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January 2025

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A new generation is embracing aquaculture in India's Bihar state

Organoleptic inspection systems cannot detect hazards in seafoods. However, examination at the point of processing seafoods is important to maintain food safety. HACCP, GMP and GHP guidelines must be implemented in seafood industry, monitored at regular intervals and verify according to the norms. It is equally important to abide by all the regulations related to the export or import of seafoods.

Dear Readers,

Greetings to the readers and advertisers of Aqua International for a Happy, Prosperous and Peaceful New Year 2025.

I wish that all of us get organised well personally in the profession and in the business in this New Year 2025. Let us focus on maintaining good health with regular exercise, balanced diet and 7 to 8 hours night sleep. Check whether you are going financially in a right and safe direction and maintain good relation with each other. Let us also change our thinking towards an open and positive mindset that we do our bit for the well being of all in the society.

The January 2025 issue of Aqua International is in your hands. In the news section, you may find news about....

Dr Abhay Kumar, scientist and program coordinator conducted the training cum demonstration program on Best aquaculture practices and value-added products. In this program lecture delivered by Dr Abhay Kumar on Basic principle of aquaculture and Fish Health Management, and Dr L. Narasimha Murthy, Principal Scientist delivered lecture on Scheme of fisheries department and NFDB to farmers. Under the guidance of Dr Abhay Kumar demonstration on how to maintain hygiene during handling the fish cleaning and cutting to make fillet and maintaining ice storage and preparation of different value-added fish products such as fish cone, fish ball, fish fingers and butterfly shrimp etc. The trainees were also given a chance to prepare customized fish products based on the regional preferences of the ingredients. A total of 30 participants from the village Vavoshi, Khalapur, District-Raigad, Maharashtra benefited from the program.

Dr B. K. Das, Director, ICAR-Central Inland Fisheries Research Institute, Barrackpore gave a presentation on "Coastal Natural Resources, Community Livelihoods and Economic Growth: A case study from Coastal Wetlands of West Bengal and Odisha". Dr Das mentioned that coastal wetlands in India supports high biological diversity, provide different kinds of ecosystem services (provisional, cultural, regulating and supporting services). Dr Das highlighted his study sites on coastal vulnerability across coastline of West Bengal and Odisha. The study included climate induced and anthropogenic stress effects on the decreasing ecosystem services of the wetlands, the likelihood of the effects on the ecosystem services of the wetlands, the adaptive capacity and measures against unfavourable events.

A new generation is embracing aquaculture in India's Bihar state, helped by several government schemes, but there's room for improvement, according to the farmers. Mr Tunna Mishra used to work as an area manager head in a private fertiliser company in Chandigarh, around 150 miles from Delhi, the nation's capital. The 49-year-old had no intention to return to Bangaon, his native village in Bihar, and was happily settled there before the Covid pandemic forced him to change his plans. "I used to get a salary of Rs 50,000 and was staying there for nearly seven years. I was completely dejected, as I was jobless. I was sitting idle looking for work and came in contact with local fisheries officials who encouraged me to start fish farming. I started farming 3

Contd on next page

NRS GROUP
Aqua International

Our Mission

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

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

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

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

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

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Send a letter: *Letters to the Editor must include writer's full name, address and personal telephone and mobile numbers. Letters may be edited for the purposes of clarity and space. Letters should be addressed to the Editor:*

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acres in 2020 and stocked 5,000 juvenile Indian major carp: particularly rohu, mrigal and catla," he recalls.

"I harvested them after four months and made a profit of Rs 80,000. The income encouraged me to do fish farming on a larger scale and I'm now farming 14 acres and earning a profit of around Rs 19 lakhs every year, which is far greater than what I made in my job. The pandemic has been a boon for me," he adds.
Roshan Kumar Jha, who also lives in Saharsa district, quit his job as a computer engineer in a multinational company in Gurugram, near Delhi, and returned to his village in 2012.

Mr Roshan Kumar Jha stated that he was paid around Rs67,000 per month but he wanted to return to his village and do something of his own. He started farming in 2 hectares and now has 10 hectares, with a production of 3-4 tonnes per hectare. The profit is ten times more than his previous salary. The produce has a huge demand in the local market.

Dr TunTun Singh, a lecturer at Bihar's Fisheries Training and Extension Centre, said that the state has lot of potential for fish production, as there are lot of floodplains, wetlands and silted ponds that can be developed for fish farming.

In Bangladesh, fish and shrimp are not just food items; they are woven into the country's culture and economy. However, a longstanding prejudice against frozen seafood has stifled the growth of the local market. Local people believe that frozen fish and shrimp lack the freshness and quality of those purchased from wet markets. This perception not only holds the industry back, but also puts consumer health at risk, as mishandled fish from these markets often undergoes multiple freeze-thaw cycles that degrade its quality. Organising taste tests and cooking demonstrations can help prove that frozen fish is just as flavourful and versatile as fresh fish. Promotional discounts and offers can incentivise consumers to try frozen fish, leading to greater acceptance. With the infrastructure in place for freezing, the industry would be better equipped to meet both domestic and export demands year-round.

In the Articles section, **Fish Seed Production Practices of Bankura District, West Bengal- A Case Study,** authored by Shilpa Koley, Gora Shiva Prasad, Suchismita Saha, Sangram Keshari Rout, Sutanu Karmakar, Raval Ajay, Manthan Tandel, Sulav Mandal and Aritriya Jana stated that Fish is the most important source of animal protein diet for humans, and fish production in India has increased significantly over the years, reaching roughly 14.16 million metric tonnes in 2020. The fisheries sector provides 1.24 % of the Indian economy. Nearly 14 million fishermen and fish growers rely on this industry, contributing significantly to foreign exchange earnings. Aquaculture is rapidly contributing to the country's fish supply, will likely become more prevalent as the industry continues to grow.

The population of Ramsagar Gram Panchayat and the surrounding areas have clearly benefited from these seed-producing strategies. This not only benefited the fish seed producers directly, but it also created 4,56,038 person-days throughout that period. Fish seed is raised in all 150 ponds, and the producers sell the fish seed to local markets and markets in neighbouring states like Jharkhand, Odisha, and Andhra Pradesh. According to nursery owners ' estimations, fingerling sale prices varied amongst growers, as did profit margins, which ranged from 20,000 rupees to 60,000 rupees per year, with an average of 34,000 to 42,000 rupees.

Another Article titled **Role of Black Soldier Fly Larvae Meal as a Replacement For Fishmeal In Aquaculture,** authored by Lakkoju Nischal, Dr A. Chandrasekhara Rao, P. Shantanna and P. Tarun Kumar Reddy discussed that As Feed plays a major role during the Shrimp Culture period i.e. about 60% of the input cost, we should focus on the ingredients for protein source which decreases the input cost and gives beneficial results. Black Soldier Fry Larvae Meal can be used as an efficient feed ingredient as an alternative to Fish meal. It can turn organic waste into biomass that contains proteins with a high biological value. Moreover, BSFL are vitamin-rich, particularly in vitamin E. Replacing commercial feed up to 50% with fresh BSFL could be feasible for L. vannamei farming when growth performances, digestive enzyme activities, intestinal histology, and antioxidant enzymes were being considered.

Another Article titled **Grow Your Worms, Grow Your Fish: A Simple Guide to Thriving Aquaculture,** authored by Abhilash C. P., Saikrishnan, K.R., Charan Ravi and V. S. Basheer, discussed Culturing live worms reduces reliance on commercial feeds, offering a cost-effective, sustainable solution for aquaculture.

Live worms provide essential nutrients, enhance digestion and nutrient uptake, boost reproductive success, and support healthy larval growth, making them vital for successful aquaculture. Provides actionable, detailed methods for culturing worms to reduce feed costs and enhance productivity. Accessible techniques for small-scale farmers to improve practices with minimal investment.

Another Article **Significance of Food Safety Inspection for a Seafood industry: An Overview,** authored by Panoth Abhirami and N. Venkatachalapathy, discussed that identification of hazards in seafood industries are crucial to implement effective control measures to obtain safe seafood for consumption. Organoleptic inspection systems cannot detect hazards in seafoods; however examination at the point of processing seafoods is important to maintain food safety. HACCP, GMP and GHP guidelines must be implemented in sea food industry, monitored at regular intervals and verify according to the norms. It is equally important to abide by all the regulations related to the export or import of sea foods.

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

M.A.Nazeer
Editor & Publisher
Aqua International

Uni-President

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Probiotics for water treatment

1. WATER QUALITY CONDITIONING

Best choice of *Bacillus* spp. that rapidly decompose uneaten feed, feces and other organic substances in pond water, keeps water quality optimal

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No cultivation is needed. Easily adapt to the changes of surroundings and grow fast in freshwater or seawater culture farming, even under low oxygen environment

3. DECREASE AMMONIA CONTENT

Prevent the accumulation of toxic substances such as NH_3, NO_2, etc.

4. IMPROVE WATER COLOR

Improve water color regulate the algae and bacteria balance in water, turning your pond from green to clear

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Compete nutrition with vibrio and inhibit them to grow. Provide nutrition for probiotics in the pond, to establish a well-balanced farming system.

6. INCREASE AQUACULTURE PRODUCTION

Good quality of water prevents fish/prawn infections, making high profit of production

* COMPOSITION:

Bacillus spp. > 1x 10^{11} cfu/kg	15%
(Bacillus subtilis, Bacillus amyloliquefaciens, Bacillus licheniformis)	
Carrier (rice bran, corn gluten)	75%
Moisture	10%

* STORAGE:

Keep at dry, well-ventilated condition. Avoid direct sunlight exposure and use as soon as possible once opened for best quality.

* DIRECTION OF USE:

No cultivation is needed. Apply Nuri BSL with water-soluble bag near to the working water wheel or pour into the pond evenly. Recommend apply Uni-Light PSB together with Nuri-BSL on sunny day to achieve a clear pond more efficiently.

UNI-LIGHT PSB Funtion:

- Decompose pond bottom
- Inhibit the growth of *Vibrio* spp.
- Purification of water quality

BSL Dosage:

/10,000 m² Quantity	10 - 30 pl/m² tiger prawn or < 80 pl/m² Vannamei	For >30 pl/m² tiger prawn or > 80 pl/m² Vannamei	For > 150 pl/m² Vannamei
7 days before stocking	800 g - 1,000 g	1,200 - 1,500 g	1,200 - 1,500 g
Day of stocking	300 g - 500 g	800 g - 1,000 g	800 g - 1,000 g
Every 7 - 10 days after stocking	300 g - 500 g	800 g - 1,000 g	3 - 5 days / use 1,000g - 2,000g

****Dosages can be adjusted according to the water conditions and practices.*

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Mumbai Research Centre of ICAR-CIFT Organizes training cum demonstration programme on "Best aquaculture practices and value-added products in Maharashtra" under Scheduled Caste Sub Plan

Mumbai: Mumbai Research Centre of ICAR-CIFT Organizes three days training cum demonstration programme for the SC community of Maharashtra. The program, entitled " Empowering the Scheduled Castes community through harvest and post-harvest technology intervention in Maharashtra, India". Best aquaculture practice and value-added product was conducted from 19th to 21st December 2024 under Scheduled Caste Sub Plan (SCSP) scheme at Village-Bhimnagar, Vavoshi, Taluka-Khalapur, District-Raigad, State-Maharashtra. The program was initiated and supported by Dr George Ninan, Director, ICAR-CIFT, Kochi, Dr A. Suresh, Principal Scientist and Nodal officer of SCSP, ICAR-CIFT, Kochi and Dr Asha K K, Principal Scientist and (SIC) Scientist in Charge MRC of ICAR-CIFT, Vashi, Navi Mumbai.

Dr Abhay Kumar, Scientist and program coordinator conducted the training cum demonstration program on 'Best aquaculture practice and value-added product. In this program lecture delivered to the farmers by Dr Abhay kumar on Basic principle of aquaculture and Fish health Management and Dr L. Narasimha Murthy, Principal Scientist delivered lecture on Scheme of fisheries department and NFDB (National Fisheries Development Board) to farmers. Under guidance of Dr Abhay Kumar demonstration how to maintain hygiene during handling the fish cleaning and cutting to make fillet and maintaining ice storage and preparation of different value-added fish products such as Fish cone, fish ball, fish fingers, and butterfly shrimp etc. The trainees were also given a chance to prepared customized fish products based on the regional preferences of the ingredients. A total of 30 participant from of Village- Vavoshi, Khalapur, District-Raigad, Maharashtra benefited from the program.

