrio colonies in TCBS plates and presence of Zoothamnium sp in gill filaments in one slide. It was a highly educative training programme, which was very well coordinated by DDF Dr M. K. Sahoo and ADF Mr S. Saha. News communicator Subrato Ghosh was one of the participants.

Dr Aranguren at laboratory

Dr Aranguren delivered Special Guest Lecture on the topic 'Health Management in World Aquaculture - Shrimp culture: a case study' at Faculty of Fishery Sciences, WB University of Animal and Fishery Sciences, Kolkata on 25 October 2019 evening, in which Faculty teaching staff, BFSc, MFSc and PhD research students participated attentively.

As aquaculture booms, it's consuming more fish than it produces

Aquaculture is one way to meet Asia's growing demand for seafood, but using fish as feed could worsen the problem of declining fish stocks globally. What alternatives has the industry come up with to end this 'fish-eat-fish' world?

From conveyor belt sushi to grilled fish stalls on the streets of Bangkok, the popularity of seafood as a source of protein is on the rise globally.

This is particularly so in Asia Pacific, which is predicted to account for 70 per cent of global seafood sales in the next 13 years, according to the Food and Agriculture Organization of the United Nations (FAO). Small-scale fisheries are also an important source of income and food in Asia, employing over 30 million people in coastal communities.

But although farmed seafood is touted as a more environmentally friendly source of protein—land-based livestock farming now facing fierce criticism and wild fish stocks in drastic decline—one issue remains a thorn in the side of farming seafood or aquaculture: fish feed.

Known in the industry as forage fish, species lower down in the food chain such as anchovies and sardines are turned into fishmeal and fed to farmed fish, and contributes to unstable fish populations. For instance, a study has found that aquaculture worsens the problem of falling fish populations in China.

Furthermore, feeding fish to fish is also inefficient. For every kilogram of salmon produced, for example, the farmer uses two kilograms of fishmeal over the course of the animal's life.

Michael Philips, director of aquaculture science and fisheries at WorldFish, an international research organisation headquartered in Malaysia, explains: "A fair proportion of the fish production on the planet relies on fish feed. As we get intensive with our farming and try to increase productivity from the water to meet global demand for fish, demand for the fish that feed them grows even more."

Alternative protein for fish feed

With the global spotlight on illegal, unregulated fishing and wild fish stocks at an all-time low, the aquaculture industry is looking to alternatives to forage fish.

One organisation doing this is the new Aquaculture Innovation Centre (AIC) at Temasek Polytechnic in Singapore, which is dedicating the first three years on research into optimal nutrition for fish farmed in intensive, high-tech environments.

Centre director Dr Lee Chee Wee reveals that the centre is experimenting with different food pellets with reformulated nutrients that will be able to meet special requirements of urban fish farming and keep the animals healthy even under stressful conditions.

Due to Singapore's limited land area, aquaculture farms are built vertically with tanks stacked on top of one another. Packed tightly, the marine creatures can suffer from heightened stress levels from being packed densely together.

"The best feed is still protein, which comes from fish meat. But catching fish to feed fish doesn't make sense, and there's no longer any fish for you to catch anyway," says Lee.

According to him, the answer to sustainable aquaculture lies in cities, where large quantities of high quality waste, such as food waste, are produced. As part of the centre's research, he is investigating how waste products can be processed into fish feed.

"Every city has their own urban waste and this waste is usually disposed with at a cost, but we can actually turn that into a high-quality valuable product for the fish. With urban fish farming, there's huge potential to have a very small environmental footprint," he says.

Fish-free opportunities for business

Companies are jumping on board the business of alternative fish feed to address the depletion of wild fish stocks and deliver health benefits to seafood consumers.

One example is a joint venture by DSM and German chemicals company Evonik. Veramaris cultivates marine algae rich in omega-3 fatty acids eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA).

Using technology developed by US space agency NASA in the 1960s, Veramaris produces an omega-3 algal oil that Karim Kurmlay, chief executive officer, says is

richer in EPA and DHA than alternatives and more than twice as rich as feed grade fish oils, leading to more benefits to both fish and consumer health.

"This innovation will help alleviate pressure on over-fished wild fisheries, enable the salmon industry to become a net producer of fish, help improve marine biodiversity and allow the salmon industry to raise the omega-3 levels in the fillet sustainably," says David Nickell, vice president of sustainability, animal nutrition and health at DSM, adding that the Veramaris facility can produce the amount of algal oil equivalent to 1.2 million tonnes of wild-caught forage fish in a year.

Farmers include fish oils in feed because fish must get sufficient EPA and DHA omega-3 fatty acids to stay healthy, while the omega-3 levels in salmon have declined to less than half of what it used to be over the last decade, says Oyvind Ihle, Veramaris' global marketing and communications director. The main reason being that forage fisheries were not able to keep up with demand as well as cost considerations.

"Fish farming relying on fish oil as a source of omega-3 cannot grow much further as there is simply not enough fish in the ocean. On the other hand, if fish farmers could get alternative sources of EPA and DHA they could both relieve some pressure off [natural fish stocks] and get on a more sustainable growth path for their business," Nickell adds.

Catching fish to feed fish doesn't make sense, and there's no longer any fish for you to catch anyway.

Dr Lee Chee Wee, director, Aquaculture Innovation Centre, Temasek Polytechnic

Around the world, business have come up with other creative ways to produce fish feed that do not further exploit the marine environment.

In Africa, cassava waste is being processed to feed fish in farms, while start-ups in Asia are investing in cultivating black soldier fly larvae and single cell proteins derived from yeast and bacteria to replace fishmeal. There are many more ways to use ingredients to feed fish that are not competing in any way with human food, said WorldFish's Philips.

"The world is eating and likely needs to eat more seafood. But oceans have limited capacity to supply the seafood that the human population requires," he adds.

Experts predict that aquaculture will have to more than double production by 2050 to meet global demand, and that within the next two years, the amount of fish farmed will exceed that caught in the wild.

"This is a part of the food system that has changed very quickly over a short period of time, from very wild-based to being a production system split between the waters and farming," says Philips.

The impact of fisheries can be managed by using alternative feedstock so that rivers and oceans can be allowed to recover, even as they are harvested sustainably for food, he adds.

Shrimp Market - Growth, Trends, and Forecast (2019 - 2024)

Market Overview

- The global market for shrimps was valued at USD 45 billion in 2018, and it is estimated to register a CAGR of 5.2% during the forecast period, 2019-2024.
- -China and Thailand are the world's leading producers of shrimp, accounting for nearly 75% of the global shrimp production. In 2018, Thailand was the biggest shrimp producer with shrimp production of 2.59 million metric ton.
- Shrimp species, such as whiteleg shrimp, giant tiger shrimps, gulf shrimps, blue shrimps, and royal red shrimps, are the most popular varieties that are consumed all over the world.

Scope of the Report

A shrimp can be defined as a small-sized marine crustacean with an elongated body, typically consumed as food, hence, is of high commercial importance. The report presents a wide-ranging analysis of the size of shrimp markets, worldwide.

Key Market Trends

Contract Farming Initiatives by Exporters Driving the Market

One of the key drivers of the growth of the shrimp market is increasing production through contract farming. Under the contract farming, the commissioners, who are often the big export firms, supply the farmers with seeds, feed, and technology required for the production. In many developing countries, shrimp cultivation is also encouraged through various governmental policies, such as easy credit policies. One of the major challenges in shrimp farming is the outbreak of certain diseases, such as early mortality syndrome. A recent outbreak of the early mortality syndrome disease in China and Thailand, especially across the contract farms, has impacted the shrimp production and its global supply to a considerable extent, in 2016 and 2017.

Asia-Pacific Leads the Shrimp Market

Asia-Pacific has been leading the shrimps market for a long period of time. Thailand has been the largest exporter of shrimp to the United States, which is the world's biggest market for shrimp, for almost every year. As the early mortality syndrome disease impacted the Thailand shrimp production, India emerged as one of the largest producers and exporters of shrimps in 2018. Adoption of Pacific white shrimp as the prominent species by the India's growing aquaculture industry, especially in the contract farming sector, is one of the main factors, which helps India to expand more into the US shrimp market.

NMFS Seeks to Streamline Aquaculture Permitting while a Washington Federal Court Interjects Caution

In October 2019, the National Marine Fisheries Service (NMFS) published its Draft Outline for a Work Plan for a Federal Aquaculture Regulatory Task Force (Draft Outline) in the Federal Register Notice. The Draft Outline identifies three goals that NMFS intends to use to improve regulatory efficiency for freshwater and marine aquaculture, as well as streamline regulations and management decisions.

1. "Improve the efficiency and predictability of aquaculture permitting in state and federal waters." Some of the objectives identified to achieve this goal include expanding the categories of use for the Army Corps of Engineers (Army Corps) Nationwide Permit 48 (NWP 48), and NPDES general permits or developing new general permits, creating regional interagency groups and regional permit processes, and establishing federal processes for testing and certifying the human health requirements of aquaculture in federal waters.
2. "Implement a national approach to aquatic animal health management of aquaculture." Identified objectives for attaining this goal include collaboration among partners and stakeholders to establish standards or guidelines for aquatic animal and aquaculture health, as well as further clarifying and defining federal agency roles in the import and export of aquatic animals.
3. "Refine and disseminate tools for aquaculture regulatory management." Objectives for this goal include identifying and preparing work plans for additional scientific information needed for permit reviews, consultations, and policy decisions, as well as "identifying two marine waters where methods for improving efficiencies and the siting, permitting, and authorization of aquaculture operations can be tested and demonstrated."

