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Aqua International

Estd. 1993

Health • Nutrition • Management • Processing

April 2024

Annual Subscription: Rs 800 Foreign $ 100

Inside...

Spiral Stopper

Bevel Gear Box

2 HP Motor

Spiral

Worm Shaft & Wormwheel

Spiral [Helical] Gear Box

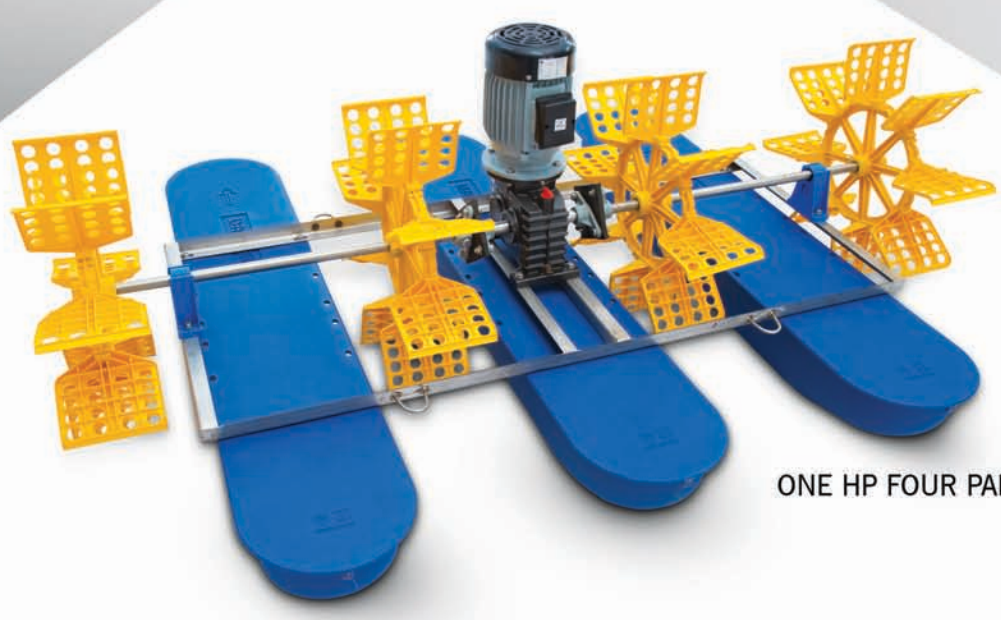
1 HP Gear Box

Paddle Wheel

Long Arm Gland

2 HP Gear Box

2 HP Out Put Shaft



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Aqua International

English Monthly Magazine
(Established in May 1993)

Volume 31 Number 12 April 2024

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M. A. Nazeer

Editorial & Business Office:
AQUA INTERNATIONAL
NRS Publications,
BG-4, Venkataramana Apartments,
11-4-634, A.C.Guards,
Hyderabad - 500 004, India.
Tel: 040 - 2330 3989, 96666 89554
E-mail: info@aquainternational.in
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India Office

Add: No 401 , Dega Towers , Raj Bhavan Road , Somajiguda , Hyderebad , Telangana - 500082
T: +62-21-30027458; 30027459
Contact: Arun Kumar K
E-mail : arunkumar@famsungroup.com
Mob: +91 9901916554

Contact: Shelby
E-mail: lxb@famsungroup.com
Mob: +91 9100436652

Nine most promising protein-rich aquafeed ingredients

The most important contributor of climate change is documented by human due to deforestation and industries that release GHGs (greenhouse gasses) accumulated in surrounding environment such as methane, nitrous oxide, fluorinated gasses and carbon di oxide. Climate change affected fisheries adversely but it is overshadowing the positive one.

Dear Readers,

The April 2024 issue of Aqua International is in your hands. In the news section you may find news about ...

A recently published report, compiled with support from the Moore Foundation by Hatch Blue, takes a deep dive into nine of the most promising protein-rich aquafeed ingredients.

The emerging Protein–rich Ingredients for Aquaculture report aims to identify the most promising ingredients to complement existing sources of protein, expand the raw materials basket and bridge the protein gap in aquafeeds. Reaching harvest volumes of 87.5 million tonnes in 2020, aquaculture production has exceeded that of capture fisheries, according to the latest FAO data.

European Aquaculture Society and the World Aquaculture Society are organising AQUA 2024 on August 26 - 30 at Copenhagen, Denmark. It will comprise a scientific conference, trade exhibition, industry forums, workshops, student events and receptions. The event will highlight the latest aquaculture research and innovation to underpin continued growth of this exciting food production sector. It will be a showcase for Denmark, and its innovation leadership in several key technologies crucial for future aquaculture, but also a meeting and exchange platform for experts from around the world.

Phileo Lesaffre organized seminar on Maintaining Health Efforts in times of Crisis at Vijayawada on February 19. The main invitees were progressive Feed millers in India.

The 3rd Annual International Conference and Exposition of the African Chapter of the World Aquaculture Society (AFRAQ24) will be held in Hammamet, Tunisia from 19 to 22 November 2024. The event will be hosted by the Ministry of Agriculture, Water Resources and Fisheries with support from other national entities in Tunisia. Tunisia, being one of the top and fastest growing aquaculture producer countries in Africa expects to receive delegates from around the world for the celebration of achievements on all aspects of aquaculture development in Africa, but also to find solutions to some of the challenges hampering the growth of the sector, and to explore new opportunities in the blue economy domain. Will undoubtedly provide numerous networking and collaboration opportunities. The conference, which is themed *"Blue Farming: New Horizons for Economic Growth",* will highlight some of the latest aquaculture research, innovations and investments to underpin continued growth of the aquaculture sector in Africa.

IB Group inaugurated ABIS Fish Feed Plant in Sukhri, Chhattisgarh on February 16, 2024. This is India's first fully automated fish feed plant manufacturing climate-resilient floating fish feed. Mr Parshottam Rupala, Union Cabinet Minister for Fisheries, Animal Husbandry and Dairy inaugurated the feed plant. and other notable state and district level dignitaries. IB Group is a forward-looking agri biz company and a leading name in Poultry, Livestock Feed such as fish, shrimp, poultry and Solvent, Edible oil and Processed Chicken in India with a turnover of INR 11000 crores. With technology at the core, IB Group is committed to building protein-rich nation and transforming the lives of millions of farmers, traders, dealers and communities associated with us, said its managing director Mr Bahadur Ali. He further stated: IB Group continues to focus on contributing to the growth of rural economy in India, empowering farmers, both agriculture and livestock with technology and knowledge to boost their income.

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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Through strategic initiatives like commissioning of 10 feed plants with annual production capacity of 25 lakhs MT, 20 breeder farms, 27 hatcheries and more than 30000 commercial broiler farms, the group is committed to combating the nation's protein deficiency and promoting rural prosperity.

PhyGeno, a division of Avitech Nutrition, introduced *Extraqua*, a 100% natural plant-based ammonia control agent for aquaculture. Proven in zoo technical trials to perform better than Yucca, Extraqua heralds a new era in ammonia control. By significantly reducing ammonia levels, Extraqua optimises the pond environment and enhances productivity. According to a release the performance and efficacy of Extraqua have been validated by trials conducted at the Department of Aquaculture, Kerala University of Fisheries and Ocean Studies (KUFOS), Kochi, India. It outperforms Yucca in multiple parameters related to shrimp health and pond environment.

It has been six years since a group of visionary producers in Ecuador joined forces to establish the Sustainable Shrimp Partnership (SSP) - a move that marked the beginning of a new era for the shrimp farming industry. Since then, the Partnership has relentlessly pushed the shrimp sector towards both social and environmental responsibility. Among SSP's founding members are renowned shrimp producers, GrupoAlmar, Grupo Camaronero Champmar, Corporación Lanec, Omarsa, Promarisco, and Songa. Together, their commitment to sustainability allows the Partnership to tackle current challenges, anticipate future ones, and inspire others to follow their example. "SSP owes its success to the dedication of our members. Through their proactive efforts, they've shown that achieving clean and sustainable aquaculture is attainable. Additionally, they have collaborated to identify areas for improvement, leading the way towards a more responsible future for the industry," said SSP Director Pamela Nath, in a press release announcing the anniversary.

Six ways to make your aquaculture operations more climate-resilient**:** Most fish and shrimp farms are heavily dependent on environmental conditions, especially the provision of clean water at a stable temperature, and this makes them especially vulnerable to the impacts of a changing climate. Sharing practical tips for small-scale aquaculture operators, particularly those based in the tropics, to adapt and become more resilient to the changing climate and extreme weather events. Ninety percent of aquaculture operations face risks from environmental change. Some of the countries with the highest climate risks – mostly in Asia, Latin America and Africa – have the lowest capacity to adapt to the changes in climate.

***In the Articles section* – Significance of Ambergris, floating treasure of the sea,** *authored by* Mr Asik Ikbal, Dr Supratim Chowdhury and Rajesh Mandalin formed that with Ambergris has been frequently observed floating on the Atlantic Sea beaches and coasts of South Africa, Brazil, Madagascar, The Maldives, China, Japan, India, Australia, New Zealand and Molucca Islands. Most of the commercially used ambergris comes from tropical islands such as the Bahamas. It acts mainly as a stabilizer in various premiumperfumes in Western countries.In Eastern countries,it is mainly used for medicinal purposes to form potions and also as a flavour enhancer. Ambergris is anindigestive end product only.

The significance of ambergris and its application in perfume & beyond perfume industry are being discussed in this article. Ambergris, the aquatic solid bio-waste has an unbelievable market value, is produced from sperm whale's intestine. Thus, called as 'floating gold' or 'floating treasure'. In the meantime, whale population is facing danger for the ambergris. In future, to protect the ocean ecosystem, illegal killing of whale should be acknowledged as a punishable offence by all countries in the world.

Another article titled **The Artificial Reefs: An Overview,** *authored by* Ms Anjali Kumari, Ms Susmita Rani, Mr Abhinav Prakash said that Coral reefs are an important habitat for organisms living underwater, but due to anthropogenic and some natural causes, these habitats are getting harmed directly or indirectly. To overcome these losses, an artificial reef is a very good option to re-establish a similar habitat as the natural coral reef habitat. Here, we will discuss some important aspects related to the artificial reef system.

Article titled **IMPACT OF CLIMATE CHANGE ON FISHES' METABOLIC PATHWAY,** *authored by* Mr Mayank Bhushan Singh, Mr Maneesh Kumar Dubey and Mr Satyaveer discussed that Aquaculture sustainability is affected by climate change which regulated livelihood, nutrition and world food security. The most important contributor of climate change is documented by human due to deforestation and industries that release GHGs (greenhouse gasses) accumulated in surrounding environment such as methane, nitrous oxide, fluorinated gasses and carbon di oxide. Climate change affected fisheries adversely but it is overshadowing the positive one. The effects of climate change on fishes can be directly by the water quality parameter such as temperature, dissolve oxygen, pH, (acidification) etc. which affected fish physiology and behavioral changes through metabolic adaptation. Due to the changes in climate fishes are adapting in novel environment like as high temperature (higher to lower latitude or lower to higher latitude), hypoxic condition due to evolutionary effect and adapting in low pH which is caused by high carbon di oxide released in the environment by human activities. Therefore, the present article is mainly focused on effect of climate change on metabolic pathway of fishes.