Dr Abhay Kumar addressing on ''Basic principle of Aquaculture and Fish health Management'' for fish farmers

A training leaflet was distributed on the participant during inauguration function. The participants were from Panchseal Mahila Bachat Gut and Sabhidhan Mahila Bachat Gud, Vavoshi, Taluka-Khalapur, District-Raigad, Maharashtra groups, and provided Mini processing unit like Ice boxes, Insulated bags Meat mincer, sealing machine, weighing balance, presser cooker, Gas stove, Microvan, Cutting board, Apron, Frying pan, Head gear,life jacket, gill net, cast net, Foldable chair & Table ,Emergency light and Mixer etc.) to help them start a small food venture shortly and improve their socio-economic condition. Present of the MRC of ICAR-CIFT staffs' members during training program was Dr Asha K. K, Principal Scientist & SIC, MRC of ICAR-CIFT, Navi Mumbai, Dr L. Narasimha Murthy, Principal Scientist, Dr Abhay Kumar, Scientist, Ms Priyanka Nakwa (Technical Officer), Mr Tulshiram Wagmare (Senior Technician Assistant) Supriya Chautala (Young Professional II) Suraj Patil (Young Professional -1) and Mr Aniket Kamble (YP-1).

Participants with prepared fish breaded and battered products with processing equipment and feedback delivered by the fish farmers

Input distribution for fish farmers

Dr B. K. Das, Director, ICAR-CIFRI speaks on Coastal Natural Resources, Community Livelihood and Economic Growth

Inaugural Session of Orissa Environment Congress-2024

OEC - 2024 at Berhampur University

Berhampur: The 15th Edition of Odisha Environment Congress - 2024 on the Theme 'Environment and Coast' was held at Berhampur University, Berhampur (Brahmapur), Dist. Ganjam, Odisha during 20th - 22nd December, 2024. It was organized by Orissa Environmental Society, Bhubaneswar; Berhampur University; HDF-cDAR, Bhubaneswar; Centre for Environment and Development, Thiruvananthapuram and other organizations. On the first day of this event, in the 2nd Technical Session titled 'Coastal Natural Resources, Livelihood and Economy', Dr B. K. Das, Hon'ble Director, ICAR-Central Inland Fisheries Research Institute, Barrackpore was the Guest Speaker and gave a Presentation on "Coastal Natural Resources, Community Livelihood and Economic Growth: A case study from coastal wetlands of West Bengal and Odisha". Dr Das mentioned that coastal wetlands in India supports high biological diversity, provide different kinds of ecosystem services (provisional, cultural, regulating and supporting services). But these open water bodies are at risk due to climate change and anthropogenic stress. It is necessary to assess and monitor the climate change induced potential impacts and vulnerability of these wetlands for sustainability, livelihood and food security. Dr Das highlighted his study sites on coastal vulnerability across coastline of West Bengal and Odisha. The study included climate induced and anthropogenic stress effects on the decreasing ecosystem services of the wetlands, the likelihood of the effects on the ecosystem services of the wetlands, the adaptive capacity and measures against unfavourable events. In the Presentation, Dr Das elaborated on the assessment of fish diversity in this study, abundance of particular fish species(s) at different sites in West Bengal; the documented species(s); fishes that could be categorized into low, medium and high resilient groups and also that on the basis of their feeding habits; climatic vulnerability and anthropogenic vulnerability of the studied wetlands; vulnerability index mapping. Extreme climatic events flood, storm, cyclone in combination with anthropogenic impact have significantly altered the coastal wetland ecosystem. Comprehensive approach of adaptive strategies are required to address the challenges in coastal wetland fisheries. There are much opportunities for fisheries enhancement here utilizing government schemes for fisheries development. He also explained on the assessment of ecosystem service of coastal wetlands of Odisha, their ecosystem service index estimated.

Dr Das mentioned that small-scale fisheries play a crucial role in the socio-economic fabric of coastal communities worldwide - providing livelihoods, sustaining cultural traditions and contributing significantly to local and regional food security. In the end, Dr Das mentioned that adaptation strategies such as mangrove restoration, integrated coastal management and community based initiatives can help reduce the impacts of climate change on these vital coastal aquatic ecosystems. These measures have to be prioritized. We can safeguard the vital functions of these coastal wetlands for future generations, ensuring the involvement of both the government and local communities. We have to ensure well-being of coastal communities, also that coastal water resources continue to benefit both the present and future generations. News communicator Subrato Ghosh participated in Odisha Environment Congress - 2024 and listened to this informative Presentation of Dr B. K. Das.

Swaroop Launches Healthcare Aqua Products under "Swaroop's Aquamart"

Hyderabad: Swaroop Agro Chemical Industries was established in 1993 by Mr Sameer Rajan Pathare in Nashik, Maharashtra. Initially, they manufactured chemicals and essential hormones for grape cultivation and made them available to the farmers. Later, they manufactured various types of agrochemicals in organic methods to increase their yield for all crops.

Over the last 30 years, more than 50 types of agrochemicals have been manufactured in own manufacturing units in completely organic methods. The Company has 4 patented products - G5 and Aegis, Humigel and Vetoneema.

28 of Company products have been NOCA certified as 100% chemical-free organic products.

The Company has PAN India marketing set up as well as they are exporting to Asian, Gulf, American and African countries.

In the same organic methods, 10 types of Health Care Aqua products were launched under the banner SWAROOP's AQUQMART in aquaculture segment today, i.e. on 25 December 2024, at Nirmala Devi Function Hall in Bhimavaram in the presence of aqua farmers, dealers and JDA Fisheries.

Speaking on the occasion, the company's MD, Mr Sameer Rajan Pathare, explained that the main objective of the company is to provide quality, innovative and organic products to the aqua sector for sustainable aquaculture. The main aim is to protect environment and human health as well as eco system and help nation in food security.

Sameer Rajan Pathare, Managing Director, Swaroop Agro Chemical Industries

Raghu Kumar, Business Head, Swaroop Agro Chemical Industries

Business Head Mr Y. Raghu Kumar, talked about the company's agro products, company details, lab facilities, manufacturing units and exports.

Assistant Development Manager, Miss Jhansi Lakshmi Bai explained about the uses of aqua products.

The product launch was graced by various dignitaries from the aqua industry.

1. Prasad garu, JDA Fisheries - Hydra lactobase.
2. Bhagwan Traders, Venkata Rama Raju garu - Hydra Active ZanZM.
3. Ravindra Ramesh garu - Hydra flora gel.
4. Jakram Murali Raju garu - Hydra oremix.
5. Suryanarayana garu, farmer - Hydra Kosher.
6. K Ramana garu, farmer - Hydra cabstar.
7. Joseph garu, Aqua Tech Magazines - Hydra proshine.
8. K. S.R. Aqua Needs & Feeds - Hydra klenz.
9. Sri Lakshmi Srinivas Aqua Traders - Hydra z15.
10. Srinivas Raju garu - Hydra Aegis.

Finfish diversity in India and West Bengal at a glance in tabular form

Compiled by: Subrato Ghosh

1) Finfish diversity in India

As on (Year)	Total fish species (nos)	Indigenous inland fish species (nos)		Indigenous small freshwater fish species (nos)	Indigenous marine fish species (nos)	Threatened fish species (nos)
-	-	Indigenous freshwater fish species (Warm water + Cold water)	Indigenous brackishwater fish species	-	-	-
1993	2246 (Source: Scientists of ICAR-NBFGR, Lucknow); 223 endemic species (Source: Dr T. R. Rao, IISc, Bengaluru)	930 (765 freshwater species)		-	1316	76
1981	-	742 (Source: Dr K. C. Jayaram, ZSI, Govt of India)	-	-	-	-
2007	-	166 in Central India (Source: Dr W. S. Lakra; Dr U. K. Sarkar, ICAR-NBFGR)	-	-	-	-
2010	2352 (Source: Scientists of ICAR-NBFGR)	871	113		1368	120 (71 endangered)
2012	2799 (2508 indigenous and 291 exotic) (Source: Scientists of ICAR-NBFGR)	877	113	450 (216 in east and north-east India) (Source: Dr U. K. Sarkar, then Principal Scientist, ICAR-NBFGR)	1518	-
2000	-	-	-	-	About 250 pelagic species (Source: Dr N. G. K. Pillai, Retd. Principal Scientist, ICAR-CMFRI, Kochi)	-
2015	-	-	-	-	-	327 freshwater species (45 critically-endangered, 91 endangered, 81 vulnerable) (Source: Conservation Assessment and Management Plan, Govt of India)
2014		422 (warm water and cold water) in north-east India (Source: Dr P. K. Pandey, Director, ICAR-DCFR, Bhimtal)	-	-	-	-

Gassen Plus

Bon Ammonia and obnoxious Gasses

Shrimp / Fish performs all their body functions and growth in water. Good quality water and proper D.O. levels determines the success or failure. Good quality water, optimum D.O. level is of prime importance for health and growth of Shrimp / Fish.

Irregular water exchange, excess and leftout feed, dead algae, fecal matter, increases the organic load at the pond bottom. Accumulation of such waste absorbs available oxygen, creating anaerobic condition which leads to pollution of pond bottom. Polluted pond bottom and unhealthy environmental conditions triggers the release of toxic gasses like Ammonia, H_2S, Methane, etc, The toxicity of Ammonia, Hydrogen Sulphide, Methane attributed mainly due to unionized form. As the concentration in water increases, ammonia excretion by aquatic organism diminishes and the level of ammonia in blood and in other tissues increases. Ammonia increases oxygen consumption by tissues, damage gills and reduces the ability of blood to transport oxygen, and increases the disease susceptibility. To eliminate / overcome the above problems 'GASSEN PLUS' Yucca Schidigera, it contains Steroidal"Saponin" which help to reduce ammonia and other noxious gasses such as H_2S, Methane, etc., Microbial enzyme "Urease' Production inhibited by Saponin which leads to an increases D.O. and reduction of BODand COD levels.

Bacterial strains such as Bacillus Subtilis, Nitrobactor, Nitrasomonas, rapidly converts ammonia into Nitrates, Nitrites and finally non-toxic Nitrogen. Hydrogen Sulphide converts into Sulphates, Sulphites and finally non-toxic Sulphur, Methane into Non-toxic carbon. This conversion reduces the obnoxious gasses in the pond bottom. Reduction of this gasses improve the D.O. level in the water and bottom.

COMPOSITION:
YUCCA SCHIDIGERA
ALOEVERA
BACILLUS SUBTILIS
BACILLUS POLYMIXA
BACILLUS LICHENIFORMIS
NITRASOMONAS
NITROBACTOR
STABILIZERS

DOSAGE : 1 Kg per Acre or consult your Aqua Technician For Specific Usage & Dosage

PRESENTATION: 500 gms &1 kg

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2) Finfish diversity in West Bengal

As on (Year)	Total fish species (nos)	Indigenous inland fish species (nos)		Indigenous small freshwater fish species (nos)	Indigenous marine fish species (nos)	Threatened fish species (nos)
		Indigenous freshwater fish species (Warm water + Cold water)	Indigenous brackishwater fish species			
2003	574 (Source: Retired Government Fishery Officers Association, West Bengal)					106 (34 endangered, 16 freshwater species endangered)
2007		239 (Source: Dr R. P. Barman, Scientist, ZSI, Govt of India)		-	-	59 freshwater species (22 endangered)
2015		190 (warm water) (Source: Dr B. K. Mahapatra, Retd. Principal Scientist, ICAR-CIFE, Mumbai; Dr U. K. Sarkar; Dr W. S. Lakra)	-	-	-	-
2017	-	-	-	-	About 314 (Source: Aquaculture Management & Technology Dept, Vidyasagar University)	-
1999	-	-	165 in Sundarbans (Source: Dr P. Sanyal, Ex Chief Conservator of Forest, West Bengal)	-	-	-
2013	-	-	267 (estuarine) in Sundarbans (Source: Aquaculture Research Unit, Zoology Dept, Calcutta University)		-	-
		190 (ornamental) (Source: Dr B. K. Mahapatra)			113 (ornamental) (Source: Dr B. K. Mahapatra)	
2021	-	71 (cold water) in Dooars region (Source: Zoology Dept, Raiganj University)	-	-	-	-

Bringing new blood into Bihar's fish farming sector

A new generation is embracing aquaculture in India's Bihar state, helped by several government schemes, but there's room for improvement, according to the farmers.

Aquaculture is inspiring a new cohort of farmers, such as Tunna Mishra

25 December 2024: Tunna Mishra used to work as an area manager head in a private fertiliser company in Chandigarh, around 150 miles from Delhi, the nation's capital.

The 49-year-old had no intention to return to Bangaon, his native village in Bihar, and was happily settled there before the Covid pandemic forced him to change his plans.