The public comment period closes on November 8, 2019.

Given the rise in freshwater and marine aquaculture, particularly in Washington, the goals and objectives contained within the Draft Outline could provide clarity for both growers and agencies. Implementation of some of the objectives in the Draft Outline, however, could face legal challenges—particularly those aimed at expanding categories of use for NWP 48.

Last week, a Washington federal court judge issued a ruling in two cases regarding NWP 48 and its application to commercial shellfish aquaculture. Plaintiffs challenged the Army Corps' reissuance of NWP 48 "authorizing discharges, structures, and work in the waters of the United States related to commercial shellfish aquaculture activities." They argued, among other things, that the Army Corps failed to comply with the Clean Water Act and the National Environmental Policy Act (NEPA) when it reissued the Permit in 2017. The court agreed, finding that the Army Corps "failed to adequately consider the impacts of commercial shellfish aquaculture activities authorized under NWP 48, that its conclusory findings of minimal individual and cumulative impacts are not supported by substantial evidence in the record, and that its [Environmental Assessment] does not satisfy NEPA requirements

Vietnam targets 65 percent growth in Marine Aquaculture industry

Vietnamese officials have announced plans to substantially increase the size of its marine aquaculture sector. The country's marine aquaculture sector has been growing by 20 percent every year since 2010 and produced 431,600 tonnes of fish and shellfish, from an area of 258,000 hectares, in 2018.

Despite this rapid growth the Ministry of Agriculture and Rural Development has drafted a marine aquaculture strategy for the period up to 2030.

According to the Vietnam Plus website, the ministry aims to increase annual marine aquaculture production to 710,000 tonnes by 2020 – an increase of 65 percent compared to 2018 levels.

By 2030 it aims to expand to 1.75 million tonnes, from an area covering 300,000 hectares, including 30,000 hectares of offshore production. In terms of value the ministry believes that exports from the sector will be worth US$4 -6 billion.

World Aqua feed Market Research Report 2019-2025: Processed Soybean is the World's Largest Source of Animal Protein Feed

Dublin: "Aqua feed Market by Species (Fish, Crustaceans, and Mollusks), Ingredient (Soybean, Corn, Fishmeal, Fish Oil, and Additives), Lifecycle (Starter Feed, Grower Feed, Finisher Feed, and Brooder Feed), Form, Additive, and Region - Global Forecast to 2025" report has been added to Research And Markets.com's offering.

The global aqua feed market size is projected to grow from USD 47.3 billion in 2019 to USD 71.7 billion by 2025, at a CAGR of 7.2% during the forecast period.

- This study covers the aqua feed market across various segments.
- It aims at estimating the market size and growth potential across different segments, such as species, ingredient, additive, lifecycle, form, and region.
- The study also includes an in-depth competitive analysis of the key players in the market, along with their company profiles, key observations related to product and business offerings, recent developments, and key market strategies.

Factors such as the growing aquaculture industry and increasing seafood trade are factors projected to drive market growth. However, fluctuations in raw material prices and the growing environmental and human health concerns are projected to hinder the growth of the market.

The aqua feed market comprises major manufacturers such as Cargill (US), Archer Daniels Midland Company (US), Alltech (US), Purina Animal Nutrition (US), Nutreco N.V. (Netherlands), and Ridley Corporation Ltd. (Australia). The study includes an in-depth competitive analysis of these key players in the aqua feed market, along with their company profiles, recent developments, and the key market strategies.

The fish segment, by species, is estimated to dominate the aqua feed market in 2019.

The fish segment accounted for the largest share in 2018, in terms of value. Fish is the cheapest and most easily digestible animal protein. However, due to excessive exploitation of resources and pollution, the availability of fish in natural waters has declined considerably. This has resulted in the adoption of various methods to increase production. The major types of fish considered for the study include tilapia, salmon, carp, and trout.

The soybean segment, by ingredient, is projected to account for the largest share during the forecast period in the aqua feed market

The soybean segment is estimated to dominate the aqua feed market in 2019. Soybean is among the non-fish sources of omega-3 fatty acids, proteins, and unsaturated fats. Soy protein is fed to farm-reared fish and shellfish to enhance their overall growth and development. Some of the commonly used soybean products in aqua feed include heat-processed full-fat soybean, mechanically extracted soybean cake, solvent-extracted soybean meal, and dehulled solvent-extracted soybean meal.

Asia Pacific is projected to be the fastest-growing region in the aqua feed market

The Asia Pacific market accounted for the largest share in 2018. According to a report published in 2018 by the National Bank for Agriculture & Rural Development (NABARD) on Fisheries and Aquaculture, countries, such as India, have focused on the adoption of freshwater aquaculture as their key activity, which has contributed to its market dominance. Also, consumer demand for convenience and processed seafood offers profitable growth prospects and diversification in the region's food sector. These factors are projected to significantly drive the market growth for aqua feed during the forecast period.

Key Benefits of Buying the Report

The report will help the market leaders/new entrants in this market with information on the closest approximations of the revenue numbers for the overall aqua feed market and its subsegments. This report will help stakeholders understand the competitive landscape and gain more insights to position their businesses better and to plan suitable go-to-market strategies. The report will also help the stakeholders to understand the pulse of the market and will provide them with information on key market drivers, restraints, challenges, and opportunities.

MSU Researcher Uses NSF Grant to Explore Variation in Electric Fish Shock Duration

The electric pulses emitted by electric fish can be quite variable in their duration: and as it turns out the reason can be quite "shocking." Jason Gallant, assistant professor in Michigan State University's Department of Integrative Biology in the College of Natural Science, has received a three-year, $680,000 National Science Foundation, or NSF, grant to continue work on a discovery that this variation may be due to unusual changes in a common protein called a potassium channel.

Gallant and members of his lab are broadly interested in the origin and diversity of unusual phenotypic and behavioral traits involved in animal communication signals.

"In this project, we will explore how genetic changes contribute to the evolution of new animal signaling behaviors, specifically in weakly electric fishes from Africa known as mormyrids," Gallant said. "These fishes use electricity not only to navigate through their environments but also to communicate with one another. Evidence suggests that when these fish develop new electric signals, these signals somehow facilitate speciation."

To generate electric pulses, the fish need both a sodium channel and a potassium channel. In earlier research, Gallant and his collaborators at the University of Texas, Austin noticed mormyrids have two copies of a potassium channel that most vertebrates, including humans, have only one of.

"What's interesting about this phenomenon is that the potassium channel in the electric organ accumulates mutations, which then change the function of the potassium channel," Gallant said. "Normally, the potassium and sodium channels in every other vertebrate are highly constrained to function very particularly. If you get one wrong amino acid, you get problems like seizures or the inability to move."

However, electric fish use these redundant potassium channels to make electric signals, an ability unique only to a handful of fish species. Evolution has acted on these channels by altering specific amino acids to operate much more rapidly than they normally work in the nervous system or muscles of humans. The end result is the ability to produce extremely brief pulses of electricity. This discovery is helping advance the understanding of the physics of ion channels work.

"When we look at the electric fish, we see a really strange substitution that actually teaches us about the physical properties of the ion channels themselves," Gallant said. "As a result, we are actually able to understand better how the charge on these particular amino acids contributes to the overall speed of the channel. This can be really important for developing drugs and for understanding how particular mutations contribute to diseases called channelopathies—diseases such as certain types of seizures or paralysis that affect ion channels, which can be very serious for motor and nervous system function."

After discovering how electric fish accomplish these brief pulses, Gallant and his lab are turning to understand how some electric signals become very long. Despite the strong selection on mormyrids for brevity early in their evolution, electric pulse duration varies widely across the more than 200 species of mormyrids: long duration EOD pulses have evolved at least three times from short-duration EOD pulse ancestors. Gallant's hypothesis is that these long-duration EODs are the result of additional mutations in the same potassium channelgene. This is the hypothesis that will be pursued under this new NSF grant.

"In this project, we will test this hypothesis by capturing some of these species in Gabon with very long electric pulses. We'll then bring them back to the lab here in Michigan, and sequence their potassium channel genes, and also evaluate how they physically function. The last step will be to examine which factors contribute to the evolution of long-duration EODs in the first place: for that, we will be conducting high-tech behavioral studies to ask whether these pulses allow fishes to find food differently or attract mates more effectively," Gallant said.

This multi-year investigation will provide a unique opportunity to understand the connection between genotypes (a particular set of genes carried by an individual) and phenotypes (the individual's physical characteristics). This is possible because a change in a single ion channel gene actually leads to a direct change in the behavior of the animal: in this case the behavior can be measured with just two electrodes, making the enterprise much simpler.