Another article titled **Satellite remote sensing: A new tool for the Investigation of Marine Floating Plastics,** *authored by* Mr Rinkesh N. Wanjari, Mr Karankumar K. Ramteke and Ms Dhanalakshmi M, said that Plastics from land and sea found in a wide range of marine environments. It's difficult to monitor marine plastic from the Earth surface since it's hard to see the entire ocean at once. Although space offers a more enticing viewpoint, the necessary technology is still in its infancy. Monitoring the millions of tonnes of plastic that enter the ocean each year from the Earth's surface is incredibly challenging. One of the most promising ways is remote sensing with reasonable to high temporal, spatial and spectral resolution, which has the potential to be a dependable source of qualitative and quantitative information on a large geographical scale. This article provides a basic overview of how satellite remote sensing can be used to investigate marine floating plastics.

Plastics growth has accelerated by around 8.7% each year since its inception as a packaging material. Plastics will probably equal and surpass fish stocks in certain oceans by 2050 in terms of weight.

M.A.Nazeer
Editor & Publisher
Aqua International

Sustainable Shrimp Partnership celebrates sixth anniversary

Six years on from the creation of the Sustainable Shrimp Partnership, the collaborative organisation continues to push for high social and environmental standards within the shrimp sector.

The Sustainable Shrimp Partnership aims to promote social and environmentally responsible practices within the shrimp farming industry.

It has been six years since a group of visionary producers in Ecuador joined forces to establish the Sustainable Shrimp Partnership (SSP) - a move that marked the beginning of a new era for the shrimp farming industry. Since then, the Partnership has relentlessly pushed the shrimp sector towards both social and environmental responsibility.

Among SSP's founding members are renowned shrimp producers, Grupo Almar, Grupo Camaronero Champmar, Corporación Lanec, Omarsa, Promarisco, and Songa. Together, their commitment to sustainability allows the Partnership to tackle current challenges, anticipate future ones, and inspire others to follow their example.

The sixth anniversary of its inception provides a time to look back over the progress made by the Partnership in promoting sustainability within shrimp aquaculture. They have initiated projects to promote transparency, environmental and social responsibility, while also ensuring that the shrimp they provide meets the highest standards. This means shrimp free from antibiotics, with neutral impact on water quality, and fully traceable throughout the production process.

"SSP owes its success to the dedication of our members. Through their proactive efforts, they've shown that achieving clean and sustainable aquaculture is attainable. Additionally, they have collaborated to identify areas for improvement, leading the way towards a more responsible future for the industry," said SSP Director Pamela Nath, in a press release announcing the anniversary.

Since beginning operations six years ago, SSP and its members have reached major milestones that have changed the inner workings of the shrimp industry. These accomplishments underscore a comprehensive commitment towards nurturing sustainability across every phase of the supply chain.

The development of the SSP qualification criteria has represented a significant advancement. This norm assures the highest social and environmental standards in shrimp production through constant farm audits to ensure the absence of antibiotics, a neutral impact on water, and complete product traceability, using Block chain technology to guarantee transparency and trust.

In another industry-altering move, the creation of the Sustainability Leadership Roundtable has been instrumental in progressing the industry towards social and environmental responsibility. Through this platform, SSP has collaborated on various projects, such as conservation and protection of mangroves in Ecuador, in partnership with Clark University and the World Wildlife Fund (WWF); and the advocacy for labour equity and living wages in partnership with the Sustainable Trade Initiative (IDH) and the Aquaculture Stewardship Council (ASC).

More recently, a significant breakthrough for the Partnership has been the launch of the 'Scale Up' Programme, which aims to advance the sustainable production and management of shrimp larvae by recognising and supporting hatcheries committed to improving product quality and their environmental and social impact.

Whilst by no means exhaustive of the Partnership's accomplishments, each of these advancements represents progress towards a more socially and environmentally responsible shrimp production chain, and to have made such significant changes in its first six years bodes well for the future of the Sustainable Shrimp Partnership.

Uni-President

AQUACULTURE PROBIOTICS EXPERT

Nu Ri

NET 200 g **BSL**

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

2. HIGH ACTIVITY OF SPORES

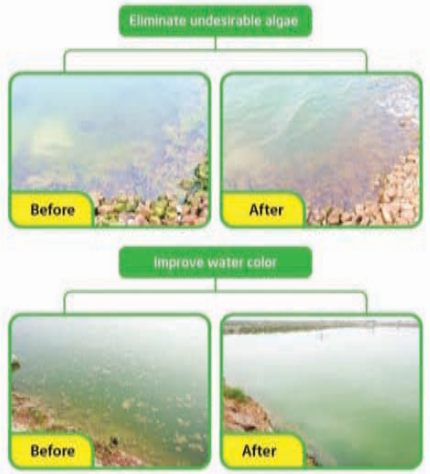
No cultivation is needed. Easily adapt to the changes of surroundings and grow fast in freshwater or seawater culture farming, even under low oxygen environment

3. DECREASE AMMONIA CONTENT

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

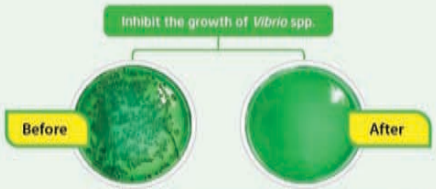
4. IMPROVE WATER COLOR

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



5. ESTABLISH BALANCED POND BACTERIA SYSTEM

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:

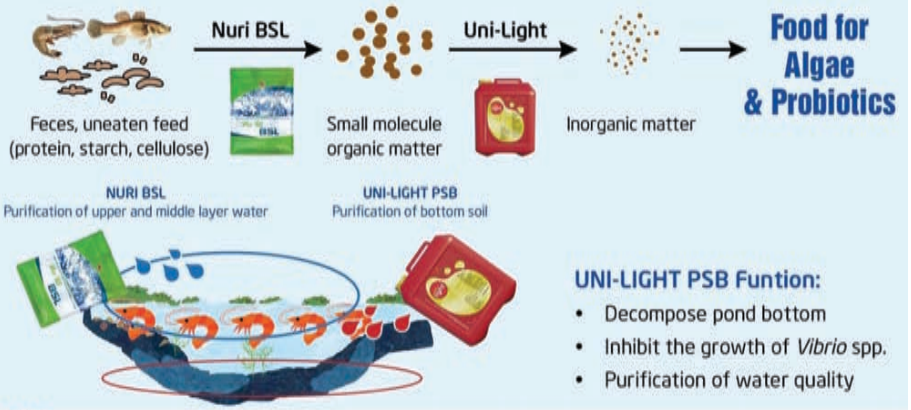
Bacillus spp. > 1x 10^{11} cfu/kg	15%
(Bacillus subtilis, Bacillus amyloliquefaciens, Bacillus licheniformis)	
Carrier (rice bran, corn gluten)	75%
Moisture	10%

* 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 m³ 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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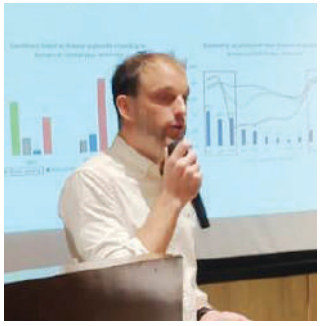
Phileo Organizes Seminar on Maintaining Health Efforts in times of Crisis



Alban Caratis is presenting technical speech about the product 'Safmannan'

Saurabh Singh, Head of Business - ECA is delivering speech regarding Phileo corporate

"Phileo by Lesaffre Team has organized a seminar on Aqua at Vijayawada on 19th February. The main invitees are progressive Feed millers of Andhra Pradesh

Phileo Customer Mr Dhaval Contractor, Director, Ishi Marine Technologies, Surat addressing the audience

like Growel, Godrej Agro, Sandhya Feeds, Deepak Nexgen and BMR. Feed millers from Gujarat like Ishi Marine Technologies also attended.

The Guest Speaker was Mr Alban Caratis, Global Aqua Manager, Phileo Global and the moderator of the Seminar was Mr Saurabh Singh, ECA Head, Phileo By Lesaffre.

The topic of discussion was "Maintaining Health Management Efforts in times of crisis, Crucial for Enduring periods of prolonged Low Shrimp prices". >>

Feed millers from A.P. attended the seminar

>> Very good interaction with the people and also Mr Alban described the benefits of Incorporation of their product Safmannan into the shrimp feed Formulation can benefit shrimp farmers and also how they got maximum ROI in the challenge period also.

EAS, WAS organising AQUA 2024 on August 26-30 at Copenhagen

Co-organised by the European Aquaculture Society and the World Aquaculture Society, AQUA 2024 will take place from August 26-30 in Copenhagen. It will comprise a scientific conference, trade exhibition, industry forums, workshops, student events and receptions. The event will highlight the latest aquaculture research and innovation to underpin continued growth of this exciting food production sector. It will be a showcase for Denmark, and its innovation leadership in several key technologies crucial for future aquaculture, but also a meeting and exchange platform for experts from around the world.

The theme of AQUA 2024 is BLUE FOOD, GREEN SOLUTIONS.

We have identified a wide range of sessions - by topic and also by species - for the scientific conference and abstract submission is now open. Please submit your abstract to the session of your choice by the April 5th deadline. https://was.org/meeting/abstract/Submit/AQUA24

If you are a student, please submit your abstract before April 5 to have a chance of being selected for the AQUA 2024 Student Spotlight Award and the possibility to pitch your work at the opening plenary session to a global aquaculture audience.

We are also working with our partners to prepare exciting programmes for the Industry Forum and Innovation Forum, as well as pre- and post-conference tours.

Hurry up to book your booth at the trade show. Over 80% sold today. https://was.org/Meeting/pdf/AQUA24ExhibitorInvite.pdf or contact mario@marevent.com.

Remember to register early for AQUA 2024 and to ensure that you pay the cheapest registration fee by joining EAS. https://aquaeas.eu/join-eas/benefits-overview After joining, head over to the registration page to get the Member Rate https://was.org/Meeting/Registration/Submit/AQUA24

Blue Food production must grow. Green Solutions will help it to do so.

We look forward to welcoming you to AQUA 2024 Copenhagen ! August 25-29, 2024

https://aquaeas.eu/
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Aquaculture Africa 2024 Conference scheduled for Tunisia on November 19-22

The 3rd Annual International Conference and Exposition of the African Chapter of the World Aquaculture Society (AFRAQ24) will be held in Hammamet, Tunisia from 19 to 22 November 2024. The event will be hosted by the Ministry of Agriculture, Water Resources and Fisheries with support from other national entities in Tunisia.

Tunisia, being one of the top and fastest growing aquaculture producer countries in Africa expects to receive thousands of delegates from around the world for the celebration of achievements on all aspects of aquaculture development in Africa, but also to find solutions to some of the challenges hampering the growth of the sector, and to explore new opportunities in the blue economy domain. AFRAQ24 will undoubtedly provide numerous networking and collaboration opportunities.

The conference, which is themed *"Blue Farming: New Horizons for Economic Growth"*, will highlight some of the latest aquaculture research, innovations and investments to underpin continued growth of the aquaculture sector in Africa. The event will comprise of a scientific forum (oral and poster presentations), trade exhibition, industry forums, satellite workshops, student events, and other organized meetings. Renowned keynote speakers from Africa and beyond are expected to attend. Visiting Tunisia will also expose participants to some famous and interesting touristic attractions in Hammamet, the Mediterranean and countrywide. Special aquaculture tours will be arranged to nearby marine finfish, shellfish and seaweed farms – that are connected to fish processing, aquafeeds and R&D facilities.

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Union Cabinet Minister inaugurates IB Group's Fish Feed Plant at Sukhri, Chhattisgarh

Union Cabinet Minister Parshottam Rupala inaugurating ABIS Fish Feed plant in Sukhri, Chhattishgarh on February 16. Bahadur Ali, Managing Director, IB Group, Zoya Afreen Alam, Director, IB Group and other Directors were present.