"I used to get a salary of Rs 50,000 ($597) and was staying there for nearly seven years. I was completely dejected, as I was jobless. I was sitting idle looking for work and came in contact with local fisheries officials who encouraged me to start fish farming. I started farming 3 acres in 2020 and stocked 5,000 juvenile Indian major carp: particularly rohu, mrigal and catla," he recalls.

"I harvested them after four months and made a profit of Rs 80,000 ($955). The income encouraged me to do fish farming on a larger scale and I'm now farming 14 acres and earning a profit of around Rs 19 lakhs ($22,695) every year, which is far greater than what I made in my job. The pandemic has been a boon for me," he adds.

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"I was paid around Rs 67,000 ($800) per month but I wanted to return to my village and do something of my own. I started farming 2 hectares but now have 10 hectares, with a production of 3-4 tonnes per hectare. The profit is ten times more than my previous salary. The produce has a huge demand in the local market," he says.

Dr Tun Tun Singh, a lecturer at Bihar's Fisheries Training and Extension Centre, said that the state has lot of potential for fish production, as there are lot of floodplains, wetlands and silted ponds that can be developed for fish farming.

"The government is also planning to develop more juvenile production. Harnessing the untapped aquatic resources and their potential can not only help to make the state self-sufficient in fish production but can also play a pivotal role in generating employment, food and nutritional security, poverty alleviation and socio-economic growth," he explains.

"Besides, the government is also bringing special schemes for renovation of oxbow lakes and lowlands for conservation, restoration and rehabilitation of endangered fish. The banks are offering low interest rates to help farmers towards fish farming. The local fish markets are being strengthened to increase the demand and also better transport connectivity and electricity is provided to farmers. But the changing climatic conditions like drought, floods along with disease outbreak and overexploitation of natural resources also remain key challenges," he adds.

In 2022-23, Bihar's total cultivable area stood at 93,217 hectares, with 29,821 ponds and tanks and 940,000 hectares of floodplain wetlands. There were reservoirs spread across 26,304 hectares, as well as 3,200 km of rivers and canals.

In 2023-24, fish production stood at 873,000 tonnes while demand is for 889,000 tonnes, and is growing at an annual growth rate of 3.17 percent. The average fish production in the state stands at 3 tonnes per hectare.

"We are very close to closing the gap between the demand and the supply and the collective efforts of the state government and farmers could help to soon achieve our goal.

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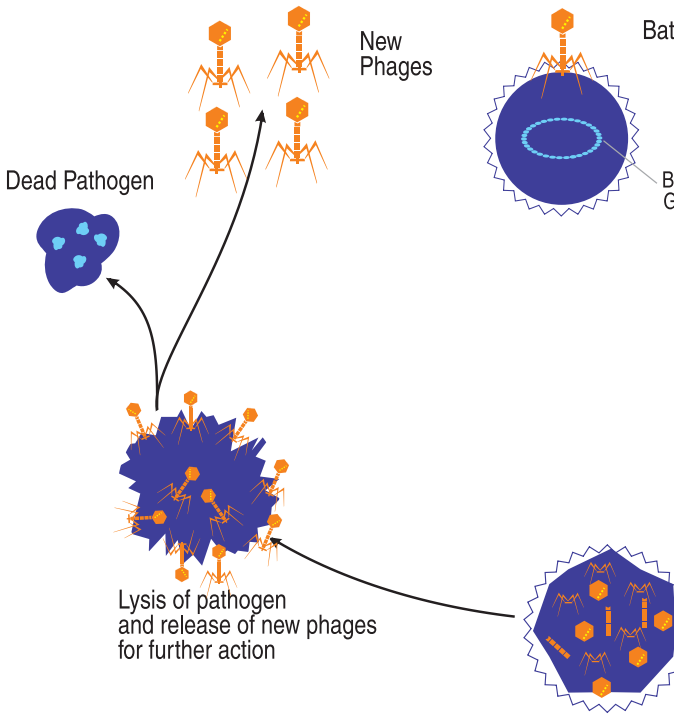

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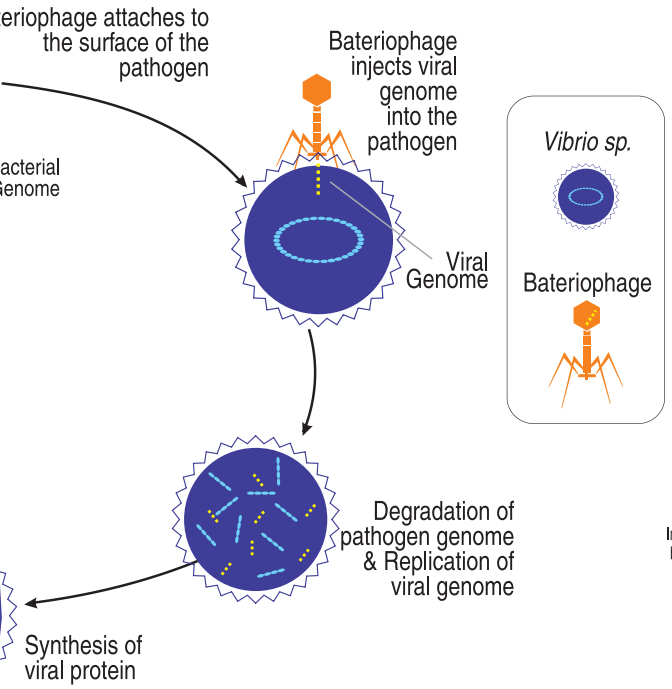

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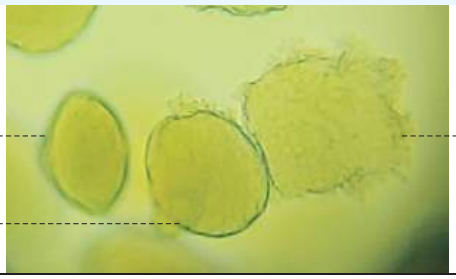
Stages of *Vibrio sp.* colonies infected with Bacteriophages & Progressive Lysis observed on an Agar plate, under Stereo Microscope

Colony 1 in Stage 1: Intact Colony may be infected or yet to get infected.

Colony 2 in Stage 2: Phage infected Colony showing Partial lysis.



Colony 3 in Stage 3: Phage infected Colony Completely lysed, cell contents with multiplied phages spreads out in search of their host.

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We already rank fourth in the list of fish production in the country," said Dilip Kumar Singh, joint director of fisheries at the State Project Unit.

Bijay Kumar Paswan, fishery extension officer in Saharsa district, said that the state government has been offering subsidies under various schemes that have been encouraging people to shift towards fish farming.

"The state government has launched schemes in which it is offering huge subsidies to new farmers. The construction cost of two ponds is around 8.80 lakhs ($10,450) out of which the farmers are paid up to 70 percent subsidy. Besides, the government has also been offering similar huge subsides for the purchase of juveniles, hatchery renovation, aerators and installation of water pumps."

However, farmers complain that they are suffering from power outages and poor road conditions.

"We are facing severe power cuts that affect the running of aerators in the farm ponds, raising the risk of mortalities. The situation of roads leading to our ponds is also bad, and it proves difficult for the traders who want to come and buy the fish from us. We have requested the officials to look into the matter but nothing has been done yet. We can play a major role in achieving the target of making the state self-reliant in fish production but the government should also help in improving the infrastructure facilities," said one farmer.

Frozen seafood: changing perceptions in Bangladesh

In Bangladesh, public opinion holds strong that frozen seafood is inferior to its fresh counterparts, however, as Zubair Khan explains, this is often not the case.

Repeated freeze-thaw cycles can result in serious food safety risks

27 December 2024:

In Bangladesh, fish and shrimp are not just food items; they are woven into the country's culture and economy. However, a longstanding prejudice against frozen seafood has stifled the growth of the local market. Local people believe that frozen fish and shrimp lack the freshness and quality of those purchased from wet markets. This perception not only holds the industry back but also puts consumer health at risk, as mishandled fish from these markets often undergoes multiple freeze-thaw cycles that degrade its quality.

Historically, Bangladesh's rivers, estuaries and canals were teeming with fish and local people could rely on fresh catches daily, whilst the storing of fish was rare. Rare, However, as Bangladesh's population rapidly expanded, the country's landscape began to change. This rapid, unplanned expansion and associated pollution greatly reduced the natural water networks that had once supported local fisheries. With fewer natural sources of fish and a growing population, the traditional reliance on wild fish was no longer sustainable. However, the concept of the superiority of fresh fish still persists today.

Starting in the 1990s, fish farming started to gain momentum, providing a reliable and controlled alternative to dwindling wild fish stocks. Today, Bangladesh ranks 5th globally in aquaculture production, according to FAO's State of World Fisheries and Aquaculture 2022.

Although many were initially reluctant to embrace farm-raised fish and shrimp, they eventually had no choice but to adapt. With the natural sources of fish becoming scarce, farm-raised varieties became the primary option in markets across the country. Now, most of the fish and shrimp available in markets across Bangladesh are farm-raised, playing a crucial role in meeting the country's food security needs.

From farm to market: hidden dangers

Fish and shrimp in Bangladesh go through a long and often problematic journey before reaching consumers. After being harvested, fish are often transported without proper cold chain procedure, which causes a decrease in freshness. At the wholesale markets, ice is applied to preserve the fish and shrimp for transport to larger markets in bigger cities.

By the time fish reaches retail shops in large urban areas, there is already significant quality loss. Retailers, eager to market these products as fresh, defrost the frozen or semi-frozen fish. Moreover, many retailers refreeze their unsold stock to sell them on the next day – a process which repeats until the stock is cleared.

Consumers, unaware of this process, purchase what they believe to be fresh fish and shrimp, often freezing products again at home for future use.

Health risks of repeated freezing and defrosting.

The prejudice against frozen fish is rooted in the belief that fresh

fish is healthier and of better quality. Ironically, this preference for fresh often leads to the consumption of fish that has been repeatedly frozen and defrosted -an unsafe practice that many consumers are unaware of. Every time fish or shrimp is thawed and refrozen it loses water and nutrients, resulting in a potentially hazardous product lower in flavour and nutrition.

The repeated freeze-thaw cycles damage the cell structure of fish and shrimp, making them prone to bacterial contamination. As the product defrosts, bacteria that had been dormant can start to grow, and when it is frozen again, these bacteria remain alive in a dormant state. As the cycle repeats, the concentration of bacteria increases, which can lead to foodborne illnesses. Furthermore, some harmful toxins produced by bacteria are heat-resistant, meaning that even cooking may not fully eliminate health risks.

The impact on local fish and shrimp industries

Current handling practices hold back the growth of the local fish and shrimp industry. While Bangladesh is a major exporter of frozen shrimp and fish, the domestic market is very underdeveloped. This is in stark contrast to international markets, where frozen fish is not only accepted but preferred for its consistency and quality.

Local people, however, continue to pay a premium for fish that has likely undergone improper handling. This reluctance to embrace frozen fish

A seafood vendor at a market in Bangladesh

hampers the development of the domestic market, which could otherwise be a major driver of economic growth. It also limits opportunities for more sustainable practices in the industry, such as improved refrigeration, reduced food waste, and year-round availability of high-quality fish.

Acceptance of frozen fish can offer substantial financial benefits to the local farmers as well as consumers. By freezing their products directly after harvesting, farmers can preserve quality. This would allow them to avoid the middlemen who often dictate prices in the wholesale markets, helping farmers take greater control over their earnings. Proper freezing techniques would also extend the shelf life of fish and shrimp, allowing them to sell their stock gradually, rather than all at once, which often results in reduced prices.

For retail sellers, frozen products provide a higher level of quality assurance. They can offer their customers fish that has been preserved at its freshest state, avoiding the risks associated with fish that has been improperly handled. This will also ensure retailers can secure their investment, as frozen fish can be stored for longer periods without the fear of spoilage.

Overcoming the frozen fish taboo

Changing consumer perceptions and current handling practices will require concerted efforts from both the industry stakeholders and the government. Below are some strategies to address these challenges:

1. **Educational campaigns**

A widespread public awareness campaign is necessary to educate consumers about the dangers of repeated freeze-thaw cycles and the benefits of properly frozen fish and shrimp. These campaigns can explain how flash-freezing preserves nutrients and freshness whilst reducing risks of bacterial contamination from repeated defrosting.

2. **Nutritional comparisons and safety information**

Detailed nutritional comparisons between frozen and fresh fish should be made available to consumers, highlighting that frozen fish retains more nutrients than fish that has been frozen and defrosted multiple times. Safety information about the bacterial risks of repeated freeze-thaw cycles can further solidify the argument in favour of frozen fish.