"A counterexample might help explain the value of this study based on the research we've already done," Gallant said. "Say that you were studying birds and asserted that a gene mutation affected bird song. You would have to know every step along the nervous system circuit and how every muscle along the way contributes to some change in that bird's song. Measuring a change in the ion channel is comparatively simpler. The story we are hoping to tell with this project is that we will identify mutations that cause alterations in the genome that lead to consequential changes in the phenotype of the animal.

"Additionally, while we're in the field, we're going to explore the factors that influence this evolution, and there are numerous possibilities," Gallant added. "One is that having a longer signal may allow a fish to catch bigger prey. Another might be that longer signals are sexier to males or females, so selection based on those channels include mutations that make those discharges longer. We'll be sorting all of this out in the field."

Malawi gets financial backing for fisheries and aquaculture sectors

Malawi's efforts to turn around its fisheries and aquaculture sector has received a major boost after the African Development Bank (AfDB) approved USD 13.2 million (EUR 11.8 million) in loans and grants to support sustainable capture fisheries, aquaculture development, and to revamp the country's fish value chains.

AfDB's financial support, which was approved in early October, includes USD 8.98 million (EUR 8.09 million) from the African Development Fund and a USD 4.21 million (EUR 3.79 million) grant. The government of Malawi, which reduced its budget for the Ministry of Agriculture by 12 percent in the 2018-2019 fiscal year, will provide USD 1.38 million (EUR 1.24 million) for the Sustainable Capture Fisheries, Aquaculture Development and Watershed Management project.

In the last financial year, Malawi's Ministry of Agriculture was allocated USD 206.6 million (EUR 186.1 million) of the country's USD 2 billion (EUR 1.8 billion) national budget, or an equivalent of 10.13 percent of total budget, which is less than the USD 233 million (EUR 209 million) it was allocated the previous financial year.

Although the national budgetary allocation is within the 2003 Maputo declaration on agriculture and food security, a large share of the ministry's budget is for recurrent expenditure, hence the importance of external financing to support the fisheries and aquaculture department, which provides 70 percent of dietary animal protein in Malawi and also directly employs more than 400,000 people.

With the AfDB financing, Malawi forecasts an increase in fish production with the construction and rehabilitation of several landing sites, acquisition of refrigerated trucks, and development of fish markets and processing facilities in addition to revamping fisheries research and upgrading road transport for market access.

The project, the bank said, will "contribute to nutritious diets, boost employment along the fish value chain and build climate resilience along watersheds."

At least 20,000 people in 11 districts within the Lake Malawi basin and others within three outlying districts will benefit directly from the project, which also entails the "promotion of commercial aquaculture ventures, integrated pond-based aquaculture systems and various pilots in selected areas as an adaptive measure to the changing offshore fisheries."

Another 250,000 people, such as the fish processors, retailers, vendors, and interns from training centers stand to benefit from the project as well. The project is expected to be at the heart of the implementation of Malawi's National Fisheries and Aquaculture Policy.

At the project sites where fisheries and aquaculture components will be implemented, the Malawi Bureau of Standards "will also be engaged to ensure that national and international standards are attained and thereby enhance food safety that is compliant with phyto-sanitary measures and Hazard Analysis and Critical Control Point (HCCAP)."

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Asian Aquaculture: How Far the Rest of the World Are?

Highlight Points

South Asia and Southeast Asian countries are the leading contributors to fish and fishery products in the world fish market. Countries such as China, Indonesia, India, Vietnam and Myanmar contest to be known as the prime fish producer in Asia, though China stands to be the biggest producer and consumer of fish since 2010 as stated in World Fisheries and Aquaculture Report of 2018. This article briefly explained about the recent advances and newly adopted technologies by different Asian countries for the rapid growth of aquaculture in a sustainable way which makes Asia at the top in aquaculture production.

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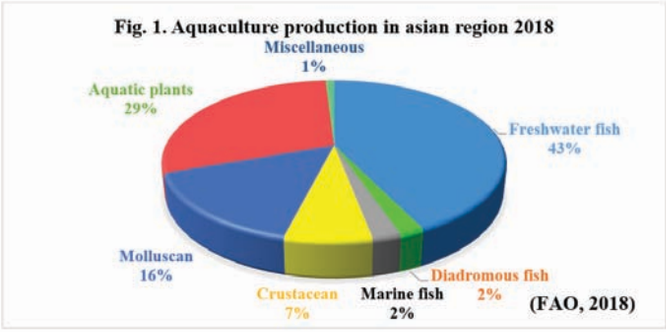
Introduction

The past 20 years have seen Asian aquaculture evolve from a traditional practice to a science-based activity and grow into a significant food production sector, contributing more to national economies and providing better livelihoods for rural and farming families. During the period 1990-2016, Asian aquaculture production grew from 16.85 to 101.21 million tonnes, increasing its value from US$27.1 billion to US$243.47 billion (FAO, 2018).

Aquaculture used to be regarded as an infant when compared with crop and livestock farming and capture fisheries. In most parts of Asia, the activity has matured to become a clearly defined economic sector that is better organized and characterized by state patronage and strong private-sector participation. Many changes have occurred alongside the sector's development. Aspirations for higher yields through technological innovation have been tempered with concerns for sustainability. Economically, the drive for higher profits has been qualified by schemes to distribute benefits fairly. As a commodity industry, the purposes of producing more food, earning higher incomes and improving economies have been expanded to include ensuring food security, alleviating poverty, and promoting social harmony and prosperity. These shifts in outlook, not confined to aquaculture and prompted by global and social forces, occurred in the last part of the previous century. It is in the midst of these changes that aquaculture development in Asia finds itself at the beginning of the new millennium (Kongkeo, 2001).

The status of Asian aquaculture

Asia dominates global aquaculture production. This simple statement covers, however, the extreme diversity encountered within the sector, not only in the species reared and the technologies and farming systems employed, but also in the role and objectives of aquaculture development in different countries, the priorities placed by governments and the threats and constraints to its growth(Fig. 1), Contribution of Asian aquaculture was, finfish - 88percent; crustaceans - 90 percent; molluscs - 92 percent; aquatic plants - 99 percent, and miscellaneous animals and products - 99 percent of the total production. The region provides 92 percent of global aquaculture production, where the top 10 Asian aquaculture producers are China, Indonesia, India, Viet Nam, Bangladesh, Philippines, Republic of Korea(also the top seven producers in the world), Japan, Thailand, and DPR Korea(Fig. 2) (FAO, 2018).



International trade in aquaculture products

By volume, Asia is a net importer of fishery products, mainly because of Japan's trading patterns where an annual trade deficit (exports less imports) of more than 3 million mt has been registered since 1994. If Japan is excluded from the trade data, the developing countries of

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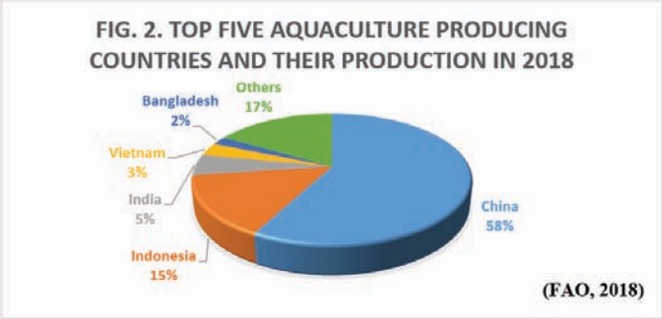
Asia would register a surplus of only 35 000 mt a year in the triennium up to 19979. The major net importers (with volumes over 100,000 mt) of fish are China, followed by the Philippines and Malaysia. The major exporters with volumes greater than 100,000 mt are India, Indonesia and Thailand. Of these, aquaculture production probably makes the biggest contribution in Thailand(FAO/RAP, 2000).



Quality of aquaculture products

The importance of aquaculture production in Asia and in particular that of freshwater fish, most of which are sold in the domestic market, has a significant bearing on the concerns of human health associated with products from aquaculture. The most common method of producing low-value freshwater fish in developing countries, especially in low-income food deficit countries (LIFDCs), is to use a combination of fertilizer application and supplementary feed. Polyculture of species that have complementary feeding habits is a general practice, especially with major and Chinese carps. However, the patterns of production are changing rapidly, with a large increase in more semi-intensive farming (WHO/FAO/NACA, 1999).

Agencies responsible for aquaculture development

In Asia, the primary responsibility for aquaculture production usually resides within one government ministry or department. By contrast, the management of the resources upon which aquaculture depends, particularly water and land, is normally the responsibility of other ministerial departments. This situation inevitably causes the potential for conflicts between different departments, and confusion or lack of clarity in the application of policy. As the private sector is the key to successful and sustainable aquaculture development, the views of industry should be taken into account in respect of policy formulation, research and development (FAO, 1995).

International developments

The adoption of the Code of Conduct for Responsible Fisheries (CCRF) by the 1995 FAO Conference (FAO, 1995) promises to provide a significant influence on the development of regulatory systems for aquaculture in the coming years. Article 9 of the Code deals with aquaculture development and sets out a wide range of relevant principles and criteria. In addition, the "Jakarta Mandate", which was adopted by the second Conference of the Parties to the Convention on Biological Diversity in 1995, provides useful guidance regarding aquatic biodiversity and related environmental aspects that should be taken into account when developing coastal aquaculture. Instead, new regulations will be incorporated under the existing Fisheries Act, and a voluntary Code of Responsible Aquaculture Practices will be introduced for cage culture and shrimp farming. These measures will be supported by incentives, and institutional structures will be strengthened to ensure the effective monitoring and continuing formulation of aquaculture policy.