Chhattisgarh, India: IB Group announced its successful inauguration of ABIS Fish Feed Plant in Sukhri, Chhattisgarh February 16. This is India's first fully automated fish feed plant manufacturing climate-resilient floating fish feed. The event was graced by the presence of Mr Parshottam Rupala, Union Cabinet Minister of Fisheries, Animal Husbandry and Dairying and other notable state and district level dignitaries.

IB Group is a forward-looking agri biz company and a leading name in the Poultry, Livestock Feed such as fish, shrimp, poultry and Solvent, Edible oil and Processed Chicken in India with a turnover of INR 11000 crores. With technology at the core, IB Group is committed to building protein-rich nation and transforming the lives of millions of farmers, traders, dealers, and communities associated with us. Through relentless innovation and strategic partnerships, IB Group is not only catalysing rural development but also driving economic growth and prosperity across the nation. As we continue to pioneer ground-breaking initiatives, we are shaping more sustainable future for generations to come.

At the inaugural event, Mr Parshottam Rupala, Union Cabinet Minister of Fisheries, Animal husbandry and Dairying said: "Establishment of the Ministry of Fisheries in Hon'ble Prime Minister Mr Narendra Modi government's regime, underscores the country's commitment to bolster the rural sector, empowering grass root level communities. Thus benefiting 3 crore fishermen in India. With focussed initiatives in the sector, Indian aquaculture industry has secured second ranking in the global aqua culture industry. Leveraging IB's technology prowess in livestock feed for more than 4 decades, the group is making great strides in reaching out high quality protein to every household in the country. IB group's fully automated fish feed plant in a non-coastal area like Chhattisgarh sets an example for this sector and emphasizes the importance of fisheries sector in Indian economy."

Bahadur Ali, Managing Director, IB Group said- "IB Group continues to focus on contributing to the growth of rural economy in India, empowering farmers, both agriculture and livestock with technology and knowledge to boost their income. Through strategic initiatives like commissioning of 10 feed plants with annual production capacity of 25 lakhs MT, 20 breeder farms, 27 hatcheries

A view of dignitories on dias during the inauguration of ABIS Fish Feed Plant in Sukhri, Chhattisgarh

and more than 30000 commercial broiler farms, the group is committed to combating the nation's protein deficiency and promoting rural prosperity. Our poultry integration program has positively impacted over 50,000 farmers till date. IB Group's focus on zero waste fish feed and catering to the need of extruded fish feed underscores our commitment to empowering fish farmers across India. Through partnerships with NGOs and with support of government initiatives, we aim to catalyse rural development and bolster the nation's economy while doubling the income of farmers. Our holistic approach to development, from grassroots initiatives to large-scale infrastructure investments, is shaping a brighter tomorrow for all."

Zoya Afreen Alam, Director, IB Group said: "On the occasion of the inauguration of ABIS Fish Feed plant in Sukhri, Chhattisgarh today, I am thrilled to announce the launch of India's first fully automated fish feed plant," said Zoya Afreen Alam, Director IB Group. "With production of oil coated, micro pellet fish feed, IB Group has significantly contributed towards modernization of fish farming in India, thus empowering farmers to enhance their income. IB Group's fish feed range currently accounts for 20 percent of the nation's cumulative fish feed production. The group will continue to provide high-protein fish feed at an optimum cost and innovate along the way towards its mission to build a healthier, more prosperous rural India."

The nine most promising protein-rich aquafeed ingredients

A recently published report, compiled with support from the Moore Foundation by Hatch Blue, takes a deep dive into nine of the most promising protein-rich aquafeed ingredients.

Led by Linda Chen, associate at Hatch Blue,and the Hatch Innovation Services team, the Emerging Protein – rich Ingredients for Aquaculture report aims to identify the most promising ingredients to complement existing sources of protein, expand the raw materials basket and bridge the protein gap in aquafeeds.

Reaching harvest volumes of 87.5 million tonnes in 2020, aquaculture production has exceeded that of capture fisheries, according to the latest FAO data. Driven by population growth, rising income, improved health awareness and urbanisation, global consumption of aquatic food is expected to increase by 15 percent to supply on average 21.4 kg per capita in 2030. To match this pace of consumption, aquaculture production is expected to reach 106 million tonnes in 2030. Underlying the growth of aquaculture is the accelerated demand for quality feed ingredients.

As Chen explains: "Global aquafeed production reached 52.9 million tonnes in 2023 and is expected to increase exponentially to meet growing aquaculture production demand. Emerging ingredients play an important role to complement existing commercialised ingredients, improve the efficiency of feed formulation, and boost overall volumes.

Many news ingredients are being developed for use in aquafeeds, in an attempt to reduce the sector's reliance on fishmeal

"We hope this report can direct more capital and resources to accelerate the production and inclusion of these protein-rich ingredients along the value chain. We also hope it will spark conversations among regulatory and industry leaders to help establish more efficient new ingredient adoption processes.

"For startups looking to enter into the aquafeed market, we hope this report provides some insights into the ingredient trialing and inclusion processes, and help startups to better organise their resources".

Incremental improvements with significant impacts

Hatch Blue is dedicated to helping impactful businesses scale in the aquaculture space. As feed contributes 30-80 percent of operational costs for most aquaculture producers, small economic improvements can have long lasting impacts.

"We want to provide patient capital and support ingredient startups through our accelerator and funds to break into the aquafeed market. We also want to provide the latest information to investors and industry players to help them identify suitable market opportunities," Chen explains.

Linda Chen: Author of the report

"We are grateful to our sponsor, the Gordon and Betty Moore Foundation, for their dedication to aquaculture and sustainability, and this opportunity for our year-long market research," she adds.

Meanwhile the Moore Foundation explained that they supported the compilation of the report in order to improve both the sustainability and stability of the aquaculture sector.

"Aquaculture has been the fastest growing food production sector over the past twenty years, and it's going to continue to grow," said Bernd Cordes, program officer with the Gordon and Betty Moore Foundation's Conservation and Markets Initiative. "That means the demand for aquafeed will also grow. For the aquaculture industry and its investors to inject greater cost stability and environmental sustainability into production systems, an in-depth understanding of the most cost-competitive, renewable and least environmentally damaging feed options is required. This study aims to be that guide."

Following a preliminary assessment of hundreds of ingredients, the report narrowed down the list by focusing on the most competitive emerging ingredients that also contain at least 50 percent crude protein, as well as have the potential to both reach at least 100,000 tonnes of annual production and be included in aquafeeds at a minimum rate of 3 percent. The nine ingredients which met these criteria are:

- Corn fermented protein
- Fermented soybean meal
- Barley protein concentrate
- Insect meal
- Methanotrophic bacteria
- Mycelium
- Grass protein concentrate
- Canola protein concentrate
- Mixed nut meal

Where data is available, the report contains detailed assessments of nutritional profiles, estimated volumes, production costs and challenges, fair market pricing, scalability, regulation and life cycle assessments for each ingredient.

Market trends

The research identified three trends in the market:

1. The improvement of protein extraction and the reduction of anti-nutritional factors to convert existing low-quality raw materials into high-value ingredients.
2. The repurposing of commercial processes developed in the early 1990s for new ingredient production.
3. Genetic enhancement of existing agricultural crops for higher protein yields.

"We've found that, in the short term, by-products from existing agricultural and terrestrial production processes will contribute significant volumes of aquafeed ingredients. Up cycling low-value plant-based agricultural and ethanol by-products into protein-rich ingredients is associated with cheaper

Ingredient	Current Volume	Volume Potential	Cost/T	Capex/T	Price/T	Crude Protein	Digestibility
Definitions	"1 - <1,000 MT/yr 2 - 1,000-10,000 MT/yr 3 - 10,000-100,000 MT/yr 4 - >100,000 MT/yr"	"1 - < 100,000 MT/yr 2 - 100k-1m MT/yr 3 - 1m - 5m MT/yr 4 - > 5m MT/yr"	"1 - $100-500 2 - $500-1,000 3 - $1,000-2,000 4 - >$2,000"	"1 - $100-500 2 - $500-1,000 3 - $1,000-2,000 4 - >$2,000"	"1 - $500-1,000 2 - $1,000-1,500 3 - $1,500-2,000 4 - >$2,000"	"1 - 50-55% 2 - 56-60% 3 - 61-65% 4 - 66-70%"	"1 - <85% 2 - 85-88% 3 - 89-92% 4 - >92%"
Corn Fermented Protein	4	4	1	2	1	1	2
Fermented Soybean Meal	4	2	NA	NA	3	2	1
Barley Protein Concentrate	3	3	1	2	2	2	4
Insect Meal	3	4	4	4	4	3	1
Methanotrophic Bacteria	3	4	3	4	3	4	2
Mycelium	2	4	NA	NA	3	3	2
Grass Protein Concentrate	1	4	2	2	1	1	2
Canola Protein Concentrate	1	3	2	NA	2	4	3
Mixed Nut Meal	1	1	3	2	3	2	3

The report assesses the volumes, costs and digestibility of nine of the most promising emerging aquafeed ingredients

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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capex and production costs. The market is shifting toward the repurposing of brownfield infrastructure. The utilisation of waste materials can reduce the amount of landfill and contribute to a circular economy," Chen explains.

The report also identified reasons for the slow adoption of new ingredients into the aquafeed market:

- **Challenging production processes** - setting up facilities to mass produce a single ingredient of consistent quality and quantity requires time, expertise and capital to overcome challenging engineering and biological hurdles. Especially for novel ingredients where production processes were not well understood or explored, the pioneer takes an unknown risk. Securing long-term off take agreements can help alleviate some stress, but sometimes requires the completion of the trialling phase.
- **Challenging financing processes** - emerging ingredient production often requires significant upfront capital to finance essential infrastructure, although capital with aligned risk appetite is often limited. At early stages, capital sources are needed to bridge "the valley of death" between venture funding and risk-conscious institutional investment, as production ramps up.
- **Long trials and sales cycles** - compound feed producers take on a lot of risk when they include new ingredients. They must include demonstrable growth and health data to convince farmers and buyers. Emerging ingredients thus need to undergo rigorous in-house testing and long trial periods, and meet consistent production volumes and nutritional values before they are seriously considered for significant inclusion in aquafeed formulation. Long sales cycles are challenging for ingredient producers, especially when development costs are high, to sustain innovation and optimisation during the scale-up processes.

Goncalo Santos, head of projects at Hatch Innovation Services, Hatch Blue's consulting unit, adds: "There is a clear need to diversify the raw materials used in aquaculture feeds, a move that not only fosters industry expansion but also confronts existing challenges associated with conventional ingredients. These challenges encompass limitations in volume, exemplified by the constrained availability of fishmeal, competition with human consumption, and diverse sustainability issues. The present study sheds light on this critical topic, examining alternative protein sources and elucidating the key success factors that companies must consider in their development trajectory.

"Ultimately, the objective is to produce ingredients at scale with minimal environmental impact, while simultaneously providing essential nutrients to farmed species and promoting the sustainable advancement of aquaculture".

Extraqua by PhyGeno - Outperforms Yucca in Ammonia Control

PhyGeno introduces Extraqua, a 100% natural plant-based ammonia control agent for aquaculture. Proven in zootechnical trials to perform better than Yucca, Extraqua heralds a new era in ammonia control. By significantly reducing ammonia levels, Extraqua optimises the pond environment and enhances productivity.

The performance and efficacy of Extraqua have been validated by trials conducted at the Department of Aquaculture, Kerala University of Fisheries and Ocean Studies (KUFOS), Kochi, India. It outperforms Yucca in multiple parameters related to shrimp health and pond environment.