3. **Certification and transparency in supply chains**

Establishing a certification system for frozen fish and shrimp may help build consumer trust. Furthermore, transparency across the whole supply chain will help improve consumer confidence in frozen fish.

4. **Endorsement by local influencers and health experts**

Engaging prominent local figures such as chefs, nutritionists, and health experts to promote frozen fish may help shift public perceptions. These influencers can share recipes and cooking techniques that showcase frozen fish and shrimp. This will also help normalise the consumption of frozen fish in Bangladeshi cuisine.

5. **Improved retail practices**

Retailers play a crucial role in changing consumer

From farm to plate, fish and shrimp are often frozen and thawed repeatedly

habits. They should be trained in proper storage and handling of frozen fish/shrimp to maintain its quality. Encouraging them to sell frozen products rather than defrosting them to appear fresh will ensure better quality and safety for consumers.

6. Proper forms & packaging

Introducing various forms, cuts and packaging options for frozen fish and shrimp could significantly benefit busy urban consumers. Additionally, providing pre-cut or ready-to-cook fish and shrimp would simplify meal preparation and reduce food waste, catering to the fast-paced lifestyles of city dwellers.

7. Tasting Events and Promotions

Organising taste tests and cooking demonstrations can help prove that frozen fish

is just as flavourful and versatile as fresh fish. Promotional discounts and offers can incentivise consumers to try frozen fish, leading to greater acceptance.

The frozen fish prejudice is not just a cultural hurdle - it is a significant public health concern and an economic impediment. By continuing to reject frozen fish, local people are unknowingly consuming lower-quality, less nutritious, and potentially harmful products. Embracing frozen fish could also benefit the entire aquaculture industry by attracting more investment and promoting sustainable development. With the infrastructure in place for freezing, the industry would be better equipped to meet both domestic and export demands year-round.

Minister inaugurates India's Centre of Excellence for seaweeds

The Mandapam Regional Centre of ICAR-Central Marine Fisheries Research Institute (CMFRI) has been designated as a Centre of Excellence (CoE) for India's seaweed research and cultivation.

India's Union Minister of State for Fisheries, Animal Husbandry & Dairying, Mr George Kurian (dressed in white) at the inauguration

Kochi: The centre was officially inaugurated recently by India's Union Minister of State for Fisheries, Animal Husbandry & Dairying, Mr George Kurian. Emphasising the crucial role of ICAR-CMFRI in advancing marine fisheries and mariculture in the nation, the minister said that this new development will further contribute to the comprehensive growth of the fisheries sector.

The minister also inaugurated the plantlet production unit for seaweed, followed by visit to the marine hatchery complex, national marine fish brood bank, recirculation aquaculture system (RAS), sea cage farm, and the green tiger shrimp hatchery.

While there Minister Kurian highlighted the remarkable increase in India's fish production over the past decade, from 95.79 lakh tonnes to 175.45 lakh tonnes. He also mentioned the government's efforts to improve the sector through various schemes.

"Under the Pradhan Mantri Matsya Sampada Yojana (PMMSY), the Union Department of Fisheries, Govt of India distributed 22 Insulated vehicles in Ramanathapuram district alone to maintain cold chain facilities for quality maintenance of fishes up to marketing with a subsidy of Rs 147.94 lakh", the Minister said.

"To enhance income and promote sustainable aquaculture, the government has introduced open sea cage farming for high-value fish species like seabass and cobia in the district. A subsidy of 9.91 lakh is provided under this scheme. To improve the efficiency and safety of traditional fishermen, the government is replacing wooden catamarans with FRP boats. 29 beneficiaries have already received these boats with a subsidy of Rs 58.18 lakh," Minister Kurian added.

CMFRI Director Dr Grinson George presided over the function and described the future plans for a strong collaboration with the ICAR-National Research Centre for Banana, Thiruchirapalli in seaweed tissue culture programmes. More than 150 fishers, fish farmers and seaweed farmers from Ramanathapuram and Pudukottai districts of Tamil Nadu attended the interactive meeting. They shared their experiences in seaweed farming and sea cage farming and also thanked the government of India, ICAR-CMFRI and Tamil Nadu State Fisheries Department for the various schemes and development initiatives being implemented for the sector.

Norwegian fisheries authority supports offshore aquaculture in three zones

The Norwegian Directorate of Fisheries believes all 3 areas under consideration by the Norwegian government may be suitable for offshore aquaculture development.

"The Directorate of Fisheries believes that all areas may be suitable for offshore aquaculture," said Director of Fisheries, Frank Bakke-Jensen.

Norway continues to explore the possibility of offshore aquaculture, most recently through a comprehensive impact assessment looking at the suitability for development in three potential zones: Norskerenna South (southern Norway), Frøyabanken North (western Norway), and Trænabanken (northern Norway).

The impact assessment, conducted by assurance and risk management firm DNV and commissioned by the Norwegian Ministry of Trade, Industry and Fisheries, was opened for consultation in October 2024.

The Norwegian Directorate of Fisheries has recently issued its official response indicating it would be in favour of offshore aquaculture development in all three zones, but stressed that adequate technical measures will need to be put in place to prevent fish escapes and thus possible impacts on wild salmon populations.

"The Directorate of Fisheries believes that all areas may be suitable for offshore aquaculture," said Director of Fisheries, Frank Bakke-Jensen, in a press statement.

Despite the impact assessment's findings that the possible consequences for wild salmon could be "very serious", the Directorate of Fisheries said its view was that "the negative consequences are limited".

"Good prevention of escapes will be crucial to limiting the negative consequences for wild salmon as a result of offshore aquaculture," Bakke-Jensen said.

"It will be important that escapes are prevented through a high technical standard," added Directorate of Fisheries section manager for aquaculture allocation, Anne Osland.

"The infection pressure for sea lice and disease must also be kept low inside the aquaculture facilities. This way we keep the probability as low as possible that wild salmon within and near the study areas will be infected," Osland added.

Technical regulations for offshore aquaculture also out for consultation

At the end of November 2024, Norway's Ministry of Trade, Industry and Fisheries also submitted proposals for technical regulations for offshore aquaculture facilities for consultation, with responses due by 25 February 2025.

"The proposed regulations, which have been prepared by the Directorate of Fisheries and the Norwegian Marine Industry Authority with input from the Norwegian Food Safety Authority and the Norwegian Environment Agency, propose provisions that will ensure escape safety in new installations intended for offshore aquaculture in a better way than the current regulations with technical requirements for sea-based facilities," the Directorate stated.

The proposed regulations include requirements for technology qualification before new technology is used, in addition to a monitoring system, verification requirements, and the need for consent before facilities become operational.

Fish Seed Production Practices of Bankura District, West Bengal- A Case Study

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Introduction:

Fish is the most important source of animal protein diet for humans, and fish production in India has increased significantly over the years, reaching roughly 14.16 million metric tonnes in 2020. The fisheries sector provides 1.24 % of the Indian economy. Nearly 14 million fishermen and fish growers rely on this industry, contributing significantly to foreign exchange earnings. Aquaculture is rapidly contributing to the country's fish supply. The development of various techniques utilized in Indian Major Carps (IMCs) culture - Catla, Rohu and Mrigal, sowed the seeds of the country's blue revolution. These carps contribute nearly 5% to world aquaculture production, of which approximately 76% comes from Indian aquaculture.

West Bengal is known as a 'rice-fish society'. This state contributes about 21-23% of inland fish production and about 37-40% of the total seed production of the country. West Bengal is a pioneer in fish seed production and contributes about 124550 lakhs (2019-20).

Natural and hysicalresources of Bankura district were influential in determining the initiation and growth of the fish seed production industry, but here the activities of the fishery sector are little concerned, so the fish breeders of Bankura district of West Bengal started bundh breeding with a new approach and modified form. The fish seeds produced at present can be compared to the wild collection and are more economical than induced breeding.

History of fish seed farming in West Bengal

Carp seed farming started in the form of natural breeding in earthen hapas. The first private hatchery in West Bengal was established in 1966 at Naihati of district north 24 paraganas, by Mr Nilu Ghosh, who was trained at CIFRI (Central Inland Fisheries Research Institute) in 1966 to spawn IMCs, and he subsequently bought 12.14 hectares of land for fish culture. Mr Nilu Ghosh has contributed to constructing 200 hatcheries and Fish spawn 2,000 nurseries in West Bengal.

1. Fish seed production practices in Bankura district:

Fish Spawn

Overview of fish seed production in Bankura district:

Pisciculture is an essential factor in the economic development of Bankura. Bankura ranked first in Pisciculture within West Bengal. Bankura was a pioneer in developing Indian major carp by simulating natural conditions in captivity by bundh breeding technique due to undulating terrain with a vast catchment area. Besides this, here modern hatchery practices are also done commercially. So the natural and physical resources of the Bankura district were influential in determining the initiation and growth of this industry. Ramsagar village of Bankura district is a widely known destination with more than 200 hatcheries.

Over the years, a sustainable convergence model between the Department of Fisheries and Mahatma Gandhi NREGA [MGNREGS] was formed at Ramsagar Gram Panchayat, Onda Block, Bankura district. The Department of Fisheries is providing technical and input support for pisciculture, and MGNREGS may be able to help with water body excavation and re-excavation as required. The departmental input in the years leading up to 2014-15 was 1.72 crores, with a corresponding NREGA contribution of Rs 8.04 crore. The Gram Panchayat has joined the list of MGNREGA's successful convergence enterprises. Residents of Ramsagar Gram Panchayat in Onda block have been producing fish seed as one of their primary sources of income since 1950. After receiving MGNREGA benefits, farmers of Ramsagar Gram Panchayat have generated a fish seed business worth Rs. 1.4 crore. At Mukutmonipur village of Bankura, a modern fish production factory was recently established. Nearly 81 hectares of pond land have been dug under the Rashtriya Sam Vikas Yojana (RSVY). The project was executed in a participatory model by fishermen's groups.Fishermen's cooperatives have been urged to contribute a small portion of their catch to Primary

Schools so that it might be included in the mid-day meal. This has created a stake in the community at large in the project.

Species cultured for seed Production:
IMCs Catla (Labeo catla), Rohu (Labeo rohita) and Mrigal (Cirrhinus mrigala) are the primary species produced with other species supplementing to varying degrees in different areas, which include –Silver carp (Hypophthalmichtys molitrix), Grass carp (Ctenopharyngodon idella), Bighead carp (Aristichthys nobilis), Common carp (Cyprinus carpio), Calbasu (Labeo calbasu), Catfish (Clarias batrachus and angasius sp.), Japanese puti (Puntius vanicus), Bata (Labeo bata), Rupchanda (Pampus chinensis) etc.

The traditional method of fish seed farming:

Fish Market

Supplementary Feeding

Boiled rice and Pea

Micro - 100

Floating feed for Carnivorous fish

Farmers in the Bankura district recognized that hatchery seeds are not only inferior in quality but also interfere with productivity. As a result, fish breeders in Bankura, West Bengal, India, began producing bundh with a new approach and changed form. Except for the common carp, all the other significant carp do not reproduce in ponds, even reaching full gonadal maturity, but they breed in Bundh. Bundh breeding takes place during the pre-monsoon (March to May), monsoon (June and July), and post-monsoon (August) seasons, with broodstock management being a continual operation.

Bundh can be classified as-

1. Perennial bundh is commonly known as "Wet bundh" or Moan

2. Seasonal one called "Dry bundh."

Wet bundh
A typical wet bundh is situated on a gradual slope of a catchment region, with an inlet towards the high land and an outlet towards the lower end to control the input and outflow of water during heavy rains. Excess water flows out of the bundh during the monsoon season, generating a water stream. Breeders in the bundh's deeper parts travel to shallower locations, where they begin breeding. This variety is mainly found in the Panchmura and Rahanagar villages of the Bankura district.

Dry bundh
This type of dry bundh consists of only one shallow depression. During the monsoon season, the shallow depression is surrounded on three sides by embankments that impound freshwater from the catchment region. Most parts of these bundhs dry up in the summer, but the middle section, which is deeper than the surrounding terrain, always has some water. During the breeding season, these ponds are supplied with brood fish. During the monsoons, when water from the catchment areas rushes into the central part as streamlets, the fish travel to the surrounding shallower region and perform sex ply for 4-5 hours. A gamcha or scoop net is used to gather the fertilized eggs. This bundh is found chiefly in the Taldangra village of Bankura district.