Balanced resource use

There has to be a balanced and more efficient use of resources obtaining conflicts. This situation can be particularly acute when the government's capacity to enforce laws and regulations is limited. There is a growing awareness that environmentally friendly aquaculture makes good business sense, and this is particularly true for commercial producers. Recognized codes of practice require further development and implementation and are becoming particularly important for aquaculture products that are traded internationally (FAO, 1998).

Aquaculture and environmental rehabilitation

Activities practising with this prospects are the following (Kongkeo, 2001):

- Mixed aquaculture-mangrove systems are being used to restore mangrove habitats in some countries (e.g. Indonesia's tambaks or earthen ponds, Viet Nam's mixed farming systems);
- Coral reef fish mariculture provides an effective alternative to destructive fishing practices in coral reef areas;
- The rehabilitation of fish populations through stock enhancement; and
- Aquaculture itself is also a technique for the effective monitoring of environmental conditions.

Regional institutions and their assistance for capacity building

Apart from NACA, there are a large number of organizations and agencies that are active in aquaculture development in the region. If aquaculture is to sustain its growth momentum within the region more effort must be focused towards the building of human capacity. To be able to respond to and to meet the increasingly complex development challenges faced by aquaculture, this effort must be directed at all levels, from the farm worker to the policy maker. At the present, a proposal for a potential cooperative regional strategy to meet these needs is being prepared within the cooperative aquaculture education project of APEC/NACA/Deakin University (NACA, 1999).

Poverty alleviation and food security

Throughout the region, the expressed national goals and priorities concerning aquaculture have invariably included and even emphasized social goals. The key issue concerning this topic has been in respect of the emphasis given to commercial and/or export-oriented aquaculture, on the one hand, and to the small-scale food security oriented activities on the other. Both the levels and the balance of the support given to either subsector are part of this issue. It has to be said that increasing recognition is being given to the importance of small-scale, socially oriented aquaculture. Initiatives have been made recently at the regional level to focus the attention of both government and regional organizations on this issue(Kongkeo, 2001).

Technological advances over the last decade

The standard that is usually set for technological development in aquaculture is livestock husbandry and, by this measure, aquaculture is way behind. The three commodities that have received intense regional R & D attention, particularly for breeding and culture techniques, are shrimp, tilapia and carps, while milkfish, seabass and catfishes have received less attention.

Genetic improvement of aquaculture species in Asia has been most advanced for tilapias and carps. Surprisingly, despite their high value, work on shrimp genetics in Asia has been confined to academic research. The topic of feed development has seen some progress, and techniques to make feeds on the farm have been widely documented, improved and disseminated.

Research on mass seed production and hatchery systems has been successful for carps, tilapia, milkfish, freshwater prawn and indigenous freshwater species. The development of new species (particularly marine species) and aquaculture technologies is a key strategy for several Asian countries. The development and implementation of best management practices (BMP) will also require more attention, and it is considered that management of the complete farming system will become more important. A further issue is that, as a wider number of species are considered for aquaculture, research needs will increase and require more investment in R and D facilities and projects(ADB/NACA, 1998).

Conclusion and future prospects

The issues that have been covered within this paper are the demands made of aquaculture, its ability to fulfil these demands, the threats to that ability and the opportunities to overcome these threats (Kongkeo, 2001). The governments envisage aquaculture to be "a major provider of food and applied to reducing societal disparities and inequities." Based on this vision, the mission will be:

- to fulfill the aspirations of all sectors of the populace, through a people-oriented approach and focusing on aquaculture for development;
- to develop aquaculture in a responsible manner and in harmony with the environment;
- to transform the emphasis of aquaculture from being an activity that is resource-dependent towards being knowledge-based; and
- to continue the pursuit of shared governmental objectives through regional cooperation and to strengthen the existing spirit and substance of this.

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Eubiotic nutrition in aquaculture: Perspectives of Nutraceuticals

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Introduction

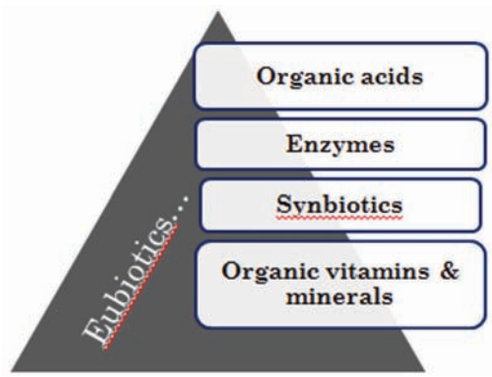
Over the last few decades, contribution of aquaculture to world food production has increased significantly and this sector presently supplies nearly half of the total fish and shellfish used for human consumption. The downside of intensification of the farming operations has been economic losses, primarily due to infectious diseases, particularly during the early production stages. Quality feed should ensure not only superior growth but also return prime health, thus intensification of the culture practices lead to increased use of feed antibiotics to improve health status and animal performance. Use of antibiotics has proved its detrimental effects such as remains of antibiotic residues, developments of antibiotic resistance and loss of beneficial bacterial flora, etc. So avoiding antibiotic and improving gut flora is required to improve the health status as well as to enhance animal performance. Although, it is necessary to find alternatives it is difficult to develop a single alternative agent to the feed antibiotics. Animal health and performance, and their microbiota of gastrointestinal tract are under the great influence of the type of diets, environment, husbandry, management and the strains of animal (Pan and Yu, 2014). Search for antibiotic replacers has opened up a fresh horizon termed as eubiotics are a new range of feed additives used to improve gut health in monogastrics.

Eubiotic Nutrition

The term Eubiotics has originated from the Greek word Eubiosis, which refers to a healthy balance of micro-flora in the gastrointestinal tract. Eubiotic Nutrition is the strategy which combines nutritional technology with the use of different modern feed additives which will result in improved health status and performance in farm animals. "Eubiotic nutrition an integrated strategy to combine different kinds of feed additives in order to achieve a healthy intestinal microbial flora by lowering pathogenic bacteria (dysbiosis) while increasing lactic acid bacteria (eubiosis) throughout the animals' digestive tract" (Kim, 2017). Dysbiosis is the imbalance in the microflora of the gastrointestinal tract.

Why eubiotics???

High demand and stagnant supply of fish meal and fish oil have increased use of plant-based ingredients in the diets of aquaculture species. Today a major part of the research in the field of fish nutrition is finding an alternative to fish meal and fish oil. Use of alternative



feed ingredients which are not a part of their natural diets especially in the diet of carnivorous fishes develops inflammation in the distal part of the intestine (Sahlmann et al., 2013). A shift in the microbial community could allow for an increase in harmful bacteria, triggering the inflammation leads to enteritis in fishes.

Objectives of Eubiotic Nutrition

1. To release energy and protein from the feed
2. To maximise nutrient absorption
3. Managing optimal Gastro Intestinal Tract microflora and thereby overall health

Exogenous enzymes for improving energy and protein utilization

Diets rich in plant-based ingredients such as cereals, legumes, and oil seeds are rich in non-starch polysaccharides (NSP's) such as arabinoxylans, pectins, and beta-glucans, alpha-galactosides such as raffinose, stachyose and verbascose and fewer amounts of mannans that adversely affect nutrient absorption. These oligosaccharides are indigestible in the stomach and the small intestine and impair the ability for the absorption of energy-yielding nutrients by decreasing enzyme accessibility to substrates (Adeola and Bedford, 2004). However, bacteria in the lower intestinal tract can metabolise oligosaccharides to CO_2, H_2, and CH_4, causing digestive disorders. Breaking down these oligosaccharides with exogenous carbohydrases such as alpha-galactosidase and beta-mannanase-enhance nutrient utilisation by reducing the degree of polymerisation of feed, decreasing its viscosity and liberating carbohydrate oligomers (Vahjen et al.,

Highlight Points

- **Eubiotic nutrition focuses on the creation of microbial balance by adding different combinations of nutraceuticals**
- **Eubiotics combines acidifiers with probiotics, NSP with probiotics, Synbiotics with pH regulators etc.**
- **Eubiotic nutrition promote absorption of the nutrients, overall immunity and growth**

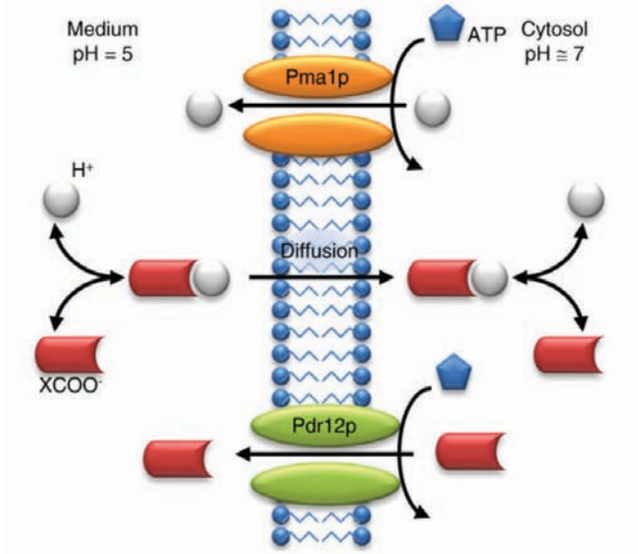
2007). Furthermore, carbohydrases can improve nitrogen and amino acid utilisation by increasing the access to protein for digestive proteases (Tahir et al., 2008) and finally can increase animal growth and production efficiency.