Extraqua contains bioactive compounds that are highly effective in reducing ammonia production whilst promoting the growth of zooplankton. These aid in the nitrification process, whilst phytoplankton utilises ammonia during photosynthesis.

Extraqua's comprehensive approach to ammonia management comprises binding, nitrification, and inhibition. Its 100% natural composition ensures a healthy pond environment, efficiently reducing ammonia and nitrite levels and enhancing production performance whilst being cost-effective.

Extraqua from PhyGeno represents a paradigm shift in ammonia control in aquaculture, offering optimal water quality and enhanced shrimp health and performance.

PhyGeno

Since 2022, PhyGeno, a division of Avitech Nutrition, has been at the forefront of the phytogenic revolution in animal nutrition and feed additives. Drawing on over five decades of knowledge and expertise in animal health and productivity, PhyGeno integrates traditional Ayurvedic plant wisdom with state-of-the-art technologies to offer pioneering plant-based solutions for the animal feed industry. Committed to high quality, PhyGeno is a research-driven animal nutrition company, with a dedicated R&D team comprising scientists, veterinarians, and animal nutrition specialists. By prioritising responsible sourcing, rigorous evaluation, and meticulous manufacturing processes, PhyGeno ensures the development of highly effective and efficient products formulated to fulfil the nutritional needs of animals.

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Prevents entry of opportunistic pathogens and safeguards health of this high value asset.

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Zoea & Mysis:
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Post Larvae:
Stagewise control of *Vibrio sp.* results in remarkable reduction of *Vibrio sp.* load in post larval tanks. This results in high health seeds.

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SANITISER ✗
DISINFECTANT ✗✗
ANTIBIOTICS ✗✗✗

One Health unified approach for balanced welfare of people, animals and ecosystems.

ONE HEALTH APPROACH

BACTERI THERAPY T PATHOGEN

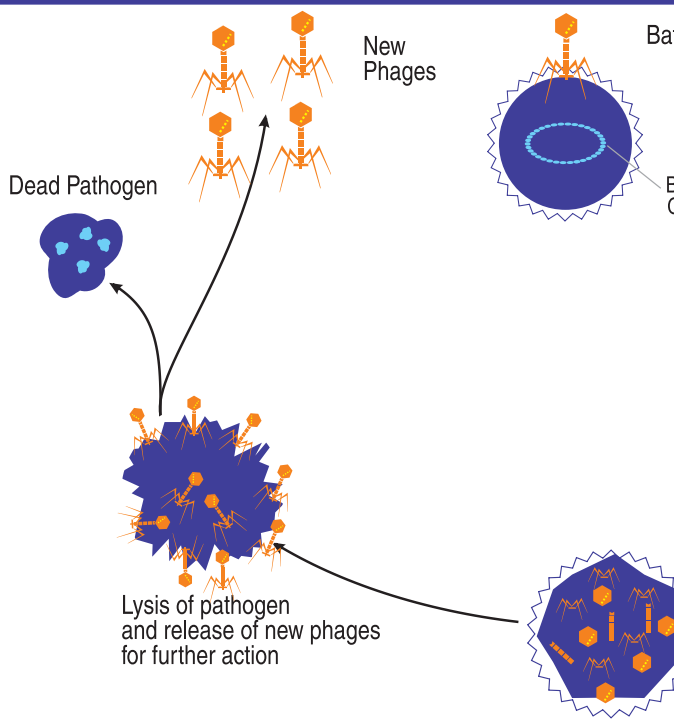
V PHAGES HATCHERY & V PHAGES GROWOUT are a c
they are safe on aquatic animals, people and ecosystem
resistant to antibiotics and incr

"V PHAGES" cocktail targets against most common pathog

• ***Vibrio parahaemolyticus*** • ***Vibrio alginolyticus*** • ***Vibrio h***

100 % Natural | Pathogen specific approach | V
Easy & Safe to use | Do

ILLUSTRATION OF ACTION OF PHA



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Very Fast action | Enhances Probiotic performance
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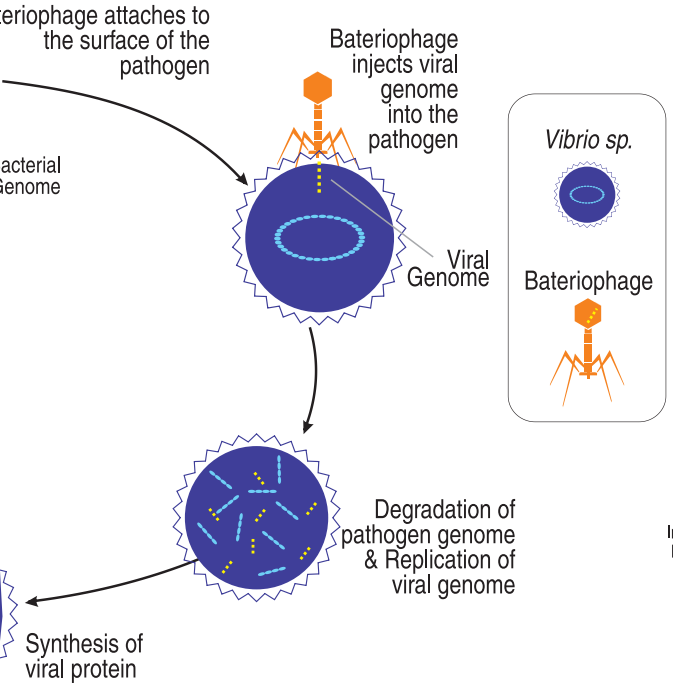

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BENEFITS

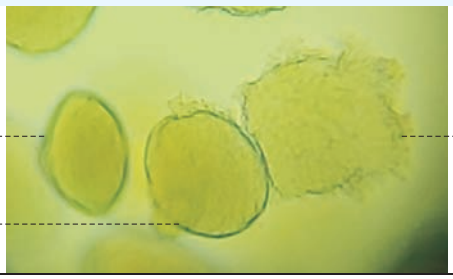
- Effective against Vibriosis, other Bacterial Infections and Running Mortality Syndrome (RMS).
- Effectively prevents Gut Infections and Improves feeding.
- Prevents sudden crop loss and extends Life of Pond during critical profit-making period.
- Enhances Probiotic performance.

Works as an Alternative to Antibiotics and complies with International Seafood export regulations.

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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Aquaculture Conferences & Exhibitions in 2024

ASIAN PACIFIC AQUACULTURE 2024 – APA24 – Surabaya, Indonesia – July 2-5, 2024.
Aquaculture – Driving the Blue Economy is the theme of the conference at the Grand City next year.

The event is hosted by the Ministry of Marine Affairs & Fisheries and co- organised with PT Tirta Anugrah Abadi.

After the successful meeting WA2005 in Bali 2005, and APA16 in Surabaya (2016), we decided to come back to Indonesia again in 2024. Asian Pacific Aquaculture 2024 will be the next chance for the international aquaculture community to visit Indonesia and see the rapidly expanding aquaculture industry in Indonesia – nearly 20% increase in the last 5 years in hectares in aquaculture production and over 50% per year increase in tons produced every year for the last 10 years! Attendees will be able to see what is happening in Indonesian aquaculture to create this growth as well as aquaculture developments in the rest of Southeast Asia. Asian Pacific Aquaculture 2024, Surabaya is the place

to learn about the latest in aquaculture, see the newest technology in the trade show with exhibits from around the world and enjoy the many tourist sites in Indonesia.

More info on www.was.org , exhibition info and sponsorship - mario@marevent.com.

AQUA 2024 - Copenhagen, Denmark, August 26-30, 2024 – time to submit your abstract and book your booth….
AQUA 2024, the combined European and World Aquaculture Societies' events, will take place from August 26-30 in Copenhagen. It will comprise a scientific conference, trade exhibition, industry forums, workshops, student events and receptions. The event will highlight the latest aquaculture research and innovation to underpin continued growth of this exciting food production sector. It will be a showcase for Denmark, and its innovation leadership in several key technologies crucial for future aquaculture, but also a meeting and exchange platform for experts from around the world.

The theme of AQUA 2024 is BLUE FOOD, GREEN SOLUTIONS. More information on the www.Was.org and the www.aquaeas.org websites. For sponsorship or exhibition contact mario@marevent.com

LATIN AMERICAN & CARIBBEAN AQUACULTURE 2024 - Medellin, Colombia – Sept. 24-27, 2024.
Colombia has a wide hydroclimatic diversity and geographical, which has favored the development of the aquaculture, thus counting on production of species both warm waters and cold waters mainly In freshwater, mariculture is still an area for develop and strengthen. The largest species production are both red and Nilotic Tilapia, Cachama, rainbow trout and native species. Aquaculture in Colombia has been growing at a rate of close to 10% per year, this is how it has reached production of about 204,000 tons in the year 2022. The main reasons for this growth are associated with productive improvement (genetic improvement, innovation in production systems, optimization in culture conditions, implementation of biosafety and quality systems). Today Colombia has about 36,000 producers distributed throughout the national territory.

The conference will be held in three languages for spoken and written materials. The conference will include all major aquatic species cultured in Colombia and the other LACC countries with a special focus on tilapia, trout, shrimp and marine species. More information on www.was.org. - for sponsorship & exhibition contact Carolina@was.org.

AQUACULTURE AFRICA 2024 – AFRAQ24 – Hammamet, Tunisia – November 19-22, 2024.
Tunisia is currently amongst Africa's top aquaculture producing countries and also one of the world's fastest average annual growth rate. The country is the second biggest aquaculture producer country in North Africa region, after Egypt and is looking forward to expand the sector owing to the competitive advantages on its blue economy domain.

In addition to appraising Tunisia's fast-growing aquaculture sector, bringing AFRAQ24 to the country is expected to inspire the African French and Arabic communities. It is expected to be a gateway platform to connect Africa to European aquaculture actors.

Submit your abstract and block you booth at the AFRAQ24 Exhibition – booth sales open now.

Six ways to make your aquaculture operations more climate-resilient

Sharing practical tips for small-scale aquaculture operators, particularly those based in the tropics, to adapt and become more resilient to the changing climate and extreme weather events.

A floating village on the Hau River in Vietnam, one of the country's key pangasius producing areas. Extreme weather events are putting aquaculture operations at risk.

Most fish and shrimp farms are heavily dependent on environmental conditions, especially the provision of clean water at a stable temperature, and this makes them especially vulnerable to the impacts of a changing climate.

The main climate stressors that affect aquaculture are temperature fluctuations, changes in rainfall patterns that cause floods or droughts, and increased storm variability and severity. Marine aquaculture is also affected by ocean acidification and the increased occurrence of harmful algal blooms (HABs). Impacts differ, depending on the farmed species, the farm environment, the type of farming system and the geographical location. Impacts can occur in a very short time (i.e. heavy rainfall), while other are long-term trends, with change happening gradually over time (i.e. ocean acidification).

Ninety percent of aquaculture operations face risks from environmental change. Some of the countries with the highest climate risks – mostly in Asia, Latin America and Africa – have the lowest capacity to adapt to the changes in climate.

A good example is Myanmar in May 2023, Cyclone Mocha hit the southern Bay of Bengal, with the centre of the storm near Sittwe City in Rakhine State. This was one of the most powerful storms to have ever been recorded in the region, with winds reaching 259 kilometres per hour, and an estimated

670,000 hectares of land were flooded, impacting livelihoods and food security of the already poverty-stricken regions. Over a million people from an estimated 237,000 households were impacted, including many fish and shrimp farmers. Stock was lost and infrastructure destroyed. The UN estimated that two in every three farming households and more than one in every three fishing households in the area lost their productive assets. The total economic loss has been calculated at US$ 2.24 billion, which is the equivalent to 3.4 percent of Myanmar›s GDP.