Supplementary Feeding

Supplementary Feeding

Hatchery practice of fish seed production:
This method allowed fish to spawn naturally in hapa, and fertilized eggs were later removed for incubation in Chinese cisterns. Now a day's, at Bankura, most of the farmers are using this technique. Natural breeding is observed in Khatra, Simlapal and Raipur areas of Bankura District and Ramsagar, Taldangra village of Bankura district use modern hatchery practice.

Bloodstock Management:
Most farmers (small and marginal) adopted bundh on lease during the breeding season and used to collect brood from leased bundh or collect matured brood fish from the neighbouring village. Still, big farmers have their own land (bundh), including stocking ponds and breeding pools for broodstock management. Healthy breeders are typically selected from the 1.5-3 years age group and 1-5 kg weight range.

Transfer of brood fish
After the preparation of the breeding pool is completed, the farmers collect brood fish from stocking bundh and release selected mature broods in the ratio of 1:1 (male: female) in the breeding bundh. Stoking of fish is generally initiated during October, and stoking rate should be 1500 – 2000 kg/ha. After releasing fish, the water supply should maintain in the morning between 6 am to 10 am as this will stimulate breeders to go for breeding following courtship.

Supplementary Feedings:
Brood stock was fed on various types and combinations of foodstuffs, including mustard cake, rice bran, boiled rice, boiled pea, groundnut shell, wheat, fish meal, lobster meat (for catfish), poultry feed, manufactured fish feed (micro-encapsulated feed, floating feed, maize, dry fish and cow dung for pond fertilization. Farmers also use to feed some commercial products like VIBNIL (a TATA product with the power of nano silver encapsulated in biopolymer), FISH BOOSTER (a TATA product with rapid growth promoter for fish), and RALLI BOND (a TATA product with holistic

growth promoter with feed binding property).

Induced breeding:
The final maturation of broodstock was induced with a diluted solution of pituitary glands. Both males and females are injected with only one dose at the rate of 1 ml. solution per kg body weight in the case of Indian Major Carp, but few farmers prefer WOVA-FH as an inducing agent. Mainly the injection is done into the muscle behind the right pectoral fin.

Spawning and Fertilization:
After injection, the brooders are released again into the breeding pool, and within half an hour, the injected male and female exhibit breeding behaviour which includes sporting. Sporting continues for 2-3 hours. Breeding ends in spawning; the females start releasing eggs, and the male enticed releases milt over the eggs, resulting in fertilization.

Collection of eggs:
The eggs are collected in the Chinese circular cistern when the embryo begins to twitch. Lower the water level in the pool to collect eggs by opening the outlet. A spawn of thin cotton cloth (gamcha) or mosquito netting material is commonly used to collect eggs and release the developing eggs into hatching bundh.

Hatching:
Farmers release the egg in the pre-selected hatching bundh or Chinese cistern in the morning between 5 and 8 am. In an empty, washed pool, a circular metal frame is fixed over the circular base in the pool. The circular base's entrance is entirely covered with a finely meshed monofilament cloth placed over it and lowered to the pool's bottom. Then the cloth is stretched tightly around the frame. A vertical pipe of 66 cm. height is to be fixed on the central outlet. The pool is filled with water, and it begins to circulate. The inlet valves need to adjust to maintain water flow at 0.2 to 0.3 m/sec. Required numbers of water-hardened fertilized eggs are to be released in the outer compartment, which keeps on moving with circulating water and continues to hatches. The egg cells break down and pass through the cloth with a continuous water flow.

Collection of hatchlings:
On the 3rd day, the hatchlings begin to move freely, and then they will be collected for stocking in the Nursery tanks. When the water level touches the opening of the outlet pipes, a happa is put inside the cistern. Then spawn passes through the outlet pipe & is collected in the happa. Spawn is then separate from the dust if any. It is measured for stocking in the Nursery tanks for further rearing. Fish seed production includes egg to spawn production for 3 days, spawn to fry nursing for 15-20 days, fry to fingerling rearing for 60-90 days and fingerling to yearling rearing for 8-9 months. Thus the carp seed may be categorized at its final size into spawn (6-8 mm size), fry (20-25 mm size), fingerlings (100-150 mm size) and yearlings (100-200 g weight).

Fish seed transportation:
Seed transportation is done in both open and closed systems. Fry and fingerlings are typically transported in open aluminium bowls (hundies or patils) or on a bigger scale. They use the metal tank in trunks. Hatchlings are transported in an open system for short distances, but for longer distances, they are transported in oxygenated plastic bags containing 8 litter oxygenated water for 500 gm of fish seed. Recently they started using UV-treated water for transport to increase survivability.

Marketing:
Fish seeds are transported both locally inside West Bengal and outside West Bengal, such as Jharkhand, Odisha and Andhra Pradesh, from the seed markets of Bankura like Ramsagar, Taldangra, Khatra, Simlapal and other places. Fish spawns are commonly assessed using the indigenous 'Bati' methodology. 'Bati; comes in various sizes, ranging from 60 to 135 ml. The 'Bati' is usually formed of metals, and each 'Bati' is expected to have 5,200 to 55,000 spawn. The dallal- golder network was mainly used by Bankura nurseries to collect hatchlings.

Constraints:
Transportation delays and water exchange problems were less concerned than high temperatures, which also caused mortalities during transportation by middlemen. Many fish seed producers and distributors lacked relevant formal training, institutional support in terms of training and business management assistance or advice. Inadequate feeding strategies responsible for poor fish health and intensive use of chemicals and therapeutics also cause motility, and Fish diseases are also significant problems for producers. Fish seed predation by fish-eating birds is another crucial problem here. So to prevent it, a complete enclosure of a site with netting is very much needed. Netting should be sufficient to withstand wind and degradation by sunlight and weathering. Netting should be strung reasonably tightly to prevent the weight of birds standing on it from causing it to sag.

Socio-economic status of seed farming:
Feed seed production procedures have certainly improved the socio-economic situation of Bankura area residents. In that zone, roughly Rs. 6-7 cores are transacted annually through spawn generation of about 50,000 million numbers in 225 to 250 hatcheries. Approximately 1500 to 2000 workers are directly involved in the manufacturing system. This economic development benefited 850 families, directly and indirectly, allowing 85% of Ramsagar Gram Panchayat residents to make a living. The annual turnover of fish seed breeding at Ramsagar village has been 20 cores in the last three years.

4. A survey on seed production at Ramsagar village:
Here some data on fish seed production are represented from

15 fish seed farmers of Ramasagar village of Bankura district. According to them, most use IMC-Rohu, Catla, Mrigal, Grass carp, Silver carp, Bata, Pangas, Rupchada, Mono tilapia, Deshi magur, Hybrid magur for seed production. His yearly production is approximately 2000-3500 quintal seeds per day, sells 5-10 kg, annual income is Rs.90,000- 250000, and yearly investment is around Rs. 25000. He used to incubate the egg in the earthen pond and Chinese cistern. They use the pituitary gland as an inducing agent. The average stocking density of brooder fish is 1.6 tonne/ha with a male: female ratio of 1:3-1:5. The average selling price for Rohu seed is 0.35 Rs/pc, Catla seed is 0.70 Rs/pc, Deshi Magur seed 2.00 Rs/pc, Hybrid Magur seed Vietnam Koi seed 2.00 Rs/pc, Pangus seed 3.00 Rs /pc, Bata seed 0.35 Ra/pc, Grass carp seed 1.50 Rs/pc. Mr Nitai uses Natural- Plankton, Farm wet feed-mustard cake, boiled rice, boiled peanut, Formulated feed- pelleted feed with vitamin premix as feed. They use an oxygenated plastic bag, and a cotton bag for transporting the seeds and do marketing at Ramsagar local market and all over India.

1. Conclusion:

The population of Ramsagar Gram Panchayat and the surrounding areas have clearly benefited from these seed-producing strategies. This not only benefited the fish seed producers directly, but it also created 4,56,038 person-days throughout that period. Fish seed is raised in all 150 ponds, and the producers sell the fish seed to local markets and markets in neighbouring states like Jharkhand, Odisha, and Andhra Pradesh. According to nursery owners ' estimations, fingerling sale prices varied amongst growers, as did profit margins, which ranged from 20,000 rupees to 60,000 rupees per year, with an average of 34,000 to 42,000 rupees.

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Pituitary injection in brood stock

Dried pituitary glands

Brood Fish

Separating Male and Female Brooder Fish

Hatching collection

Chinese Cistern

Hatching bundh

Magur seed

Plastic Bags

Oxygenated Plastic

Short Distance Transport Motor Bike

For long Distance nsport in Metal Tank by Trunks

Netting Enclosure to Prevent Fish eating Birds

ROLE OF BLACK SOLDIER FLY LARVAE MEAL AS A REPLACEMENT FOR FISHMEAL IN AQUACULTURE

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Introduction

Aquaculture refers to the use of or in freshwater, seawater, brackishwater, and inland saline water for the farming of aquatic organisms such as fish, crustaceans, molluscs and algae. Aquaculture is the highest-ranking food sector with an annual growth rate of 8.8 percent for the past 25 years. It is one of the fastest growing animal food sectors and provides over 13% of the animal protein for the human consumption. Due to its distinctive flavor, excellent nutritional content, and sustained demand on the global market in general, shrimp culture gained the most attention in terms of human consumption. Feeding makes up the majority of the aquaculture farms' costs (approximately 60% of the total economic balance). Therefore, the cost of feed must be decreased while the effectiveness of its utilization must be raised. The primary and most expensive component of a shrimp diet is protein. As a result, research efforts have been focused on identifying efficient sources and optimal dietary levels. For every kilogram of shrimp produced, 0.75–1 kg of fish meal, or the equivalent of 3–4 kg of fresh trash fish (75% moisture content), is required at feed conversion ratios of 1.5–2. Concerns about the declining availability of fish resources (trash fish) in the wild have been raised in response to the growing demand for fish meal because of the more uncontrolled degree of exploitation. As a result, in order to make the activity more environmentally friendly, a different protein source that can be used in replacement of fish meal in shrimp feed is required. Insects could be vused as a source of protein in feed.

- As Feed plays a major role during the Shrimp Culture period i.e. about 60% of the input cost, we should focus on the ingredients for protein source which decreases the input cost and gives beneficial results.
- Black Soldier Fry Larvae Meal can be used as an efficient feed ingredient as an alternative to Fish Meal.
- It can turn organic waste into biomass that contains proteins with a high biological value. Moreover, BSFL are vitamin-
rich, particularly in vitamin E.
- Replacing commercial feed up to 50% with fresh BSFL could be feasible for L. vannamei farming when growth performances, digestive enzyme activities, intestinal histology, and antioxidant enzymes were being considered.

Insect protein was more affordable, friendly to the environment, and played a crucial natural role.

Black soldier fly

The insect known as black soldier fly (BSF), Hermetia illucens, belongs to the family Stratiomyidae of the order Diptera, and it resembles wasps externally. However, the black soldier fly lacks a stinger andv, like the majority of flies, has only two wings (wasps have four). Its natural distribution includes Asia, Europe and the southeastern United States. They spread widely to other regions, and today they are primarily found in the equatorial tropics.

Taxonomical classification

Kingdom	:	Animalia
Phylum	:	Arthopoda
Class	:	Insecta
Order	:	Diptera
Family	:	Stratiomyidae
Genus	:	Hermetia
Species	:	Illucens

Hermetia illucens

Description and Life Cycle

Adults

Soldier flies belong to the Stratiomyidae family, and they come in a variety of colors, including yellow, green, black, and blue, with some even appearing metallic. Adult black soldier flies are black or blue in colour and resemble wasps in appearance. On their 8 first abdominal segment, soldier flies have two transparent "windows" as well. The adult's legs are white near the ends, and its antennae are long and contain three segments. Mating can take place two days after the adult emerges from the pupal case.

Eggs

In cracks and crevices around or in decaying stuff such as dung, carrion, rubbish, and other organic waste, the female black soldier fly lays a mass of about 500 eggs. The eggs take about four days to develop into larvae. Each oval-shaped egg measures around 1 mm in length and is either creamy white or pale yellow in colour.

Larvae

The larvae can grow to be 6 mm in width and 27 mm in length. They have a tiny, protruding head with chewing mouthparts and are dull, yellowish in colour. The development of a larva requires six instars and takes about 14 days. Black soldier fly larvae are insatiable feeders while they are still developing. They rely on the fats retained during the larval stage and do not need to feed as adults.

Pupae

To initiate pupation, the sixth instar larvae disperse from feeding site to dry sheltered area such as ground vegetation. The exoskeleton (skin) darkens and a pupa develops within. Pupation requires about two weeks.