Eubiotics for improving nutrient absorption in high energy diets

Feed with high lipid demand efficient emulsification, digestion, and absorption. Nutritional emulsifiers, like hydrolysed lecithins such as hydrolysed soy lecithins like lysophosphatidyl choline (LPC) and lysophosphatidyl ethanolamine (LPE). LPC and LPE are components of the lipid bilayer of the cell membranes. They have the ability to act as mediators for fat absorption and thereby improve the efficacy of transport of dietary fatty acids and lipids from the gut to the rest of the body probably through enhanced lipoprotein synthesis. Improved lipid digestibility has been reported in salmon fed diets containing soy lecithin, attributed to emulsification properties of the phospholipid (Hung et al., 1997).

Eubiotics way of managing gut health

Organic acids have been added to fish feed for many years. Organic acids comprise short-chain fatty acids (C1-C7) volatile fatty acids and weak carboxylic acids with one or more carboxyl groups in their structure. Organic acids can penetrate through the cell wall of gram-negative bacteria and release protons into the cytoplasm. Thus, the bacteria consume a large amount of ATP to excrete protons in trying to maintain a balanced intracellular pH, resulting in the depletion of cellular energy with eventual cell death (Defoirdt et al., 2006). Furthermore, certain essential oil compounds, like eugenol and thymol can increase the permeability of bacterial cell membranes, allowing the organic acid to work more efficiently (Hyldgaard et al., 2012). Organic acidifier shows stronger antimicrobial effect against gram-negative bacteria such as *Escherichia coli, Salmonella* sp. etc. at the same time acid tolerant bacteria like *Lactobacillus* sp. etc. remained unchanged or may even be enhanced in numbers (Zhou et al. 2009).



Antimicrobial effect of weak organic acids (WOAs): At low extracellular pH, WOAs are mainly in their undissociated form, -diffuse through the cellular membrane. WOAs dissociate in the cytosol. The cell responds by upregulating transporter proteins, Pma1 and Pdr12, to secrete protons and carboxylate anions (XCOO-), to avoid toxicity. (Vital-Lopez et al., 2013)

Eubiotics in aquaculture

Eubiotic strategy can be the preparation of pre-mixed active agents, whose individual efficacies in farm animals were proven (Kim, 2017). Usually, the synbiotics products with a mixture of pro- and pre-biotics may provide eubiotic effects (Zhang et al., 2010; Pandey et al., 2015). Organic acids with or without phytogenic additives can be used as a eubiotic mixture (Ragaa and Korany, 2016) and successfully used an alternative to the feed antibiotics in poultry (Polycarpo et al., 2017).

Research	Mixtures	Effect
Baruah et al., 2007	Microbial Phytase, Citric Acid interaction effect (*L.rohita*)	Synergistic effect: Mineral Utilization at the subnormal level of crude protein
Elala and Ragaa, 2015	dietary acidifier (potassium diformate) in *Oreochromis. niloticus*	a clear eubiotic effect: positively affecting gut health and animal performance
Kumar et al., 2017	Dietary supplementation of acidifier in *Cirrhinus mrigala*	growth performance, beneficial intestinal microbiota
Kumar et al., 2017	Synbiotic *Bacillus subtilis* and MOS (*C mrigala*)	Beneficial effects on growth, digestive , and intestinal microbiota

Eubiotic products

Organic acids-mVevoVitall is a product containing 99% pure benzoic acid of food quality origin. Benzoic acid is well known for its antimicrobial efficacy, especially against *E.coli, Salmonella* and yeasts. Organic acids with essential oils-CRINA Poultry plus is a combination of benzoic acid with essentials oils (main compounds thymol, eugenol, piperine). The probiotic Cylactin® ME 10 is available as a micro-encapsulated product which contains 1 × 1010 CFU/g of *E. faecium* NCIMB 10415 on a carrier derived of cellulose and sucrose. Salbiotic-SCFA/MCFA based product against *salmonella*. Microbial fermentation containing several active agents in naturally protected form.

Prospects of formulating eubiotics

Is it so easy to mix? Combination of synbiotic mixtures with organic acids, essential plant oils and feed grade enzyme may be too complex. Mixture contains pure chemical substances which interfere with the remaining active agents should be taken care of. A pre-coating or capsulation of multiple active agents is crucial for the protection from the digestive secretions and for their mode of action in the specific sites of the digestive tract. For each different task, it is necessary to define which of these compounds can demonstrate positive effects on fish health, and under what conditions they are effective.

Conclusion

As there is a worldwide pressure for the elimination of antibiotics in aquaculture, eubiotics offer a different way of managing gut health. The significance of eubiotics is much more when we use plant-based diets. There is a futuristic need in fish nutrition for making eubiotic mixtures with known nutraceuticals.

Reference can be provided on request.

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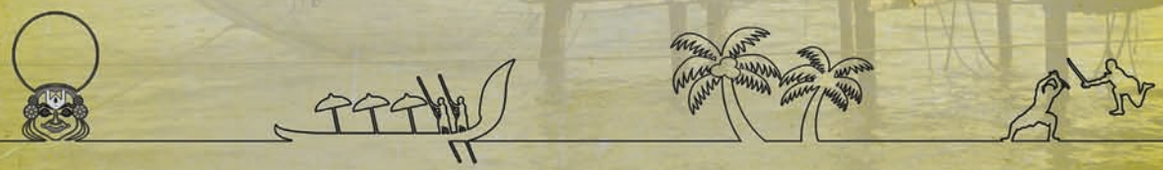

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Exotic Species Introduction, Escapement and Contamination of Indigenous Gene Pool

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Introduction

Exotic species are otherwise known as alien species or non-indigenous species. They are defined as plants or animals growing under non-native environment have arrived by human activity, often unintentionally or trade. Exotic fishes are the species whose origin is in another geographical region; therefore, have not adopted through the long natural selection process to the new environment to which they introduced. Introduction of exotic species is one of the reasons for the extinction of native species. The reason for this extinction is competition for limited resources, predation by the introduced species and the diffusion of new diseases. Exotic fish species introduction has been receiving more attention in important forums like Convention on Biological Diversity and in the FAD code of conduct for responsible fisheries. Much of the recent attention mainly focused on the adverse effects on the introduction of exotic fishes. There is the realization that allexotic species performs terribly under every circumstance.

Exotic Fishes Transplanted in India

Game fishes

Species	Native	Year	Purpose
Brown Trout (Salmo truttafario)	U.K.	1863-1900	For planting streams, lakes and reservoirs.
Loch Leven trout (Salmo levensis)	U.K.	1863	For planting streams, lakes and reservoirs.
Rainbow Trout (Salmo gairdneri)	Sri Lanka, Germany	1907	For planting streams, lakes and reservoirs.
Eastern Brook Trout (Salvelinusfontinalis)	U.K.	1911	For planting streams, lakes and reservoirs.
Sockeye salmon (Oncorhynchusnerka)	Japan	1968	For planting streams, lakes and reservoirs.
Atlantic salmon (Salmo salar)	The U.S.A.	1968	For planting streams, lakes and reservoirs.

Food fishes

Species	Native	Year	Purpose
Common carp (Cyprinuscarpio)	Thailand	1957	Experimental culture
Grass Carp (Ctenopahryngodonidella)	Japan	1957	Experimental culture and weed control.
Silver Carp (Hypophthalmichthysmolitrix)	Hong Kong	1959	Experimental culture
Tawes (Puntius javanicus)	Indonesia	1972	Experimental culture.

Larvicidal Fishes

Species	Native	Year	Purpose
Guppy (Poeciliareticulata)	South America	1908	Mosquito Control.
Top Minnow (Gambusiaaffinis)	Italy	1928	Mosquito Control.

Ornamental Fishes

Species	Native	Purpose
Livebearers (27 Species)	From various countries	Aquarium Keeping
Egg layer (261 species)	From various countries	Aquarium keeping

Impact on Bio-Diversity

Exotic or alien fishes make some adverseeffects on aquatic biodiversity. Those impacts categorized as:

1. Genetic impact
2. Ecological (Including biological) impact and
3. Socio-Economical impact.

1. Genetic Impact

The Genetic impact of the introduction of exotic fishes on native fishes can classify into two categories.

A. Effective population size reduction by several factors like biological, ecological and genetic effect of introduction and

B. Alternation or extinction of gene pools of the stocks by hybridization and Backcrossing.

Introgression through Hybridization

Exotic species introduction is one of the primary reason for the increased frequency of hybridization. Hybridization may lead to heterosis or hybrid vigor due to overdominance and heterozygosity at many loci and may lead to genetic contamination. Thus, the result of hybridization with exotic species, in particular, is unpredictable in advance. Hybridization between exotic species and a native one leads to genetic introgression. So the transmission of genes from one species to another species occur.