Similarly in 2021, Indian Shrimp farmers were struck by Cyclone Yaas, losing around 12,000 tonnes of shrimp (valued at USD 130 million). It was hard for farmers to start again, since some had loans to pay off on top of the losses of shrimp and infrastructure.

Marine farms are also regularly hit by more severe storms that seem to have been increasing in recent years. In Scotland 50,000 salmon escaped after damage to the nets by storm Ellen in 2020 and in Chile between 500,000 and 800,000 fish escaped due to storm damages. Damage to floating cages in Thailand by the tsunami in 2005 amounted to USD 32.7 million, with over 40,000 cages destroyed.

Effects of climate change are highly unpredictable and extremely localised, complicating things further. While some areas will experience more rainfall, others are impacted by more severe droughts or more frequent and bigger storms. Therefore, adaptation measures should be adjusted to suit local circumstances, as different threats need different adaptation options. In principle, the goal is that all adaptation measures should be designed to reduce vulnerability and effectively adapt to the climate impact. Selection of effective adaptation measures also depends on community acceptance, the urgency of implementation, technical feasibility, ease of implementation and the costs required to implement the measures.

In this article we provide general tips for small-scale farmers to follow when starting an aquaculture farm or when adapting their farm to the changing climate. Doris Soto, who has worked for the United Nation's Food and Agricultural Organization (FAO) for 12 years, leading the aquaculture team on environmental issues and climate change, adds her insights to our own expertise from working on small-scale aquaculture in Southeast Asia, the Middle East, and Africa for the past 20 years.

1. Implement best management practices

"Improving management practices is the first move towards climate adaptation, especially improving biosecurity, considering lower stocking densities and ensuring a good farm location," says Soto.

Implementing best management practices (BMPs) in all aspects of production will improve the overall resilience of the farm. Susceptibility to disease is particularly likely to increase with the changing climate, as the immune system of animals is compromised when they are stressed (from for example, by warmer water in and around the farm). Ensuring fish and shrimp health through the implementation of BMPs will reduce disease risks. Environmental measures that ensure the protecting of local ecosystems will also decrease the vulnerability of farms to climate change. BMPs also contribute to improved hygiene, feed efficiency and water quality.

Guidelines on best management practices for aquaculture are provided by

ASEAN, World Fish and Sustainable Fisheries Partnership. World fish also published a series of videos on good aquaculture practices some guides are applicable to certain geographical areas or species, but much of the content can be transferred to other areas or similar species.

2. Perform a risk-based analysis

During site selection and farm planning for a new farm, a risk-based analysis should be performed in relation to climate change and extreme weather events. This can also be done for existing operators who want to adapt their farm. An assessment needs to examine the climate risks of an area in terms of exposure, potential impacts, and the risk mitigation capacity. The ultimate goal of a risk assessment is to come up with recommendations for measures that reduce climate-related risks: so-called adaptation measures. Based on the risk assessment, a disaster preparedness plan can be developed, with the aim to monitor risk mitigation actions such as adaptation measures.

Usually, a risk assessment is carried out by organisations covering a whole country, region or project. However, risk assessments can also be done by a group of farmers

(A farmers' association or cooperative) or larger individual farmers. Guidelines on how to conduct risk assessments are available from Care, UN and GIZ.

Flooded shrimp ponds in the wake of Cyclone Amphan, which struck Bengal in 2020. Extreme weather events are putting aquaculture operations at risk.

If the risk assessment finds very high risks that cannot be mitigated, relocation to safer areas should be considered. Alternatively, short-cycle aquaculture projects can be implemented in areas that face longer and regular periods of drought or flooding. For example, a fast-growing fish species can be grown which can be harvested before the rainy or dry season starts. Stocking larger fingerlings also shortens the farming period and so reduces production risks too. Finally, culturing species with the capacity to breathe air such as catfish, pangasius and climbing perch, can be a viable option where water quantity and quality is restricted. Such species can also be moved more easily in case of emergency.

3. Diversify your production

Do not put all your eggs in one basket: diversification of products is a strategy commonly used to spread risks against losses. It can enable continued production if one crop fails. When selecting species that can benefit from each other, farm diversification also reduces waste and increases productivity by using by products from one species as inputs for other species. It also diversifies the income sources of farmers, stabilises production and increases resource efficiency.

However, as Soto observes: "Diversification only works if different species or products are not subject to the same hazard, for example extreme events such as the one that took place in Myanmar in 2023 can impact all aquaculture farming systems and species".

The use of integrated agriculture-aquaculture and polyculture aquaculture systems should also be considered. This approach diversifies livelihoods further, provides extra food for the family and to sell, and uses scarce water more efficiently, making it an effective climate adaptation measure. Pond water can be used for the irrigation of crops, while crop waste can be used as feed for the fish. Nutrients in the pond water from fish excretion act as a natural fertiliser for the crops. Vegetation on pond dykes also strengthens them and reduces erosion.

Selecting local strains and varieties for both the fish and crops is key, as these are in most cases best adapted to the local climate and to local pathogens.

For marine farms, integrated multi-trophic aquaculture (IMTA) can be implemented as a means to diversify. Seaweeds can be cultured around the sea cages and filter feeders such as bivalves and sea cucumbers can be grown under or around the cages. IMTA or any diversified system cannot however solve issues resulting from a common hazard, such as an extreme storm event.

Doris Soto (right) with one of her PhD students at a mussel farm in southern Chile.

Additionally, the market can be diversified between local, national, and international options. Supply to local markets has the advantage that transport requirements are limited, and it contributes to local food security.

4. Make use of early warning systems

Farmers should be familiar with reliable sources of information on climate change and climate variability. Timely information can enable farmers to respond quicker to climate risks. It is important to understand and interpret the meteorological predictions, such as weather forecasts, well. Make use of forecasts to prepare for extreme weather events. Daily online weather forecasts provide information on upcoming extreme weather events, like cyclones and extreme high tides. When changes in salinity, water availability and other important parameters are predicted in advance, farmers can prepare their farm to minimise losses and damage.

According to Soto, more and more farmers are already starting to use early warning systems. Most farmers now have a cell phone and early warning systems can be used with simple technology mostly coming from governments, so there is large potential for every

village to be informed in case a severe cyclone is approaching, or to stay updated on the latest developments regarding an El Niño season. The main gap is understanding the forecast and improving preparedness and emergency response. Farmers can often access training through NGOs or government programmes.

Technology used in early warning systems include artificial intelligence, remote sensing and satellite imaging, and the Internet of Things. Companies such as Scoot Science and Blue Lion Labs and use tools to predict outbreaks of extreme ocean events and HABS.

Examples of emergency responses to hazards include early harvesting, strengthening farm infrastructure, increasing the rate of water exchange, and the provision of aeration. Some cage farms can be towed to safer places and ropes and nets should be checked to ensure everything is tied well.

5. Farm infrastructure improvement

For inland pond farms, higher and stronger dykes can protect against flooding and provide an opportunity to have deeper ponds in preparation for droughts and hot weather, since they have a more stable water temperature and a greater dissolved oxygen reserve. They are also less sensitive to environmental factors in dry periods. Dykes should be made

Fish ponds with very low dykes, such as these in Zambia, are vulnerable to flooding.

as stable as possible to endure floods and storms. This can be done by using the correct ratios of dyke height and width and the correct angle of the slope. Nets can be placed on dykes around ponds to prevent escapes during flooding and heavy rains.

For areas with heavy rain or floods, it is important to ensure water can flow out of the pond. For this piping and sluices for water intake and outlets are important, as well as drainage canals. Canals should be wide and deep enough to uptake extra water in case of heavy rain and floods. In case the area suffers dry periods, an inlet canal can be useful to ensure water supply from the sea or river. Water reservoirs (or spare ponds) can also be constructed to buffer for dry spells.

For marine farms, submersible sea cages can be deployed, but these are expensive and more difficult to manage, so are currently not suitable for small-scale farmers. Cage structures, mooring, and nets should be of sufficient quality to withstand the strongest storms. Farms should also have equipment to recapture escaped fish. As improving farm infrastructure is expensive, it is possible that governments, as part of their policy on climate change, provide micro-finance schemes, insurances and loans to invest in farm infrastructure. Farmers can inquire if these options are available in their respective countries.

6. Collaborate with other farmers

Most adaptation measures cannot be implemented by a single farmer alone. Therefore, farmer organisations and other community and government entities should play an important role in building resilient farms and communities. Farmers' organisations allow for collective pooling of resources and skills. Other than implementing adaptation measures together (for example disease prevention), they can also work together on receiving training, exchanging information, understanding their ecosystem, infrastructure development, buying inputs and marketing of products.

Where do we go from here?

Despite a number of encouraging projects in this field, there are still very few detailed, data-backed success stories relating to how the adaptation measures have worked, so it is important that more studies are conducted in this area.

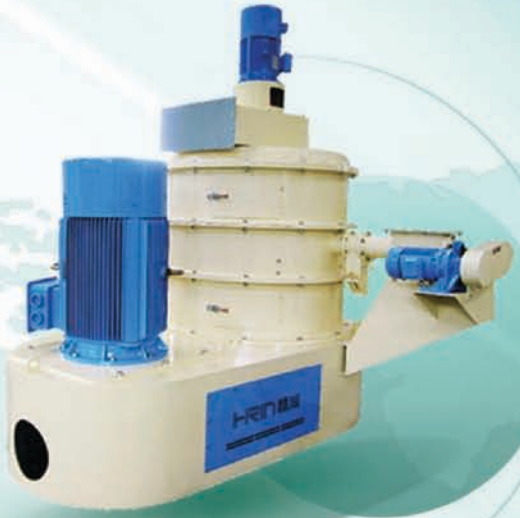
"At the moment, we do not have very good monitoring systems or indicators in place to measure the success of adaptation measures," says Soto. She stresses that this is needed to select effective and feasible measures.

Additionally, the implementation of adaptation measures often comes at a considerable cost. For small-scale farmers, who work tirelessly to put food on the table in communities worldwide, while often living in poverty themselves, implementing some of these changes will thus be challenging. Government support is needed through policies, legislation and financial support for the implementation of adaptation measures. Part of this cost should also be shouldered by consumers, through higher prices.

Food security is of critical importance to our still growing global population. By working together and taking collective responsibility, aquaculture operators can help to create a climate-resilient future-proof food system.

A meeting of a fish farmers' association in Zambia.

Professional Feed Machinery Manufacturer



Hengrun SWFL Series Vertical Pulverizer

Vertical shaft with no-screen grinding, Bearing no maintenance. The production is uniform and the fineness is adjustable (Range from 40~200 mesh.)

Hengrun HRYTZ Series Vacuum Sprayer

Totally enclosed spraying space, Precision & Efficient spraying proportion widely ranged from 2%-30%.