Black soldier fly larvae meal (*BSFL, Hermetia illucens*)

It is one of the insect proteins that could be used for producing shrimp feed, through the bioconversion of organic waste, BSFL meal is created. Black Soldier Fly (Hermetia illucens) is one of the insect species currently reared in union which is used for production of feed. Black soldier fly processing of organic waste has been extensively developed, and it generates a significant amount of meal larvae that can be harvested and utilized as fish food. The most intriguing source for sustainability is Hermetia illucens larvae meal since it can turn organic waste into biomass that contains proteins with a high biological value (40–45%), ash (11–15%) with high mineral concentrations and a high Ca/P ratio and fat (30–35%) with nutritionally rich fatty acids are also present.

Nutrient content of black soldier fly larvae

The black soldier fly larvae's (BSFL) composition largely depends on the nature of the substrate. From day-old larvae through the prepupal stage, 9 the dry matter (DM) content of BSF larvae steadily rises to an average of 35-45%, remains constant during the pupal stage, and decreases to 20-25% when the larvae reach the adult stage. Through its whole life cycle, the crude protein (CP) content of BSFL changes remarkably, but it stays constant at about 40% while in the larval stage. However, the CF value stays at an average of 24-28% from day-old larvae to prepupal stage. In every growth stage, a variety of necessary amino acids and fatty acids are synthesized, but the levels are significantly higher in the early larval stages. Larval stages are also observed to have significantly higher calcium and phosphorus levels than adults (3000 mg.100 g-1 and 620 mg.100 g-1 , respectively). Additionally, chitin content gradually rises with age and substantially rises when it reaches the prepupal stage. Also, levels of other minerals such sodium, iron, and zinc are 100 mg, 200 mg, and 60 mg.100 g-1 respectively. Moreover, BSFL are vitamin-rich, particularly in vitamin E (7 mg.100 g -1) .

Black soldier fly larvae meal as replacement to fishmeal:

Many studies have been conducted on the inclusion of BSFL in finfish aquaculture. Different inclusion levels of BSFL have been observed in studies, with some claiming complete replacement of fishmeal. Such studies have focused on the effect of the BSFL diet in different life stages of finfish species. Most studies demonstrated little or absence of negative effects on the growth of finfish species. Soldier fly larvae (Hermetia illucens), grown on chicken manure at a commercial caged layer house, were fed to channel catfish and tilapia, alone, and in combination with high-(45%) and low-(30%) protein commercial diets. Results of the taste tests indicated that fish fed soldier fly larvae are acceptable to the consumer. study evaluated survival, growth performance, digestive enzyme activities, intestinal histology, and antioxidant enzyme activities of the Pacific white shrimp (Litopenaeus vannamei), which were fed with five different diets, containing 0%, 25%, 50%, 75%, and 100% fresh black

soldier fly larvae (BSFL), respectively, to replace commercial feed at an equal wet weight. In conclusion, replacing commercial feed up to 50% with fresh BSFL could be feasible for L. vannamei farming when growth performances, digestive enzyme activities, intestinal histology, and antioxidant enzymes were being considered.

Conclusion

Black soldier fly (BSF) is an important alternative protein source recognized by the Food and Agriculture Organization (FAO) to maintain sustainable economic and environmental development. Meanwhile, BSF is abundant in bioactive substances that can significantly boost aquatic animals' immune systems. Numerous studies have examined the dietary black soldier fly's immunostimulatory effects on terrestrial animals. Several literatures show that appropriate supplementation of BSF meal to the basal diet could improve blood and serum biochemical response, promote health of intestine and liver, enhance the antioxidant activity, decrease oxidative metabolites and down-regulate relative gene expression, up-regulate the immune gene expression, increase disease resistance. However, the research in aquaculture is still in its development.

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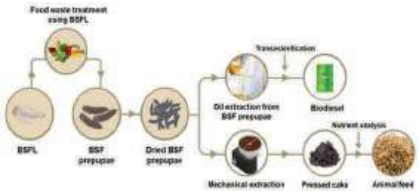

Extraction of Black Soldier Larvae Meal

Grow Your Worms, Grow Your Fish: A Simple Guide to Thriving Aquaculture

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- Culturing live worms reduces reliance on commercial feeds, offering a cost-effective, sustainable solution for aquaculture.
- Live worms provide essential nutrients, enhance di ges tion and nutrient uptake, boost reproductive success, and support healthy larval growth, making them vital for successful aquaculture.
- Provides actionable, detailed methods for culturing worms to reduce feed costs and enhance productivity.
- Accessible techniques for small-scale farmers to improve practices with minimal investment.

Introduction

Live feeds are a cornerstone of successful aquaculture, providing the essential nutrients needed for the growth, reproduction, and health of fish. Among these, worms are particularly valued for their high protein content and natural appeal to fish. They play a crucial role in conditioning broodstock, supporting fry development, and enhancing immunity, coloration, and overall vitality. Unlike artificial feeds, worms encourage natural foraging behaviors, which improve digestion and nutrient uptake. With options such as grindal worms, tubifex worms, bloodworms, polychaetes, and microworms fish farmers can meet the specific dietary needs of fish across all life stages. Beyond improving breeding success, live worms also offer a sustainable, cost-effective solution for backyard fish farming, reducing reliance on commercial feeds while maintaining high productivity.

Benefits of Using Live Worms in Brood Fish Diets

Incorporating live worms like polychaetes, tubifex, and bloodworms into brood fish diets enhances breeding success and overall health. Rich in essential nutrients, these worms promote natural foraging behaviors, keeping fish active and well-conditioned for spawning. A varied diet of live worms ensures balanced nutrition, improving vitality and reproductive performance. For ornamental fish, live worms are especially effective for conditioning, while micro worms and vinegar eels are ideal for fry, boosting survival and growth. In catfish aquaculture, live worms are crucial during early larval rearing, supporting optimal growth and survival during this critical phase.

Cost-Effectiveness

Established, worm cultures are cost-effective to maintain and require minimal space and equipment. They

can be easily refreshed and provide a continuous supply of fresh food for your fishes. This makes them an accessible option. While worms provide excellent nutrition, they should complement a balanced diet that includes commercial fish foods. This ensures that fish receive all necessary nutrients for long-term health. Culturing worms for aquarium feeding not only supports the health and growth of fish, but also creates a more engaging environment that mimics their natural habitat.

Different type of live worms

Polycheate worm

Polychaete worms, belonging to the class Polychaeta, are segmented marine worms essential to coastal and marine ecosystems. They serve as decomposers and a food source for various aquatic organisms, including fish, making them important in aquaculture, due to their nutritional value. Most polychaetes reproduce sexually, with distinct male and female individuals releasing gametes into the water for external fertilization. They can also reproduce asexually through fragmentation, allowing segments to regenerate into new individuals. Their reproductive cycles are influenced by environmental factors such as temperature, light, and food availability. Polychaete worms inhabit diverse marine environments, including coastal waters, deep-sea trenches, and intertidal zones.

Culture Method

Culturing polychaete worms to make suitable environments, that mimic their natural habitats. FRP / Cement tanks with sand, gravel, or mud substrates to allow burrowing. Aeration and filtration are essential to maintain water quality, as polychaetes require well-oxygenated water. Temperature and salinity should be carefully monitored. For instance, many polychaetes grow at temperatures between 15 to 25°C and salinities around 30 - 35 ppt. Feeding polychaetes is very important for successful culture; they are typically provided with a diet of organic matter, such as detritus, algae, and commercial feeds. Regular maintenance and water changes are essential to prevent the buildup of waste and maintain a healthy culture.

Life cycle

Polychaete worms have varying life cycles, but they generally follow similar stages. After fertilization, eggs develop into free-swimming trochophore larvae, which settle on the floor and become juvenile worms. This larval stage promotes dispersal, increasing genetic diversity and colonizing new areas. As they grow, polychaetes molt several times, gaining size and adult features. The time to maturity varies widely.

Tubifexworm

They are also known as sludge worms, small in size, thread-like in structure. Grow in freshwater environments rich in organic matter, such as ponds and marshes. They are highly adaptable and can live in both clean and polluted waters, including low-oxygen regions. As decomposers, tubifex worms play an important role in breaking down organic waste in sediments. Due to their high protein content, they are commonly used as live food for fish in the aquarium industry. These worms reproduce both sexually, as hermaphrodites, and asexually through fragmentation, allowing for rapid population growth. Their presence often indicates pollution, as they can tolerate high levels of contamination and serve as bioindicators of water quality.

Culture method

To successfully culture tubifex worms, start by selecting a suitable tank, such as FRP tank or any other appropriate container. Fill the tank with a mixture of cow dung and clay or soil, as this combination provides essential nutrients for the worms. Allow the substrate to settle for one to two days to create a stable environment. After settling, introduce a water flow, using a submersible pump, since tubifex worms grow in running water, which promotes faster growth. Once the environment is established, inoculate the tank with the tubifex worm culture and ensure they are fed adequately to support their growth and health. By following these steps, you can create an optimal environment for effectively culturing tubifex worms.

Life Cycle

Tubifex worms starts with fertilized eggs that develop into juveniles and then mature into adults. As hermaphrodites, they have both male and female reproductive organs and exchange sperm during mating. The fertilized eggs are placed in cocoons in the substrate, where they develop into juvenile worms. These juveniles grow through molting stages, while feeding on detritus. Their growth is influenced by temperature, food, and oxygen levels. Tubifex worms reach reproductive maturity in 3 to 4 weeks and can reproduce either sexually or asexually through fragmentation.

Microworm

Panagrellus redivivus is tiny nematodes, measuring 0.25 to 1 mm in length, that serve as live feed for fish fry and ornamental fishes. Their small size, ease of culture, and high nutritional value make them ideal for feeding small fishes during their early life stages. Microworms reproduce rapidly through ovoviviparity, with eggs hatching inside the female, and can also reproduce asexually, allowing females to produce offspring without males. They grow in moist, decaying organic matter, feeding on bacteria and microorganisms, which makes them a popular choice among fish breeders for their fast growth and straight forward culture requirements.

Culture method

To culture the microworm, fill an empty container with oatmeal, wheat flour, or bread crumbs. Next, lightly spray the surface with water to moisten. Once the substrate is ready, inoculate the starter culture in the centre of the surface. To enhance fermentation and growth, add a small pinch of yeast to the top. After inoculation, cover the container with a lid. It's important to create an air passage to allow for proper ventilation and you can made this by making a small hole in the lid. Cover this hole with mesh material to prevent contamination, while still allowing air to circulate. Within three to four days, a flourishing microworm culture, ready for harvesting.

Life cycle
Microworms reach reproductive maturity within just 1 to 3 days after birth. Once they mature, they start reproducing right away, leading to a rapid increase in their population. Although the average lifespan of a microworm is around 20 to 25 days, the culture can grow for weeks or even months, provided that the environmental conditions remain optimal.

Grindal Worm
Enchytraeus buchholziis small, white, segmented worm valued in aquaculture for their high nutritional content and ease of cultivation. Worms are hermaphroditic, possessing both male and female reproductive organs, and reproduce asexually through fragmentation, allowing rapid population growth - a new generation can emerge in just 4 to 6 days under optimal conditions. Grindal worms thrive in moist, organic-rich environments like decaying plant matter, compost piles, and forest floors, where they feed on decomposing material and microorganisms.

Culture method
To prepare the culture container, begin by placing a 2 cm layer of coir scrubber at the bottom as the substrate. Next, add water until it covers the substrate to a depth of 0.5 cm. In the center of the container, introduce a small amount of oats or dog pellets along with the inoculum. Cover this mixture with a flat piece of fiber sheet or a tile to create a barrier. For proper aeration, make a hole in the lid of the container and cover it with plankton cloth. Within just four days, your culture will be ready for harvesting.

Life cycle
Grindal worm mature in just 2 to 4 days. Following reproduction, they can survive for several additional weeks, contingent on environmental conditions. Their rapid and continuous reproduction makes them an excellent food source for aquaculture, providing fish fry with a dependable supply of live feed during the important broodstock conditioning period.

Earthworm
Earthworm is terrestrial invertebrate belongs the phylum Annelida, are vital for soil health through aeration and nutrient cycling. They consume decaying organic matter, producing nutrient-rich castings, that enrich the soil. Common species include Lumbricus terrestris and Eisenia fetida, often used in vermiculture. These hermaphroditic creatures possess both male and female reproductive organs, but require a mate for fertilization. After mating, they lay eggs in cocoons, which hatch into juvenile worms that mature in 15-30 days. Earthworms grow in moist, nutrient-rich soils like gardens and forests, preferring cool, damp environments. Their burrowing enhances soil structure, allowing better air and water penetration, ultimately improving fertility.