Extinction Due to Hybridization

Hybridization between native and exotic species has not only brought in genetic contamination but also resulted in species extinction in some cases. Destruction faced by two native species of Southwest USA, Apache trout (*Oncorhynchus apache*) and Gila trout (*O. gilae*), due to hybridization with the non-indigenous species such as Cutthroat trout (*O. clarkia)* and O. *mykiss.*

Loss of Traits

Uncontrolled hybridization between exotic and native species leads to Loss of traits and further results in economic value decline. Hybridization between Bighead *(Aristichthys nobilis)* and Silver carp *(Hypophthalmichthysmolitrix)* showed beneficial properties regarding growth, disease resistance and food conversation. But in a later generation, uncontrolled hybridization of these fishes takes place and result in the offspring lost the acquired essential traits

Genetic Bottleneck

A genetic bottleneck is a sudden and drastic decline in numbers, it effectively samples (although not necessarily randomly) a few individuals from a more extensive gene pool, resulting in a remnant population with a less overall variation. Loss of contrast has two components like reduction in the variance of qualitative traits and loss of specific and usually rare alleles.

Inbreeding Depression

Inbreeding depression is the most severe problem in the small population of endangered species. It defined as the mating of individuals that shares acommon ancestry and genes due to decline than randomly selected individuals from the population. Fitness characters with low heritability effected inconsanguineousmatings including severe body deformity, growth reduction, behavioral changes and reproductive failures.

2. Ecological impacts

Competition of exotic fishes with the native species for living space with same niche preference, for food with fishes of similar feeding habits, or of omnivorous feeding habits, or predation on native fishes, spreading parasites and pathogens thereby are some common ecological concerns.

Case studies related to theintroduction of exotic fish in India

Competition

Introduced species create competition with native species for habitat, food, mates, etc. An example of the problem seen in Mozambique tilapia, *Oreochromis mossabicus*, that is a threat to native diversity in the areas where they have introduced, and most of the impacts have reported for inland waters. In the Philippines and Pacific islands,O. mossambicus compete for algae and other resources and have displaced mullet *(Mugil cephalus)*, brackishwater shrimp, (*Penaeus merguiensis*) and milkfish (*Chanos chanos*) in brackish water fish Ponds.

Predator-Prey Interaction

Many exotic species are predatory to the endemic species, for example, the Nile Perch, was intentionally introduced into Lake Victoria in 1962 to establish the new fishery. In the 1980's it is estimated that about 300 indigenous fish species became extinct.

Disease Impact

The spread of disease and the pathogen by traded species in aquaculture is a most serious concern that is dealing with several international agencies such as FAO, WHO, WTO and OIE. The alien species also act as the carrier/ vector for pathogens and may cause a problem in the new environment. An example of the problem seen in abalone imported from South Africa carries Sabellid worm parasite that caused no problems in South Africa but had devastating effects of abalone under culture in California. The impact on other Californianmollusk's is unknown.

Habitat Impacts

Many species of freshwater animals significantly modify aquatic habitats when placed into a new environment, for example, crayfish, beavers, common carp and grass carp. The Asian clam, *corbiculaluminea,* was probably introduced into the USA by Chinese immigrants as a food item in 1938. The Clam has since spread widely inland and coastal areas of 38 states in the USA. The most significant effect of this clam is in biofouling of freshwater systems; it can also grow in such large numbers to alter the flow of substrate in streams and lakes and can remove a significant amount of phytoplankton from the water column. Atlantic salmon have escaped from farms into the wild population in Pacific Northwest, resulted in hybrids with less survival and leads to habitat loss.

3. Socio-economic impacts

The economic effects can be seen at two levels:

1. Capture fisheries
2. Aquaculture

Since the exotic fishes never fetch a higher price than the native varieties and also the decline of native fish production is observed in the presence of exotic species in natural waters, the total economic returns declined for the stakeholders of the capture fisheries. In Aquaculture, however, it provided immediate gain, in most cases without consideration of the long-term ecological consequences.

Conclusion

The present status and global experience of exotic species introduction in different countries including India their ecological, biological and genetic impact analysis in this contribution indicate their deleterious effect on autochthonous species. In addition to direct devastating eco-biological impacts, it has also seen that some fishes are even extinct due to loss of genetic variability and heterozygosity.

Highlight Points

- **Exotic fishes are mostly introduced intentionally to support recreational fisheries and commercial fisheries, and there have been many accidental introductions also.**
- **The impact of exotic species is highly variable; some have an adverse effect, some do not affect, and some have a minor effect on the native environment.**
- **Some of the negative effects caused by exotic species are competing for food and habitat with native species, predation and introduction of the pathogen to the native ecosystem.**

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More reference can be provided on request.

Sustainable livelihood framework and approaches to the development of fish farming

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Introduction

A livelihood encompasses the capabilities, assets and activities required for a means of living (Scoones, 1998). A livelihood is sustainable when it can cope with and recover from problems, and congruence or enhance its capabilities and assets (DFID, 1999).

Sustainable livelihood framework as an analytical tool to identify the livelihoods of fish farmers. The analysis shows that, how the fish farmers can achieve sustainable livelihoods through access to a range of livelihood assets. Fish farming potentially provides higher economic returns and social benefits. However, lack of resources, vulnerability and poor institutional support are identified as constraints to long-term sustainability.

Sustainable livelihood objectives

DFID aims to increase the sustainability of poor people's livelihoods through promoting:

- Improved access to high-quality education, information, technologies and training and better nutrition and health
- A more supportive and cohesive social environment
- More secure access to, and better management of, natural resources
- Better access to basic and facilitating infrastructure
- More secure access to financial resources
- A policy and institutional environment that supports multiple livelihood strategies and promotes equitable access to competitive markets for all

Five key indicators are important for assessing sustainable livelihoods:

- Poverty reduction
- Well-being and capabilities
- Livelihood adaptation
- Vulnerability and resilience
- Natural resource base sustainability

Sustainable livelihood approaches (SLA)

SLAs are very important in recent development programs that aim to alleviate poverty and vulnerability in communities engaged in small-scale aquaculture and fisheries (Edwards et al., 2002).

It is increasingly being used by many development agencies and NGOs to accomplish a better understanding of natural resource management systems (Allison and Horemans, 2006). The livelihoods approach seeks to improve rural development policy and practice by distinguishing the seasonal and cyclical complexity of livelihood strategies (Allison and Ellis, 2001). It embraces a wider approach to people's livelihoods by looking beyond income making activities in which people involvement (Shankland, 2000).

Sustainable livelihoods framework

The sustainable livelihoods framework helps in thinking holistically about the things that poor might be very vulnerable to, the assets and resources that help them thrive and survive, and the policies and institutions that impact on their livelihoods (DFID, 1999).

The framework provides a way of thinking through the different influences (constraints and opportunities) on livelihoods. The sustainable livelihood framework has achieved through access to a range of livelihood assets which are combined in the pursuit of different livelihood strategies. Central to the framework is the analysis of the range of formal and informal organizational and institutional factors that influence sustainable livelihood outcomes.

Elements of framework

- Livelihood assets
- Vulnerability context
- Transforming structures and processes
- Livelihood outcome

Livelihood assets of fish farmers

People require a range of assets to achieve positive livelihood outcomes. Different combinations and components of capital assets are essential for farmers to involve in fish production. The presence or absence of several components of capital assets can facilitate or hinder, respectively, the likelihood of success. The sustainable livelihoods framework draws attention to five types of capital upon which farmers livelihood depends.

Highlight Points

- **Sustainable livelihood framework as an analytical tool to identify the livelihoods of fish farmers.**
- **SLAs are very important in the development of programs that aim to alleviate poverty and vulnerability in communities engaged in aquaculture and fisheries.**
- **Transforming structures and processes are the institutions, organisations, policies and legislation that shape livelihoods.**

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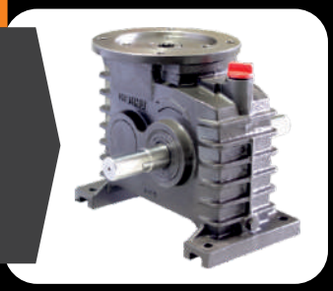

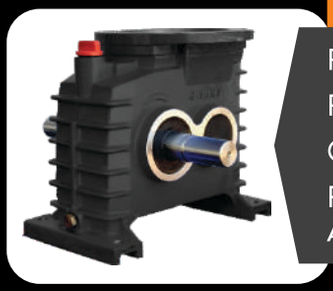

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O/p RPM : 72 & 115
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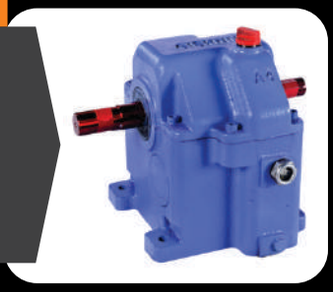
3 hp = 16 Pedals