Significance of Ambergris, floating treasure of the sea

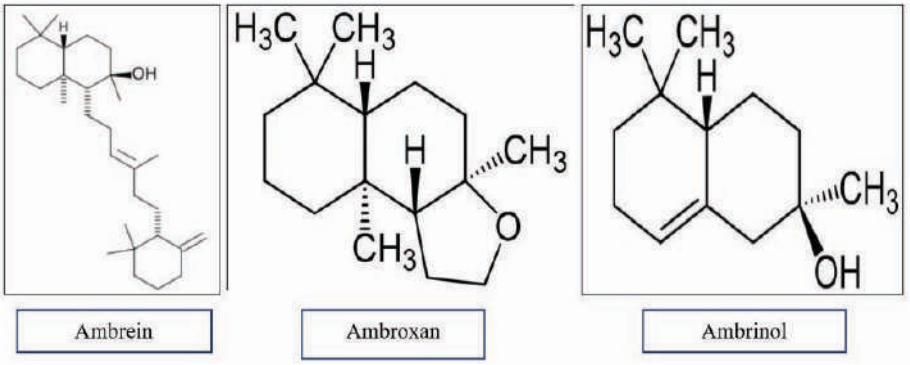
Email: **asikikbal25@gmail.com**

Asik Ikbal, Dr Supratim Chowdhury & Rajesh Mandal
Dept. of Fish Processing Technology, Faculty of Fishery Sciences, West Bengal University of Animal and Fishery Sciences, Kolkata - 700 094, WB, India

Abstract
There are lots of valuable by-products processed out of fish and fish waste which have important commercial usages. Among the fish waste, Ambergris, a fatty grey substance produce from sperm whale gut, has one of the most commercial value in perfume industry. In India, it is extensively utilised in the Ayurveda medicine industry. It is one of the strangest natural substances found on earth and has historical importance. This article aims to provide the historical background, chemical properties andtherapeutic effects of ambergris.

Introduction
Ambergris has been frequently observed floating on theAtlantic Sea beaches and coasts of South Africa, Brazil, Madagascar, The Maldives, China, Japan, India, Australia, New Zealand and Molucca Islands. Most of the commercially used ambergris comes from tropical islands such as the Bahamas. It acts mainly as a stabilizer in various premiumperfumes in Western countries.In Eastern countries,it is mainly used for medicinal purposes to form potions and also as a flavour enhancer. Ambergris is anindigestive end product only produced in the intestine of both male and female sperm whales and the pygmy sperm whale (Physeteroidea).It is rare and can be found only in 1-5% of the total whale population. Controversies are there whether the substance is physically departed from sperm whale or ejected as 'vomit' or as a 'faecal matter'. So, it is widely known as 'Whale Vomit' or 'Whale Poop'. Ambergris often called the floating treasure of the sea because of its huge market price much higher than gold in the fragrance industry,

- The significance of ambergris and its application in perfume & beyond perfume industry are being discussed in this article.
- Ambergris, the aquatic solid bio-waste has an unbelievable market value, is produced from sperm whale's intestine. Thus, called as 'floating gold' or 'floating treasure'.
- In the meantime, whale population is facing danger for the ambergris.
- In future, to protect the ocean ecosystem, illegal killing of whale should be acknowledged as a punishable offence by all countries in the world.



found on sea beaches or coastal areas. Ambergris is mentioned in various languages worldwide: in Hindi 'amber';in Sanskrit 'ambara' or 'sugandh'; in Gujarathi 'ambara'; in Tamil 'minumbar'; in Arabic 'amber'; in Persian 'musk amber'; in Burmese 'payan-anbhat'.

The history of Ambergris

From the ancient days, ambergris has been valued as a medicinal substance, drug and perfumes. Several historical events in the fifteenth, sixteenth and seventeenth centuries were reported where many European mariners found ambergris on beaches. They used to trade the ambergris illegally in the eastern regions from overseas. Thereafter, it became newsworthy. After the discovery of the valuable rare substance on the beach, people are misguided and many Portuguese tourists or voyagers in that time started trading it illegally in European countries. After various thoughts and theories, in the middle of the 19th century, rumours regarding the origin of ambergris had been reached their peak. However, in the middle 20th century, ambergris had been found its origin as a 'consequence of a disease that originated in the large intestine and was expelled once in a while in the animal's stool'.Experts found fossils of ambergris, are 17.5 lakh years old and claimed that human has been using it for more than 1000 years. Recently, on 1st June 2021, some 35 fishermen spotted a sperm whale carcass near the Gulf of Aden. The interesting fact has happened when the ambergris found from the dead body worth $1.5 million recently (Times of India news, 2021).

Formation &Chemical Compositions

Sperm whale (*Physeter macrocephalus*) consume a high number of cephalopods like squids and cuttlefish. These foods are not digested properly so they vomit it. Like ruminants, whales too have four stomachs, and the food is digested while moving from one to another. While continuing this steady voracious feeding, the non-digested cephalopods remain filled and formed a big glittering substance in any of these stomachs. Whales often unload these remaining substances in the open oceans but not all of these vomits are ambergris according to some experts. A published paper from the University of Chicago Press claims that 'Whale vomit' and the ambergris are two different things. While Richard Sabin of Natural History Museum (NHM) firmly believes that ambergris is formed in the whale's intestines only and get out of the body through the faecal matter.Though there is a complex pathological procedure to produce ambergris. Ambergris (in Latin 'ambra grisea' and Old French 'ambre gris', which means grey amber) is a solid, waxy, flammable, grey coloured waste product derived from the sperm whale. Ambergris contains alkaloids and is comparatively non-reactive to acid.In 1946, scientists Ružička and Fernand Lardon discovered a white crystal compound similar to cholesterol called ambrein ($C_{30}H_{52}O$). They separated it from ambergris by applying heat in alcohol and allowed it to cooldown. On oxidation, it produces ambroxan and ambrinol which provide a typical scent and extensively used in the perfume industry.

Applications

a) Early usage: humans have using ambergris for different purposes since ancient times. While ancient Greeks used it for increasing the intoxication strength of wines. While in medieval time, the strange substance used to treat impotency.

b) Perfume industry: The whale vomit (Ambergris) is highly popular for its use in making perfume and fragrance very much similar to musk. The well-known fragrance company like Chanel and Lanvin takeadvantage of the ambergris which canhelp to fix scent to human skin and have made it the most valuable natural raw material in perfumery according to GQ magazine. For this reason, ambroxan (a derivative of ambergris) is now produced synthetically.

c) Cosmetics industry: Ambergris has considered a rare material for some cosmetic products as its worth goes up to several dollars.

d) Flavouring agent: It has been used as a flavouringagent in coffee and hot chocolates in some western countries.

e) Medicinal usage:

- ✓ Ambergris has potential usage in the treatment of human liver cancer, colon cancer, lung carcinoma and human breast cancer.It shows cytotoxic actions against the above cell lines.
- ✓ It has ananti-inflammatory activitythat inhibits human neutrophil function.
- ✓ Ambergris influences some endocrine hormones. It has been reported that after the inclusion of ambergris, the level of testosterone, estradiol, prolactin, insulin, cortisol, thyroxin hormones have been increased.
- ✓ It has some traditional aphrodisiac use.
- ✓ It shows anti-diabetic effect in some Ayurvedic medication.

The legality of trading Ambergris

Mainly between the 18th to the mid-19th century, there had an overwhelming business of sperm whale's meat, oil, bone and vomit

Ambergris is found at sea beaches or on coastal shorelines

generally in Europe. According to some reports, this industry was prospered by killing nearly 50,000 whales, including sperm whales each year. For this reason, whale populations were in great danger and being threatened. In 1982, the International Whaling Commission has been established for regulating the status. Due to the reasoncountries like Australia (Under the Environment Protection and Biodiversity Conservation Act,1999), United States (Under the Endangered SpeciesAct, 1973), India (Under the Wildlife Protection Act, 1972) have banned trading of ambergris. Though, the use of ambergris is allowed in some countries like United Kingdom, France, Switzerland, Maldives. However, the Convention on International Trade in Endangered Species (CITES) regards ambergris as a by-product or waste materials, like urine or faeces that occurs naturally, legalise it to collect from beaches.

Conclusion

We have been observing the successful application ofAmbergris in Ayurvedic and/or Unani medicines for decades. There are a smaller number of researches on ambergris. If we focus on more studies andconduct more clinical trials of ambergris, it must give some fruitful results on itstherapeutic use.Further development may be done in combinationwith other herbs or drugs and can investigate the potent effects on healthcare. We have to emphasise more on the use of the existing alternatives of ambergris which will discourage the exploitation of whales for resources.

Sperm whale

Solid Ambergris

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The Artificial Reefs: An Overview

Anjali Kumari, Susmita Rani & Abhinav Prakash
ICAR-Central Institute of Fisheries Education, Mumbai, Maharashtra

Email: susmita.fpbpa902@cife.edu.in

Abstract
Coral reefs are an important habitat for organisms living underwater, but due to anthropogenic and some natural causes, these habitats are getting harmed directly or indirectly. To overcome these losses, an artificial reef is a very good option to re-establish a similar habitat as the natural coral reef habitat. Here we will discuss some important aspects related to the artificial reef system.

Introduction
An artificial reef is a human-made underwater structure, typically built to promote marine life in areas of generally featureless bottom or where existing natural reefs have been destroyed. It improves hydrodynamics for surfing or to control beach erosion. These structures are either deliberately or unintentionally submerged underwater, commonly with the result of mimicking some characteristics of a natural reef. They alter local habitat by providing a hard substrate and complex vertical relief where typically none previously existed.

History
In the early 18th Century, Japanese fisherman discovered that fish catches were more productive in waters around sunken wrecks. This led to the deliberate sinking of wooden structure weighted down ropes, which enables fishermen to choose the areas where improved fish catches were desired. This approach is called Artificial Reefs which is being spread worldwide while it is in extensive use in many coastal countries using a variety of materials, techniques, and configurations. It can either be a bane or blessing, depending upon many circumstances. The use of artificial reefs has been extensive in the Philippines.

Materials
AR materials are selected based on certain characteristics of the particular material, i.e., function, durability, compatibility, stability. Material quality also ensures its compatibility with the aquatic environment.

Types of Artificial Reef Materials
Vessels: It functions as a safe habitat for various fishes and invertebrate communities. It also provides a suitable site for scuba divers to explore and dynamic habitat for fishermen to fish.

Pipe: Different shape and size of damaged or dug up pipe are used as structure of the reef. It can stack easily to provide profile, and the hollow area of pipes provide a hiding place for fishes and other aquatic organisms.

Concrete castings: Different types of prefabricated structures like culverts, junction boxes, etc., are used as artificial reef structure. These are essential reef structures as they provide more surface area for fish to hide.

Reef balls: These are ball-like structures with many holes leading to a hollow interior cavity which helps fish to evade predators. They provide enough surface area for the attachment of invertebrates.

Material type	Benefits	Drawbacks
Concrete	Highly durable and stable .It can be casted into many forms .It provides settlement and attachment surface for growth of encrusting organisms. It is cost-effective and it's highly compatible to the marine environment.	Highly weighted
Steel hulled vessels	Creates attractive diving location and generates high revenue to coastal communities. It also provides surface for epibenthic colonization, etc.	Less stable during hurricanes

Gas and oil platforms	Easily available, more durable, and stable. It serves as habitat for various species.	It can attract invasive species, and also cause an obstruction in navigation.
Natural materials (e.g., rock, shell, wood, etc.)	Easy availability	It can cause loss to the terrestrial environment.
Automobiles	Easy availability and easy to handle	Less durable; requires more effort in preparation prior to deployment.
Tires	Easy availability, easy to handle, cost-effectiveness, long life	Leaching of toxicants like petrochemicals and heavy metals, unstable.
Wood	Easily available	Short-term stability and life span cause damage to terrestrial habitats like forests.

Comparison of materials that can be used in the development of artificial reefs

Deployment

The use of artificial reefs is gaining popularity because of its fish aggregating function. Artificial reefs, as a habitat enhancement, too, increase the productivity of barren sea floors by providing shelter and eventually sources of food. Throughtime, as the encrusting community develops onthe surface, they serve as nurseries. Ineffect, they enhance marine life in the areas where they are deployed. However, it should never be concluded that an artificial reefcan serve all the bio-ecological and economic functions of natural foods.