Culture method
Culturing earthworms or vermiculture fill a container with organic waste like vegetable scraps and coffee grounds, along with bedding materials such as peat moss or shredded cardboard. The red wiggler (Eisenia fetida) is the preferred species for its ability to grow in the said environments. Keep the bin moist and in a cool, shaded area with temperatures between 20 -25°C. After a few months, the worms will convert the organic material into castings, which can be harvested. Maintain the culture by regularly adding food scraps and ensuring proper aeration and moisture.

Life cycle
The life cycle of an earthworm begins, when fertilized eggs are deposited in a protective cocoon in the soil. After hatching, juvenile worms emerge, resembling smaller versions of adults. These juveniles go through several stages, maturing in 20-45 days. Earthworms can live for several years in favorable conditions, with some species living up to 6-8 years. Earthworm's growth and reproduction rates are influenced by environmental factors such as temperature, moisture, and food availability.

Vinegar eel
Vinegar eels, (Turbatrixn aceti) is tiny, transparent nematodes found in vinegar and other fermented products. Valued in aquaculture as nutritious live feed for juvenile fish, they reproduce both sexually and asexually. Grow in acidic environments, they feed on bacteria and yeast, supporting fermentation, and also inhabit decomposing organic matter, contributing to nutrient breakdown in moist soils.

Culture Method
The desired culture involves, creating a suitable medium that closely resembles their natural habitat. A glass bottle with a small mouth, which should be filled with a mixture consisting of 50% apple cider vinegar, beer, or coconut vinegar, and 50% water. To provide a food source, a small piece of potato or apple is added to the mixture. Once the medium is well mixed, a small quantity of inoculum can be introduced to initiate the culture. The bottle should be covered with mesh to allow for airflow, while preventing contaminants from entering. It is important to keep the culture at room temperature. Within three days, the culture will begin to develop.

Life cycle
Vinegar eels have a short life cycle with several stages. After fertilization, eggs hatch into juvenile worms that molt as they grow. The complete cycle from egg to adult takes just 3 to 7 days, with maturity reached in about one weeks, allowing for fast reproduction. This rapid development makes vinegar eels an efficient live feed option for fish larvae.**Bloodworm**
Bloodworms, Glycera dibranchiate is striking red annelids found in shallow waters, and stable water known for their hemoglobin-rich blood. They serve as a nutritious live food source in aquaculture and reproduce by laying eggs in protective capsules. These worms burrow into substrates, feeding on organic matter and playing a important role in ecosystems by recycling nutrients and supporting aquatic food webs.

Culture method
Culturing bloodworms for aquaculture requires FRP tank with sandy or muddy substrate. Use a freshwaters, starting with wild-caught bloodworms. Maintain a temperature of 20 to 25°C and ensure good aeration. Feed regularly with organic materials like finely ground fish food. Harvest by gently sifting the substrate to sustain

the culture.

Life cycle

Bloodworms undergo a life cycle with four stages: Egg, larva, juvenile, and adult. After fertilization, eggs hatch into trochophores, free-swimming larvae that feed on plankton. Once mature, they settle on the substrate and transform into adult bloodworm.

Mealworm

Mealworms, the larvae of the darkling beetle (Tenebrio molitor), are valued for their adaptability and sustainability as food for humans and livestock, including aquaculture and poultry. Males attract females using pheromones, and females lay hundreds of eggs in grain or organic matter, with hatching occurring in 1 to 3 weeks under optimal conditions. Thriving in warm, dry environments, mealworms feed on grains, seeds, and plant debris. While beneficial, they can also become pests in grain storage facilities.

Life Cycle

The life cycle of mealworms consists of four stages: egg, larva, pupa, and adult beetle. After fertilization, the eggs hatch into larvae, which grow through several molts over a period of 1 to 3 weeks while consuming large amounts of food. Once they reach maturity, the larvae pupate for one to three weeks.

Culture Method

Culturing mealworms is easy and can be done at home or on a larger scale. It requires a substrate like whole grains, oats, or wheat bran, which provides substrate and a place for the larvae to burrow. Mealworm larvae or beetles are introduced into the substrate, and give some vegetables as a feed like carrot , potato the culture is maintained at a room temperature with regular moisture. Excess moisture should be avoided to prevent mold growth.

Conclusion

Live worms are a versatile and sustainable choice for aquaculture, enriching fish diets and promoting natural behaviors. By cultivating a variety of worms, backyard fish farmers can enhance broodstock conditioning, fry survival, and overall fish health while reducing dependency on commercial feeds. Their cost-effectiveness and ease of culture make worms an invaluable resource for thriving backyard fish farming.

Acknowledgment

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Polycheate worm

Bloodworm

Grindal worm

Microworm

Vinegar eel

Mealworm

Earth worm

Tubifex worm

Significance of food safety inspection for a seafood industry: An overview

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Introduction

The consumption of seafood is highly recommended as a part of a healthy diet because it is a potential source of protein with high biological value, Vitamins, unsaturated fatty acids, and minerals such as phosphorous or calcium. Furthermore, seafood intake is related to a low risk of pulmonary diseases. Despite these health benefits, generally, seafood contains many pathogenic microorganisms introduced during processing or after processing. These microbes can cause severe foodborne outbreaks. According to the report from WHO, it is revealed that seafood is one of the high-risk categories causing foodborne illness.

The major hazard involved in sea foods is biological hazards. Even though the microbial contamination of seafood can occur at any processing stage, from the capture to intake, practices followed by food handlers may have a significant role in contamination and foodborne illness. Improper handling and inadequate hygiene are the most prevalent reasons for foodborne infections (Baptista et al., 2020).

There are a variety of harmful microorganisms and different forms of deterioration in sea foods. Although spoilage microbes are mostly not harmful, they can alter a product's colour, flavour, odour, appearance, and longevity. Conversely, pathogenic microorganisms may cause illnesses or generate toxins, making them disease-causing agents. Decreased shelf-life, qualitative degradation, and in certain cases, the safety of the sea foods is associated with chemical and enzymatic alterations. Safety in the seafood industry will be ensured by rapid cooling, quick freezing and stable low-temperature storage by inhibiting microbial growth and slowing down deleterious alteration in color, appearance and texture.
Following Best Management Practices (BMPs) aboard commercial fishing vessels at aqua farms, harvesting, handling / processing, storage, and

- Identification of hazards in sea food industries are crucial to implement effective control measures to obtain safe sea food for consumption.
- Organoleptic inspection systems cannot detect hazards in sea foods; however examination at the point of processing sea foods is important to maintain food safety.
- HACCP, GMP, GHP guidelines must be implemented in Sea food industry, monitored at regular intervals and verify according to the norms.
- It is equally important to abide by all the regulations related to the export or import of sea foods.

transport is the initial stage in ensuring safety. The seafood industry uses a hazard management food quality program called Hazard Analysis Critical Control Point (HACCP) to avoid, eliminate, or control possible hazards present in sea foods (Jahncke 2016).

Role of food inspector in a seafood industry

Inspection in the seafood industry is a key step to ensure safety in the seafood industry. A qualified auditor can audit the industry to examine the hygiene practices, HACCP implementation, PRPs and production process and raise noncompliance if any hazards are present. Auditing in the seafood industry involves the inspection of the given parameters.

- Production procedures
- Production amenities and premises
- Health fitness of food handlers
- Personal hygiene practices
- Pest control
- Raw materials
- Hazard accessing facilities
- Temperature of storage facilities

Identification of hazards

Seafood processing is the process related to aqua fish between the time the fish is caught and delivered to the consumers. Any possibly foreign substances that are not typically present in food and can harm humans is generally termed a hazard.

Physical hazards

Physical hazards can result in serious consequences such as choking, bleeding, and piercing of tissue in the oral cavity, throat, abdomen, and intestines. Gum injury and broken teeth are also possible. The occurrence of physical hazards at different levels should be monitored and controlled. Some of the physical hazards are enlisted below.

Figure 1 Physical hazards in the seafood industry

Control measures for physical hazards

- Visual examination
- Use of sieves, filters, magnets and installation of metal detectors, x-rays
- Following personal hygiene by the food handlers
- Periodic checking of the equipment to make sure that no parts are missing

Chemical hazards

The hazard associated with the chemical contamination of seafood is growing due to the daily increase in chemical pollutants. Metals such as lead and dioxins are two common pollutants considered harmful to the environment. Even though they already exist in the environment, anthropogenic effects might raise their level. Toxins generated by fungus and algae, such as ciguatoxin, can also be contaminants.Food additives, such as preservatives and color-retention agents that are knowingly added to foods, can also be considered chemical pollutants in seafood. The pollutants, such as acrylamide and heterocyclic amines, can also be produced during processing or cooking.

Human health risks have been associated with the residue of agricultural chemicals left behind after using pesticides and prescription drugs while cultivating and storing food crops and animals. However, adequate usage guidelines and their presence can potentially manage these pollutants. Additionally, certain naturally occurring dietary ingredients, such as phytohaemagglutinin and allergenic compounds, might behave as contaminants (ICAR).

Table 1 : Types of chemical hazards in sea foods (ICAR)

Naturally occurring	Unintentional	International
Allegens	Pesticides	Antibiotics
Micotoxins	Fungicides	Sulphites
Histamine	Fertilizers	Nitrites
Ciguatera Poison	Toxic metal	Food Additives
Shellfish toxin		

Critical Limits for Chemical Hazards

Table 2: Critical limits for some chemical hazards present in seafood (ICAR)

Chemical Hazard	Critical imit
Histamine in fish	10 mg/100g
Tetradotoxin	< 1-2 mg/100g
Saxitoxin	80µg /100g
Sokadoic acid	0 – 60µg/100g
Tetracycline	0.1ppm
Trimethoprim	0.05ppm
Oxolinic acid	0.3ppm

Bilogical hazards

Like any other food product, seafoods have the risk of spreading parasite, bacterial, and viral pathogens that can lead to illness. These contaminants are obtained from a variety of sources, including (1) the natural aquatic surroundings, which is mostly feacal contamination, (2) industry, the retail sector, restaurant, or domestic preparation and processing (Syron et al. 2019).

Table 3 : Bilogical hazards in the seafood industry

Biological hazards	Type of Marine food
Clostridium botulinum	Fish
Norovirus	Shell fish
Vibrio cholerae	Fish
Listeria monocytogens	Salmon
Hepatitis A virus	Raw clams
Salmonella spp	Fish Shell fish

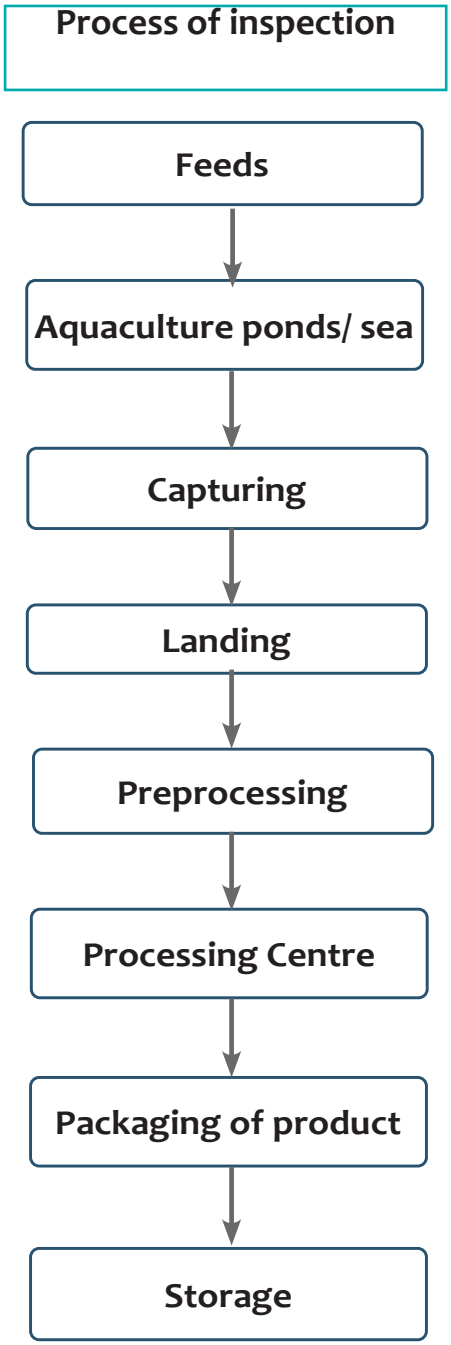

Figure: 2 Processing in the seafood industry

The raw materials, components, processing procedures, storage, and distribution are all checked for potential risks in the seafood production operation. Disease-causing organisms, poisons, environmental pollutants like pesticides, chemicals such as (lubricants,cleaners andsanitizers) and physical hazards like glass, metal pieces, and wood are just a few risks. A crucial control point is established for each risk, where the possible issue with food safety is managed. At each crucial control point, records are preserved so that inspection authorities may be sure the HACCP system is working to produce safe food. Certain sanitation procedures must be carried out as a safety precaution and documented (Hicks 2016).