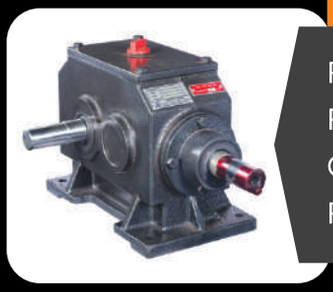


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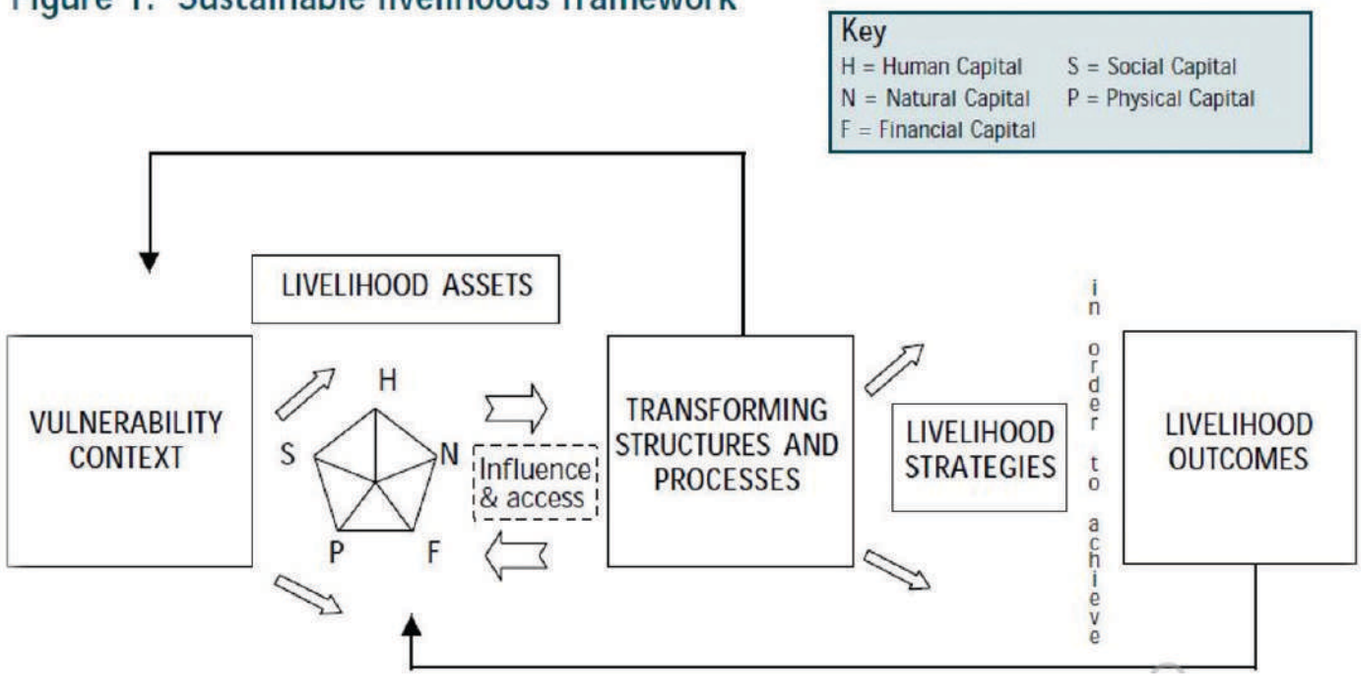
Figure 1. Sustainable livelihoods framework



i) Human capital

Human capital represents the skills, knowledge, ability to work and good health that enable people to pursue their livelihood strategies and achieve their livelihood objectives (DFID, 1999). Fish farming practice has developed as an indigenous technology and farmers have built up skills through their own knowledge. Farmers were involved in income generating activities such as fish farming, fish marketing, agriculture, homestead gardening and poultry rearing.

ii) Natural capital

Natural capital in the form of land, water, wild fry and wider environmental goods are critical for farmers in fish production. Small ponds, water and natural resources have been used for fish production. Farmers relied on rainfall, ground water and sometimes canal water for fish farming. Rapid population growth in fish farming communities has accelerated natural capital depletion that has affected fish production.

iii) Financial capital

Financial capital refers to incomes, savings and credit. Fish culture has the potential to generate considerable amounts of financial capital.

iv) Physical capital

Transport, road, market, electricity, water supply, sanitary and health facilities are the physical capital of fish farming that enable people to pursue their livelihood strategies. Lack of electricity supply meant risk of losses through poaching of fish and poisoning of ponds.

v) Social capital

Social capital in the form of networks, cultural norms and other social attributes have significantly helped in exchanging experiences, sharing of knowledge and cooperation among rural households. Department of Fisheries and various NGOs should conduct the training program on fish culture to empower the knowledge of fish farmers.

Vulnerabilities

The vulnerability concerns refers to: i) shocks, ii) adverse trends iii) unfavourable seasonal patterns that can affect the livelihood of fish farmers. All these can have major impacts on capital assets of households and individuals, and consequently on their abilities to generate incomes.

i) Shocks

Shocks in the form of floods or droughts in fish farming communities can destroy assets. Other natural disasters (heavy rains and cyclones) can also have significant impacts on natural resources or environmental sustainability on which a farmer's livelihood heavily relies. Illness of farmers, diseases in fish and poor harvests are all shocks and make fish cultivation hazardous.

ii) Trends

Fish farmer livelihoods can be made more or less vulnerable depending on long-term trends. Environmental changes, political conflicts and increasing population may aggravate the problem of meager incomes. As poor farmers' access to local natural resources declines, they are forced to use more less sustainable resources.

iii) Seasonality

Various types of seasonal stress emerge in fish production systems. Seasonal shifts in fish farming are one of the greatest and most enduring sources of hardship for poor farmers. Fish farming communities with predominantly natural resource-based livelihoods are subject to seasonal cycles of stress. Seasonal employment opportunities such as fry trading, fish harvesting and marketing, and day laboring all affect livelihoods of poor people. These people rarely have protection against seasonal stress periods due to lack of alternative sources of income.

Transforming structures and processes

Transforming structures and processes are the institutions, organisations, policies and legislation that shape livelihoods. The institutions and their policies have a profound influence on access to assets (DFID, 1999). Understanding institutional processes allows the identification of barriers and opportunities to sustainable livelihoods. An absence of appropriate structures and processes is a major constraint to the development of fish farming in rural areas. Government agencies, NGOs and the private sector can provide technical support to poor farmers. Private and public institutions can support and facilitate aquaculture sector development.

Livelihood outcomes

Transforming structures and processes directly influence livelihood strategies as well as livelihood outcomes. Livelihood resources, institutions and organizations, and vulnerabilities are key determinants of livelihood outcomes in fish farming. Livelihood outcomes can be thought of as the inverse of poverty. The eradication of poverty depends on equitable access to resources. In spite of poor resources, livelihood outcomes for fish farming are positive. Some disadvantaged farmers had incomes that left them vulnerable. Most of these less successful farmers explained that due to lack of technical knowledge, floods, poaching of fish and poisoning of ponds were the principal reasons for their disadvantaged situation.

Conclusion

Farmers made a profit from fish production. The gross revenue, net return and BCR for the different farming systems are relatively sound from an economic perspective. The farmers have improved their socio-economic conditions through fish production which plays an important role in increasing income, food production and employment opportunities. An intensive farmers have benefited the most and extensive farmers the least. Moreover, poor livelihood assets, vulnerabilities and weak transforming structures and processes are identified as constraints for sustainable livelihoods of farmers and associated groups. It is therefore necessary to provide institutional, organisational, and government support for sustainable fish farming.

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More reference can be provided on request.

Scanty rainfall and less-successful seed production of Pacu

Subrato Ghosh, Kolkata

Introduction

In West Bengal, the primary goal of fish seed production industry is to produce quality fish seed (spawn, fry, advanced fry) and subsequently distribution of the same to fish farmers for culture or further growing out (Courtesy: Dr N. R. Chatterjee and B. Majumdar). In fish breeding operations, deficient/scanty rainfall disrupt fish breeding; adverse climatic conditions including low and erratic rainfall, delayed monsoon, higher temperature and less humidity do not provide suitable conditions for fish to breed. Environmental perturbation is a hindrance to enhancement of maturity of brood fishes of both sexes. Delay of breeding of IMC and lesser success in seed production due to delayed monsoon, lack of sufficient water in pond and high temperature has been experienced by author {Ref: N. Sarangi, B. K. Das and others. 2008. Carp seed production under extreme temperature: an experience at Tanar village, Kendrapara, Odisha. Fishing Chimes, Vol. 28(3)}. According to fish farmers, prolonged drought reduces egg production, reduce breeding performance, reduce egg hatching and larval dispersion of pond fishes {Ref: Md. Abdul Halim and others. 2017. Impacts of climate change on pond fish farming in Amtoli, Borguna, Bangladesh. Int. Jour. Fisheries and Aquatic Studies, Vol. 5(2)}. In many freshwater fishes where males usually complete spermatogenesis and spermiation in captivity, it is often observed that amount of good quality sperm produced may be diminished and considerable percentage of spawn found to be qualitatively inferior.