Site selection is one of the most important aspects of the success of these reefs. Placing one in an already rich reef flat may cause more damage than good because the artificial reefwould compete with the natural reef as an aggregating habitat and may physically damage the existing reefs. Hence, they should be sited in locations that have already been denuded or that support very little marine life. These are placed on the bottom, but another innovation of **fish aggregating device** is used near the surface of the sea.

The choice of the materials to be used as artificial reefs and their configuration are further important planning considerations.They can be made of inexpensive and readily available materials. Used car tires have become extremely popular because of their easy availability, durability, and cost-effectiveness. The use of concrete structure, although more expensive, is also widespread. But waste material that contains toxic chemicals (old refrigerators and air conditioners containing CFCs) should be forbidden because of their polluting impacts on the marine environments. Materials to be deployed must be exercised in preventing the creation of a solid waste dumpsite for unwanted waste materials.

When setting up an artificial reefprogram, the agency or country must first critically examine the need for such structures. Further, those concerned must specify an exact role as these areintended to fulfill. Theestablishments of artificial reefs in Brunei Darussalam and Singapore, which have limited coral reef resources, are good examples. These reefs cater to the needs of recreational fishermen and tourists so that the natural reefs can be completely conserved and relieved of fishing pressure.

But these arenot a panacea and should be viewed as only a part of a larger fishery management program. A definite limit exists on the number of fishermen who can participate if sustainable benefits are to be achieved. What appears to be lacking in many cases is a master plan to ensure that these reefs can serve as an effective ecological and economical tool. Experience in the developed country has shown that benefits are possible when an artificial reefprogram is carefully planned, managedand maintained. If not, artificial reefs will begin to be used as excuses for the dumping of waste materials or the overexploitation of fish and other marine life.

Artificial reefdesign and construction require a professional approach. An unskilled person attempting reef placement can cause trouble, as in Curacao (West Indies) when the local "**seaquarium**" decided to sink a wreck in the nearbywater. The result was that the ship, being improperly secured, slipped into the deep, leaving behind only a much-damaged reef and a sea bottom littered with remnants of the ship.

Effectiveness

Artificial reefuse can be cost-effective to enhance nearshore reef fish populations, increase fishermen net income, demonstrate sound fishery management principles. Their abuse can be wastefully expensive, contribute to greater overfishing and perpetuate bad resource management practices. Success or failure, for the immediate use and for the coastal fishery as a whole, dependson howartificial reefs are used in the existing fishery situation.

Theyinitially attract fish, particularly fingerlings from surrounding waters. Fast-growing tropical species can develop stable populations in 6-12 months' time. Their aggregating power appears to be strong as they have been reported to support up to seven times the fish biomass of natural reefs. These reefs with relatively high relief (rising 2 meters

from the bottom) typically support several fish populations, including

1. Residents living within the reef structure such as groupers and moray eels,
2. Mobile bottom feeders (grunts, goatfish, rabbitfish, and snappers) which range over larger areas as they move from one reef module to another within a cluster and between clusters,
3. Schooling plankton feeders (fusiliers and sturgeons) which use the water column above the general reef area. In addition, visiting schools of travelers often linger over the reefs.

Evaluation

The application of artificial reefs may result in one or more of the following impacts on marine resources.

1. Biomass that is currently exploited gets redistributed from natural habitat to artificial reef.
2. Biomass that is currently not being exploited is attracted to the artificial reef to increase the total available exploitation.
3. High relief habitat is increased by artificial reef structures, and stocks that are limited by high relief habitat can increase.

It can be useful in closing areas to trawling (bottom obstructions), protecting juveniles in shallow nursery grounds, and providing fishing sites for artisanal fishermen using that they can capture the older fish. They can substantially reduce travel and research time for artisanal fishermen and improve the catch ability of their gear.

The artificial reef has proven particularly effective for artisanal applications in which fishing effort is relatively low. Where fishing effort is controlled, these reefs may result in over-fishing. Therefore, the structures may not be appropriate except in situations where fishing mortality is controlled.

Artificial Reefs of India

In India, the idea was initially adopted by the traditional fishermen. For the very first time, three artificial reefs were established in some villages of the Trivandrum at Kanyakumari coast in the late 80s and early 90s. The artificial reef was in the form of triangular concrete modules and bamboo modules and was led at a depth of 12-14 fathoms. These establishments of artificial reefs were supported technically and financially by Trivandrum based program for community organization (PCO). Between the years 1988 to 1994, various artificial reefs were led in many villages in Trivandrum - Mariana, Thumba, Kannanthura, Valiathura, Adimalathura, Puthiyathura, Paruthiyoor, and Kollemcode.

Fishing Methods in Artificial Reefs

Hooks and lines: mainly three types of hooks and lines are used in the reefs. They are long lines, mid-water hand lines, bottom hand jigging

Gill nets

Trammel nets

Seine nets

Fishing Season in Artificial Reef

Fishing in artificial reef is mainly done for a period of six months, from the month of Oct to March. When the catch decreases in inshore water in a post-monsoon period, also known as panjamasom locally, at that time, fishermen depend on these reefs for fish catch and livelihood. The fish catch start decreasing from February, and by March, the catch gets highly reduced. As the catch in the artificial reef system decreases, the catch increases in the open waters; maintaining balance in fish catch between the artificial reef and open waters.

Largest Artificial Reef in the World

The **Great Barrier Reef, Australia** is the world's largest coral reef, and the **world's largest artificial reef** is the **Ex-USS Oriskany, Florida, United States**. This reef initially was the naval vessel USS Oriskany which was turned to an artificial reef later on by the purposeful sinking of the 44,000 ton aircraft carrier, off the coast of Pensacola, Florida, in 2006. The vessel was built in 1945 and commissioned in 1950 with a total weight of 44,000 tons and got its retirement in 2006. After retirement, the navy sunk it in the southeast of Pensacola pass. This reef is often referred to as the **Everest of diving** because divers can explore it in the depth range of 80-212 ft.

Conclusion

Artificial reefs are the human-made structures, meant to combat the loss in the aquatic environment due to anthropogenic activity like overfishing which destroy natural fish habitat. These reefs have a number of advantages like it act as a study area for scientist, a tourist attraction for divers, rehabilitation of naturally destroyed areas, creates a breeding and nursery ground, beneficial use of solid waste like old boats, tyres, and automobiles waste, etc. Hence, we need to focus on the establishment of artificial reefs where it is needed.

IMPACT OF CLIMATE CHANGE ON FISHES' METABOLIC PATHWAY

Mayank Bhushan Singh[1], Devarshi Ranjan[2], and Maneesh Kumar Dubey[3] & Satyaveer[4]

[1]Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya-Uttar Pradesh, India.

[2]Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar.

[3]College of Fisheries, Karnataka Veterinary, Animal and Fisheries Sciences University, Mangaluru, Karnataka.

mayankbhushan4142.singh@gmail.com

Abstract:
Aquaculture sustainability is affected by climate change which regulated livelihood, nutrition and world food security. The most important contributor of climate change is documented by human due to deforestation and industries that release GHGs (greenhouse gasses) accumulated in surrounding environment such as methane, nitrous oxide, fluorinated gasses and carbon di oxide. Climate change affected fisheries adversely but it is overshadowing the positive one. The effects of climate change on fishes can be directly by the water quality parameter such as temperature, dissolve oxygen, pH, (acidification) etc. which affected fish physiology and behavioral changes through metabolic adaptation. Due to the changes in climate fishes are adapting in novel environment like as high temperature (higher to lower latitude or lower to higher latitude), hypoxic condition due to evolutionary effect and adapting in low pH which is caused by high carbon di oxide released in the environment by human activities. Therefore, the present article is mainly focused on effect of climate change on metabolic pathway of fishes.

Aquaculture system includes fresh water, marine and brackish waters environments and scattered under tropical, subtropical, and temperate region. The production of an aquaculture depends on water quality parameters, which is affected by climate change such as increasing temperature, raining pattern. According to Dabbadie *et al.*,2019 and FAO,2020Aquaculture sustainability is affected by climate change which regulated livelihood, nutrition and world food security. Most important contributor of climate change is documented by human due to deforestation, that release GHGs (greenhouse gasses) accumulated in surrounding environment such as methane, nitrous oxide, fluorinated gasses and carbon di oxide.

Aquaculture species will need to be adapted or adjust in their continuing global warming or raising temperature as studied by Hoffmannand Sgrò, 2011. There has been cumulative evidence; few aquatic animals can manage in increasing temperature by acclimatization through phenotypic plasticity. According to Parmesan,2006in terrestrial and Poloczanska and Brown*et al.*, 2013 in marine, species has been migrated from lower latitude to higher latitude but few geographical distributions in the majority of species are still unaffected due to raise temperature. In all three climatic regimes such as tropical, subtropical, and temperate region, the tropical species are mostly prone to climate change since they grow in moderately constant thermal location. As compared to temperate aquatic species, tropical species have less thermal tolerance and also have less phenotypic plasticity acclimation. Thus, the genetically adapt to climate change probably might be necessary for tropical species through heritable variation in trait of interest with good selection and evaluating evolutionary potential to climate change for the future.

Climate change effects on fishes and fisheries

Aquatic animals like fishes are the ectothermic or poikilothermic animal and it is totally regulated by surrounding aquatic climatic factors. There are two essential factors in the aquatic environment that is the biotic and abiotic elements. Biotic factors consisted of species composition and availability of food, anotherabiotic factor is included temperature, sea level, salinity, nutrients, availability of oxygen, water current and pH, all

are influenced by climate change. Direct (fish physiology, behaviour, reproductive ability, distribution, mortality and growth alteration) and indirect impact (productivity, structure and ecosystem composition related to fish feed) on the aquatic organism by the alteration of climate change.

The mortalities of fishes are likely to happen, mostly of cold-water fishes like as Salmon, Atlantic halibut intertidal shellfish and Cod due to thermal stress because, this century forecasted temperature increases in average 1.5°C Gubbins *et al*., 2013. Deviation in species availability and distribution that alters species composition of marine environment due to increasing temperature of ocean by global warming. Increasing temperature creates geographical distribution in significantly of marine animals which is established by geomorphology, salinity, stratification, depth of water and ocean currents.

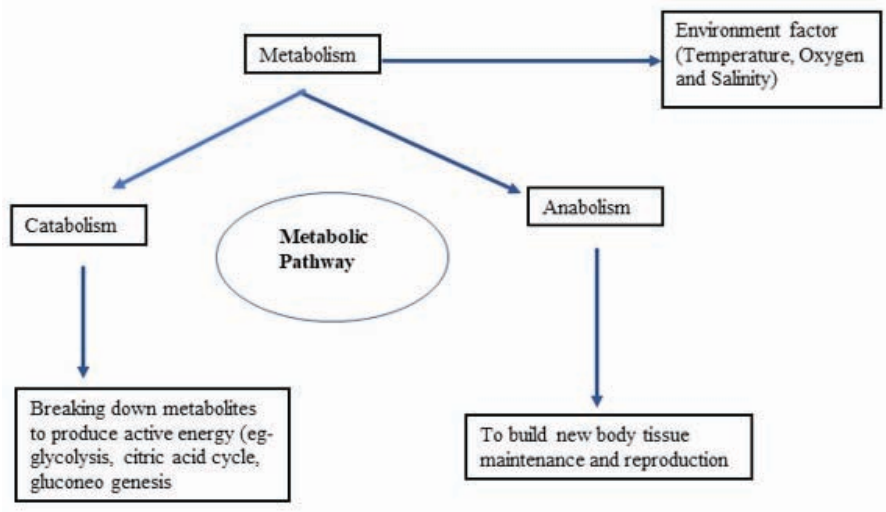
The diversity of fish species has been extensively explored by the collected long-term data series to examine population size and its structure and breeding behaviour which is affected by climate change in North Atlantic Oscillation (Alheit *et al*., 2005). Alteration in geographical distribution mostly occurs near to northern or southern pole where increasing temperature happen in higher latitude and cooling occur in lower latitude fishes due to climate change.