Allergies and intolerances

An allergy to consuming some kinds of seafood is uncommon and is more frequently linked to certain people at risk due to other health issues. Although they are harder to identify and record, shellfish allergies, differentiated as immune system reactions rather than inability to digest food, seem more common. Some are allergic to shell fishes. Identification of allergic food components must be identified before (Hicks 2016).

Low-temperature storage

The growth of harmful microbes can be slowed down by maintaining seafood cool at 40°F or lower, and thorough cooking will eliminate any pathogenic bacteria that may be present. Food safety also includes important components like adequate sanitation and cleanliness. Cross-contamination throughout the cooking process due to poor food handling techniques and cleanliness might result in foodborne disease. Cross-contamination is dangerouswhen bacteria are spread from one food to another through cutting boards, utensils, or hands. Keep raw fish and its fluids apart from already cooked or ready-to-eat meals while storing or preparing it to avoid cross-contamination.

Notable hazards associated with seafood and its critical limit

Due to biological and chemical risks in seafood, import denials and refusals from nations including the USA, Russia, Japan, and the European Union are increasing, causing the seafood industry to suffer significant financial losses. The USA frequently rejects imported seafood due to Salmonella, Listeria, or illicit veterinary

medications. The presence of heavy metals, veterinary drug residues, histamine content, unwanted materials, biotoxins, poor packaging, inaccurate labelling, inappropriate health certificates, unapproved colours or additives, and organoleptic features are among the alert notices listed on the European Union's Rapid Alert System for Food and Feed (RASFF) webpage. Most of the objections from Japan in recent months were brought on by the presence of ethoxyquin and furazolidone (AOZ) in prawns.

As per the Food Safety Standards Act of 2006, various fish and other sea foods standards are given in section 2.6 of the Food Safety Standards Regulation 2011. These include Frozen squid, Frozen shrimp, Frozen lobster, Dried shark fins, parts of Frozen finfish, Frozen fish fillets, Salted fish/dried salted fish, Smoked fishery products, Frozen cephalopods, Canned Fishery Products,Sardine Oil, Ready –to-Eat Finfish or Shell Fish Curry in Retortable Pouches, Fish Pickle, Frozen Minced Fish Meat, Edible Fish Powder, Frozen clam meat, Live and Raw Bivalve Molluscs, Freeze dried prawns, Sturgeon caviar, Fish sauce, Quick Frozen Fish Sticks (fish fingers), Fish Portions and Fish Fillets - Breaded or Fresh,Battered, and Quick Frozen Raw Scallop Products.

Additives are not permitted in fresh fish or other fresh fish products. However,the maximum level of sulphites mentioned in crustaceans is 100ppm. Noncompliance raised for process hygiene criteria leads to implementing corrective actions, whereas noncompliance with food safety criteria in which the presence of microbes directly leads to withdrawal or rejectionof the seafood from the market. The limits of heavy metals in the sea foods are illustrated in Fig3.

The limit of polychlorinated biphenyls for inland and marine fishes is 2 ppm, howeverthe limit is 0.5 ppm for marine fishes. Many marine fishes have the potential to cause Histamine fish poisoning. The histamine level can be in the range of 100-200ppm.Chemical contamination is a bigger problem even if a pesticide is not permitted in aquaculture since water is a sink for all toxins. Quinalphos (0.01 ppm) and carbaryl (0.2 ppm) are mentioned in the most recent FSSR. A default

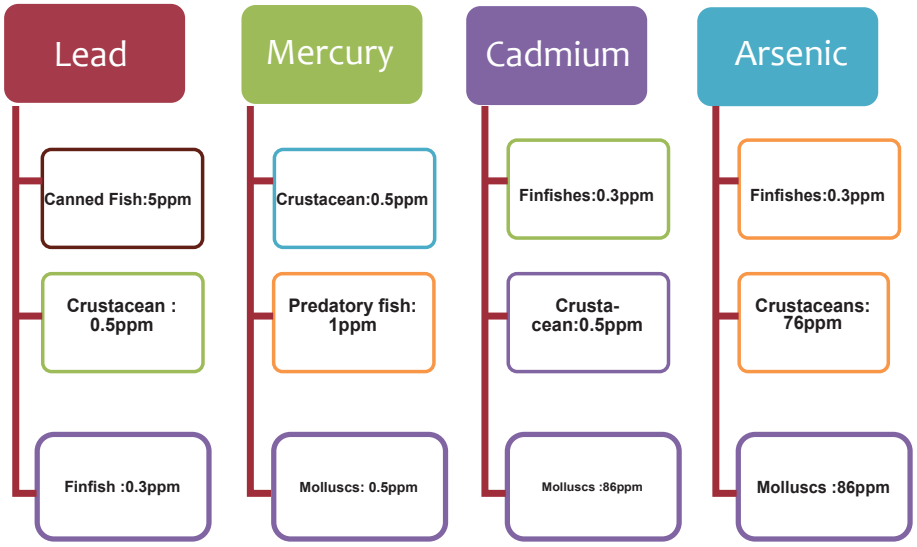

Fig 3: Limits of heavy metals in different seafood

tolerance level of 0.01 ppm is used for all other pesticides. The maximum tolerance limit for ampicillin is 0.01ppm in fish, and amoxicillin is 0.05ppm.

Implementation of and effective HACCP plan

The Hazard Analysis Critical Control Point (HACCP) system finds, assesses, and eliminates major risks to the safety of food.HACCP does not guarantee zero risk. It is a methodical technique to reduce the likelihood of food safety risks. Once designed, a HACCP plan is not necessarily the best strategy. When necessary, it must be changed. HACCP is a continual procedure that focuses mostly on hazards. HACCP must be used from farm to table. OPRP, PRP, SOP, GMP, GHP,GAP andSSOP, are all included in the ACCP program. HACCP performs its duties using a scientific methodology.

SOP, SSOP, GMP, and other PRP are applied before HACCP plans. Pre requisite programs concentrates on staff, equipment and facilities, and relates with employee hygiene, anitizing and cleaning protocols, waste collection, pest management, and equipment selection. It also handlesissues including personnel training, water storage and shipment safety, plant cleanliness, and general plant environment control that are not directly connected to food production (Gehring and Kirkpatrick, 2020).

Conclusion

Most environmental health concerns related to seafood safety should be controlled at harvest or at the site of capture. With a few notable exceptions, organoleptic inspection systems cannot detect hazards. However, examination at the point of processing is crucial to maintaining the safety of seafood, no proofthat intensifying inspection efforts at this stage will significantly lower the prevalence of seafood-borne illness. However, properly identifying hazards associated with the sea foods is crucial to determining the CCP and establishing critical limits, thereby eliminating hazards. The food inspector must examine each stage in the processing, and the documents must be recorded for audits. It is equally important to abide by all the regulations related tothe export or import of sea foods.

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Tilapia Farming in Sundarbans: Opportunities and Ecological Challenges

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The Sundarbans, a UNESCO World Heritage Site, is the largest mangrove forest in the world with an area of about 10000 square kilometres spread across India and Bangladesh. Its unique ecosystem, rich biodiversity, is under constant pressure from climate change and anthropogenic activities. In recent years, tilapia farming has emerged as a potential economic activity in this region. While it promises significant economic returns, there are critical ecological concerns that need to be addressed.

Why Tilapia Farming?

Tilapia, often referred to as the "aquatic chicken," is one of the most widely farmed fish globally. Its rapid growth rate, adaptability to various water conditions, and high market demand make it an attractive choice for aquaculture. In the Sundarbans, where traditional livelihoods like fishing and agriculture are increasingly threatened by salinity intrusion and erratic monsoons, tilapia farming offers a resilient alternative.

Several factors make the Sundarbans suitable for tilapia farming:

- Abundant Brackish Water: The region's network of rivers, creeks, and estuaries provides ideal conditions for tilapia farming. The fish can tolerate a wide range of salinity levels, making it suitable for the brackish waters of the Sundarbans.
- Economic Viability: Tilapia farming requires relatively low investment and has high productivity, offering a sustainable income source for local communities.
- Food Security: As a protein-rich and affordable food source, tilapia can address nutritional deficiencies in rural populations.

Ecological Concerns

While tilapia farming has its merits, it also raises significant ecological concerns, particularly in a fragile ecosystem like the Sundarbans.

- Invasive Nature of Tilapia: Tilapia, particularly species like Oreochromis niloticus, is known to be invasive. If farmed fish escape into the wild, they can outcompete native species for resources, disrupting the local aquatic biodiversity. In the Sundarbans, this could threaten the delicate balance of fish populations, including commercially valuable and ecologically important species.
- Water Quality Issues: Intensive aquaculture often leads to water pollution due to the accumulation of uneaten feed, fish waste, and chemicals. In the Sundarbans, where water quality is already affected by tidal flows and human activities, tilapia farming could exacerbate the problem, affecting both aquatic life and mangrove health.
- Disease Risks: Monoculture farming of tilapia can lead to the spread of diseases, which may affect both farmed and wild fish

populations. Disease outbreaks could have devastating economic and ecological consequences.

- Mangrove Degradation: In some cases, aquaculture practices involve clearing mangroves to create fish ponds. Mangroves are vital for protecting the Sundarbans from storm surges, providing habitat for wildlife, and maintaining water quality. Any loss of mangroves for tilapia farming would undermine the region's ecological resilience.

Sustainable Approaches

To balance the economic benefits of tilapia farming with ecological protection, sustainable practices are essential:

- Integrated Multi-Trophic Aquaculture (IMTA): Combining tilapia farming with other species like shrimp, crabs, or filter-feeding molluscs can reduce waste and improve water quality.
- Controlled Farming Systems: Using closed or semi-closed farming systems can prevent the escape of tilapia into the wild and reduce environmental contamination.
- Regular Monitoring: Periodic assessment of water quality, fish health, and biodiversity impacts can help mitigate potential ecological risks.
- Community Training: Educating local farmers about sustainable aquaculture practices and the ecological importance of the Sundarbans can foster responsible farming.
- Regulatory Frameworks: Following guidelines for tilapia farming, including restrictions on species and farming locations, can help safeguard the ecosystem.

Conclusion

Tilapia farming presents a dual-edged sword for the Sundarbans. It holds the promise of economic upliftment and food security for vulnerable communities but also poses risks to the region's unparalleled ecological heritage. A careful and balanced approach, emphasizing sustainability and conservation, is imperative. By adopting environmentally friendly practices and robust regulatory measures, the Sundarbans can harness the benefits of tilapia farming without compromising its ecological integrity. The future of tilapia farming in this iconic landscape hinges on finding harmony between human needs and nature's delicate rhythms.

Key Highlights

- Economic Opportunity: Tilapia farming offers a sustainable livelihood with low investment and high returns for Sundarbans' communities.
- Adaptability: Tilapia thrives in brackish water, making it suitable for the Sundarbans' changing salinity levels.
- Ecological Risks: Concerns include invasive species disrupting biodiversity, water pollution, and potential mangrove degradation.
- Sustainable Solutions: Practices like Integrated Multi-Trophic Aquaculture (IMTA), controlled systems, and regular monitoring can minimize impacts.
- Balancing Act: Responsible farming and regulatory frameworks are essential to harness benefits while preserving the Sundarbans' fragile ecosystem.

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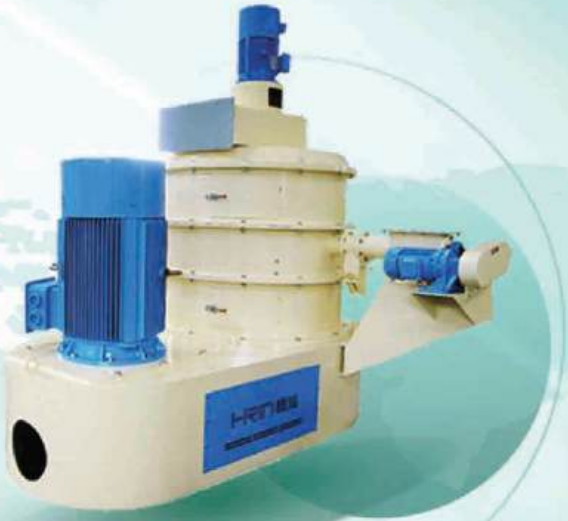

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