Aspect of concern

Recently in a conversation with author on 7/7/2019, similar condition has been described by experienced and noted fish breeder Mr Bimal Biswas in connection with induced breeding and seed production of exotic freshwater fish Pacu or *Piaractus brachypomus* at his hatchery. Mr Biswas and his son Mr Sujoy Biswas are proprietors of Biswas hatchery, located at Vill. Fulpukur-Uttarayan under Deshbandhu GP, P.O. Naihati, Block Barrackpore - I, Dist. North 24 Parganas, WB. In this 2019 season, considerable percentage of P. *brachypomus* hatchlings produced within egg incubation-cum-hatching chamber found to be somewhat unhealthy. After hatching out, on 12th-15th hour, larvae have been found to exhibit visible less-healthy body features. Mr Biswas and his son opined that such a condition may be due to lack of essential vitamins, minerals and protein in proper proportion in Pacu broodstock diet; and, at the same time, unfavourable pond water conditions and drought-prone state in this current fish breeding season contributes to production of considerable numbers of such less-healthy larvae. Sperm quality of male P. *brachypomus* is most probably not good, Sri Biswas remarked. In 2019 season, Mr Biswas is able to produce only 70-80 bati (spawn measuring cup) of P. *brachypomus* spawn in his hatchery in a single breeding operation from his entire set-up of egg incubation pools whereas in earlier years, he had produced 120-200 bati of P. *brachypomus* spawn. All egg incubation pools are not made to function simultaneously; about half kept reserved for transfer of hatchlings.

A stunted P. hypophthalmus fingerling

Fry of P. brachypomus

In order to save the tender P. *brachypomus* hatchlings from the unhygienic condition created in water column of outer chamber of egg incubation-cum-hatching chamber due to steady decomposition of ruptured egg shells adhering to fixed nylon screen, the hatchlings on 14-16 hour old stage are carefully collected from this original egg incubation pool (where hatchlings had its birth) to a rectangular hatchling/ spawn receiving chamber positioned beneath ground level and subsequently shifted to a fresh egg incubation pool provided with continuous sprinkler-type water aeration system at two positions. In the original egg incubation pool also having facilities

Highlight Points

Exotic fish *Pacu Piaractus brachypomus* has established a place in hatchery seed production and grow-out farming sector of West Bengal. Biswas hatchery, located at North 24 Pgs district, WB and well-known in southern WB has been producing best quality seeds of IMC, Pangas catfish *Pangasianodon hypophthalmus* and Pacu *Piaractus brachypomus* but proprietors of this hatchery Mr Bimal Biswas and son Mr Sujoy Biswas explained to present author in a conversation on 7/7/2019 that they are unable to produce desirable amount of spawn-staged Pacu in 2019 due to high water temperature, scanty rainfall and improper condition of brooder males.

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A view of Biswas hatchery

of sprinkler-type aeration system, much of the 14-20 hour old hatchlings found to be less-healthy, even a considerable amount of unfertilized eggs have been found to settle at the bottom. Such hatchlings with well-developed tail came out from egg shell after definite incubation period of 12-14 hours but showed abnormal movement and probably will not survive, stated Mr Biswas. The 14-16 hours old hatchlings are again transferred to new egg incubation pool once in every 24th hour and till 96th hour, when those are ready to be harvested and supplied to fish farmers or transferred to earthen nursery ponds.

Biswas hatchery

This hatchery started in 1986 at Vill. Uttar Rajendrapur, P.O. Malancha, Dist. North 24 Parganas. Mr Bimal Biswas, aged 62, is the founder of this hatchery, presently located at Vill. Fulpukur - Uttarayan. He is brother of highly reputed fish seed producer of WB Late Nirmal Biswas. Mr Bimal Biswas has been involved in the business of reliable and best quality fish seed supply within and outside WB since 1986. Another hatchery-cum-seed production unit namely Biswas Fish Centre, belonging to same proprietors and established in 1989, is located adjacent to their residence at Vill Rajendrapur - Khasbati, GP Mamudpur, P.O. Madarpur under Barrackpore - I Block where seed production (spawn and fry) of only Indian major carps and Labeo bata is done commercially. It obtained accreditation and seed certification from Department of Fisheries, Government of WB on 3rd April, 2014. This centre comprises four circular breeding pools and ten egg incubation-cum-hatching pools (Chinese model). During spawn production, purposeful hybridization between species of major carps is not done here at all, only pure variety is produced.

Biswas hatchery also obtained accreditation and seed certification from Department of Fisheries, Government of WB on same date. Presently there are 14 egg incubation-cum-hatching pools of 3-4mt diameter each {eight in operation for spawn production of P. *brachypomus*, as observed on 7/7/2019 and rest not in function temporarily; inner walls and base of which treated (disinfected) with limestone powder and subsequently KMnO4 and being prepared for next operation or for transfer (shift) of growing hatchlings into it} and two large breeding pools. Mr Biswas stated that induced breeding and seed production of Pangas catfish and Pacu is mainly being done here in this 2019 season. At Biswas hatchery, there are 7 well-maintained nursery ponds each 33-50dec in area (which are used as broodstock ponds when required) and 9-10 rearing ponds.

Cleaning of egg incubation pool

Aeration system in egg incubation pool

Flush-type aeration with pump in fish transportation vehicle

Selection of Pacu brooder (female)

Selection of Pacu brooder (male)

At this hatchery, male and female P. brachypomus brooders, 2500-4500gm in weight, are maintained in two separate ponds. Those are fed a mixture of boiled broken rice and boiled good quality peas (Rs 54/-/kg); an aluminium Hundi (24 inch diameter at mid-portion)-full amount of supplementary feed is provided to every 300nos of broodfishes everyday for two months prior to breeding. Stripping is conducted to obtain fertilized eggs. Spawn of P. *brachypomus* is sold from Biswas hatchery @ Rs 900-1000/-/bati (65000-70000nos/bati) to customers, which, after attaining 2.0-2.5 inch size in nurseries are transferred to grow-out ponds. According to eminent fishery expert Prof. N. R. Chatterjee, for nursery management of P. *brachypomus*, spawn are stocked in nursery pond, prepared beforehand, @ 1,50,000nos/ha. Those are fed with prepared feed made from groundnut oil cake, rice polish and soyabean dust and also fed zooplankton. Generally feed is applied @ 2000gm/ha daily at this stocking rate. Within 8-10 days, P. *brachypomus* spawn develop into fry, which are transferred to rearing ponds. Seeds of Pangas catfish are sold from Biswas hatchery at fry stage (24-40mm); 90% of the produce is supplied to Andhra Pradesh (AP) and 10% to local fish farmers.

Trying to increase survivability of hatchlings

During July-August, Sri Biswas stocks spawn of Indian major carps and L. bata in his ponds and harvest in February of next year; harvested stunted carp fingerlings (60-80nos/kg) are loaded on Tata 407 trucks, transported live to distant wholesale markets and sold @ Rs 110-115/-/kg. Two fingerling holding tanks, each loaded with 400-500kg fingerlings, can be carried in one truck, Sri Biswas explained. An Eicher truck can hold three such fish tanks, which are also used during

Author with Sri Bimal Biswas

transportation. Mr Biswas had established a monosex Tilapia fry production unit (hatchery) in 2014 and produced monosex Tilapia fry on a commercial scale till 2017. Its market demand reduced later on.

In off season every year, Mr Biswas maintains a stock of about 10,00,000-12,00,000nos P. *hypophthalmus* fry after sale in his farm; those are stocked at a higher density during August-September and maintained on lesser amount of supplementary feed. During March-April of next year, each of stunted Pangas catfish fingerling (100nos/kg) after harvest are sold @ Rs 3.00-3.50/-/piece, exhibits high growth rate in grow-out ponds and has good demand among fish farmers in Bihar and Uttar Pradesh. In 2018 season, fish seed traders of AP had purchased fry/advanced fry of Pangas catfish from fish seed producers and hatchery owners of North 24 Pgs district but unfairly have not paid the full price of it. In 2019, many hatchery and fish seed farm owners of North 24 Pgs are reluctant to supply Pangas catfish fry to AP. If this market does not exist, it will pose a concern to these people. Mr Biswas stated that cost of pituitary gland required for breeding of Pangas catfish and other fishes has increased to Rs 7/-/piece, so too the cost of pelleted fish feed and wages of hired labours. Scanty rainfall, improper water conditions in hatchery ponds due to weather aberration may make this profession of fish seed production less remunerative.

End note

On behalf of Biswas hatchery, Mr Sujoy Biswas has obtained MeenMitra award from Department of Fisheries, Government of WB in 2013 for his achievements and contribution to fishery sector of WB. Officials of various State Governments of India undergoing Post-graduate Diploma in Inland Fisheries and Aquaculture Management and other trainees from ICAR-CIFE Kolkata Centre; trainees from ICAR-CIFA Kalyani Regional Centre and from Kalyani University have visited Biswas hatchery at various times on educational tours. Mr Bimal Biswas stated that there has been no policy in WB for subsidized electric supply for fish hatchery operation by private fish seed producers. Electricity has been made commercial, which is a setback for fish hatchery owners. He opined that it will be good if subsidy is given upon electricity, as in agriculture sector and if it happens, progressive fish breeders will be benefitted.

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