There is few research have been analysed to examine, the changes in abundance of phytoplankton and zooplankton spring blooms (Wiltshire*et al.,* 2008) and phenology of breeding habitat of fish species (Sims *et al.,* 2004). According to Beaugrand *et al.,*2002shifting availability of food for larval and juvenile, same author in 2004 have studied probably leading to regime alteration between before and latter due to climate change. Global warming affected species-specific at several biological mechanisms such as changes in physiology at molecular level, cellular and entire organism level, which is necessary to diagnose the effect of climate change.

According to above information climate are changing day to day and it influences the fish metabolic pathway due to increasing temperature and adaptation to its new environment temperature by reason of shifting species, we need to analyze it.

Effect of climate change on metabolic pathway

Fishes are poikilotherms or ectotherms so the physiology highly influenced by temperature which is affected their metabolic pathway, feeding behaviour, locomotion and energy balance. With the 10°C aquatic environment temperature can raise 2-3-fold metabolic process (Q10) (Willmer *et al.,* 2009). Temperature influences oxygen consumption, cellular respiration and enzymatic reaction (Liu *et al.,* 2019) and author showed that due to heat shock stress induced histopathological changes, significantly rises in Hsp 70 (heat shock protein, indicate thermal stress) as well as significant alteration in metabolisms. Liu *et al.,*2019worked on Lenok (*Brachymystaxlenok*) to thermal stress and found suppression of energy metabolism, amino acid catabolism, biosynthesis of glutamate and glutamine that altered in nucleotide metabolism and changes in lipid metabolism. Thus, high temperature raises biochemical reaction.



Metabolic pathway

Mitigation of climate change in aquaculture

According to IPCC,2018, increases the temperature probably 1.5 °C and it can be further raise expected by 2°C which create global warming and its related risk to health such as food security, economic development, human security, water supply and livelihood. Zolnikov, 2019.

Adaptation and mitigation is the only way to deal with climate change with its resilience as successfully as possible, and it might be helping to prepare the farming communities, populations and ecosystem. The mitigation of climate change involves, the reducing of anthropogenic activity which mostly by greenhouse gasses GHGs such as carbon di oxide by human which is accounted more than 60% (IPCC, 2014; Environmental Protection Agency, 2016).

In the developing country it may or may not be reversed so it needs to be adapted those changes. So, this is another way to minimize the effect of climate change, many experiment have been done on feed based to survive fishes in fluctuating temperature. For example, Kumar *et al.,*2016investigated the modulating effect of temperature variation on the metabolic status and growth performance of tropical freshwater fish *Labeo rohita* reared with starch based gelatinized (G) or non-gelatinized (NG)and high protein diet. He founded enhanced enzyme activity due to higher temperature and elevated temperature lasted for 3 weeks after exposer NG starch and

high protein diet and it support the growth of fish.High dietary protein combats stress caused by heat shock is also effectively evaluated in *Labeo rohita* by Kumar *et al.*,2011.

Conclusion

Climate change affected fisheries adversely but it is overshadowing the positive one. To overcome of those issues, it needs to be built resilience and sustainable aquaculture production in an alteration of climate; the aquaculture species are adapting or adjusting in their continuing global warming or raising temperature, lowering dissolve oxygen and acidic water environment. There has been cumulative evidence; few aquatic animals can manage in increasing temperature by acclimatization through phenotypic plasticity. Some of the fishes have been adapted in low concentration of oxygen by its evolutionary history that will permit to cope in new hypoxic environment which is caused by pollution for survival. Many fish species can adapt to high pH if acclimation time progressively increase to long time. There is certain limitation according to literature it has not been clear whether the adaptation of species is feasible for all fish species at what life stages or not. All those information giving future adaptation strategies that would be provided ideas to farmers about which species resilient to climate change. Thus, adaptation, mitigation approaches would be highly effective but it is requiring more research in climate change prone areas.

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Satellite remote sensing: *A new tool for the Investigation of Marine Floating Plastics*

Rinkesh N. Wanjari[1]
Master of fisheries science in the department of fisheries resource management
PhD scholar at SKUAST-K, Faculty of fisheries, Rangil (J&K)

Karankumar K. Ramteke[2]
Scientist at Central institute of fisheries education, FRHPHM Division, Mumbai.
PhD in the department of fisheries resource management

Dhanalakshmi M[3]
Master of fisheries science in the department of fisheries resource management
PhD scholar at ICAR- Central Institute of Fisheries Education, Mumbai - 400 061

Corresponding author email id: dhanalakashmi86@gmail.com

Abstract
Plastics from land and sea found in a wide range of marine environments. It's difficult to monitor marine plastic from the Earth surface since it's hard to see the entire ocean at once. Although space offers a more enticing viewpoint, the necessary technology is still in its infancy. Monitoring the millions of tonnes of plastic that enter the ocean each year from the Earth's surface is incredibly challenging. One of the most promising ways is remote sensing with reasonable to high temporal, spatial and spectral resolution, which has the potential to be a dependable source of qualitative and quantitative information on a large geographical scale. This article provides a basic overview of how satellite remote sensing can be used to investigate marine floating plastics.

Introduction
Marine plastics that float in the waters cause serious damage to the world's oceans. Every year, millions of tonnes of plastic end up in the oceans. It is one of the most serious environmental issues, and efforts to address it are emerging at all levels, from government agencies to forward-thinking organizations. Since the 1950s, global demand for plastics has increased at a 10% annual rate, with total mass production having reached 359 million tonnes in 2018. (European Plastics, 2019). If current manufacturing and waste management inclinations continue, an estimated 12,000 Mt of plastic waste will end up in landfills or the natural habitat by 2050. (Geyer et al. 2017). Plastics growth has accelerated by around 8.7% each year since its inception as a packaging material. Plastics will probably equal and surpass fish stocks in certain oceans by 2050 in terms of weight (Moore et al. 2001). The total amount of plastic pollution in the world's oceans is assessed to be 270.000 tonnes or 5.25 trillion pieces. Plastic is now everywhere, but due to ocean circulation patterns, it collects in gyres, forming "trash patches." Because of the detrimental effects on marine life caused by absorption and subsequent bioaccumulation of contaminants, plastic pollution is a global issue (Setala et al. 2014). Plastic particles can transfer contaminants from mesozooplankton to macrozooplankton at a higher trophic level, as well as to absorb and transport pollutants. In the marine environment, millions of tonnes of micro- to macroplastic garbage enter worldwide oceans each year. The cost of plastic to marine natural investment is predicted to be between $3300 - $33,000 per tonne (Beaumont, 2019). Larger plastics entering ocean waters have two possible outcomes: floating on top or sinking due to biofouling and ballasting (Pham et al. 2014; Lebreton et al. 2019). Research on plastic revealing using airborne data (Garaba and Dierssen, 2018; Moy etal. 2018), models and theoretic studies have demonstrated the possibility to identify macroplastics in optical data (Aoyama et al. 2014; Hu et al. 2015; Maximenko et al. 2019). On a global scale, satellite remote sensing is a crucial technique for assembling high-quality, standardised optical imagery. However, limited studies have been successful in detecting

- Plastics growth has accelerated by around 8.7% each year since its inception as a packaging material.
- Plastics will probably equal and surpass fish stocks in certain oceans by 2050 in terms of weight.
- The total amount of plastic pollution in the world's oceans is assessed to be 270.000 tonnes or 5.25 trillion pieces.
- Plastics are estimated to invade aquatic environments at a rate of 19–23 million metric tonnes per year, with this number projected to increase by an order of magnitude in the next decades.
- Only 9% of the nine billion tonnes of plastic ever generated by the globe has been recycled.

floating microplastics in the marine environment. Satellites gathering optical data provide a unique viewpoint for observing the issue of plastics in the ocean. Scientists reported earlier plastic pollution in the marine ecosystems in the 1960s (Carpenter and Smith, 1972; Carpenter, 1972). Plastic pollution not only has environmental impacts, but it also causes challenges for maritime traffic and can have significant socio-economic financial implications in fisheries, human health, and tourism (Gregory, 2009; GESAMP, 2015).As a result, at the regional or global level, a comprehensive examination of the spatial and temporal range and quantity of debris, as well as monitoring techniques, are missing. Due to the many various kinds and forms of plastics, using satellite and aerial remote sensing methods to estimate ocean plastic contamination is challenging. Because of the large area coverage and frequent observation, remote sensing is unique to the tools required for the identification of floating marine plastics. Martnez-Vicente et al. (2019) provided a first estimate of the observation needs for measuring marine plastics from space. Because of their great geographic resolution, areal images appear to be capable of mapping plastic contamination. All of the proposed concepts take advantage of space's more favorable driven framework, although they cover a wide range of applications and technologies. There are several approaches for looking at plastic in rivers, shorelines, and the open ocean with modern techniques and technology including artificial intelligence, LIDAR, and thermal scanning. Satellite remote sensing has been extensively used for oil spill detection because the release of ERS-1 in 1991, the very first European satellite with a SAR sensor onboard (Nirchio et al. 2002, 2005; Fan et al. 2015; Sineva and Ivanov, 2016; Topouzelis and Singha, 2017; Chaturvedi et al. 2019;), further to the locating of ships (Mallas and Graber, 2013) and watching sea ice (Matsuoka et al. 2002; Nakashima et al. 2011). Plastic contamination in natural areas has negative consequences for wildlife, habitats, and human health. Plastics are estimated to invade aquatic environments at a rate of 19–23 million metric tonnes per year, figure expected to rise by an order of magnitude in the next decades (Gallo et al. 2018; Borrelle et al. 2020). According to Meijer et al. (2021), rivers carry 0.8–2.7 million metric tonnes of microplastic into the oceans each year. Many studies on different monitoring techniques to improve the large-scale detection and quantification of riverine macroplastic loads and plastics accumulated on beaches, lakeshores and riverbanks. Newly, remote sensing (RS) that assembles multi- to hyperspectral imagery has in progress to show far-reaching potential for the finding and monitoring of riverine as well as marine plastic pollution (De Giglio et al. 2020; Garaba et al. 2020). The planet facing one of the prevalent threats in human history. The earth is about to receive one of the greatest gifts in human history. Only 9% of the nine billion tonnes of plastic ever generated by the globe has been recycled (UNEPa, 2019). Every year, about 8 million tonnes of plastic wind up in the ocean, the equivalent of dumping a garbage track of plastic every single minute (UNEPb, 2019). The majority of plastics do not biodegrade and instead break down into smaller particles called microplastics. According to some predictions, oceans will carry more plastic than fish by 2050 if we continue to discard goods like plastic bottles, bags and cups after a single use at the current rate and nearly all seabirds will have consumed plastic (UNEPa, 2019). About 30% of marine litter is anticipated to float on the surface or in the water column, while the remaining sinks to the ocean floor (UNEP, 2005; 2019). Microplastic particles with a diameter of much less than five mm may be found in a huge variety of aquatic and terrestrial environments and additionally within the atmosphere. Microplastic pollution has become a foremost global issue in recent years due to the potential threat it poses to human health as well as the ecosystem (Auta et al. 2017; Hale et al. 2020; Zhang et al. 2020b; Zhang et al. 2020c).Using frequent satellite observations of floating plastics could aid in tracing the source of pollution and several authors have recently

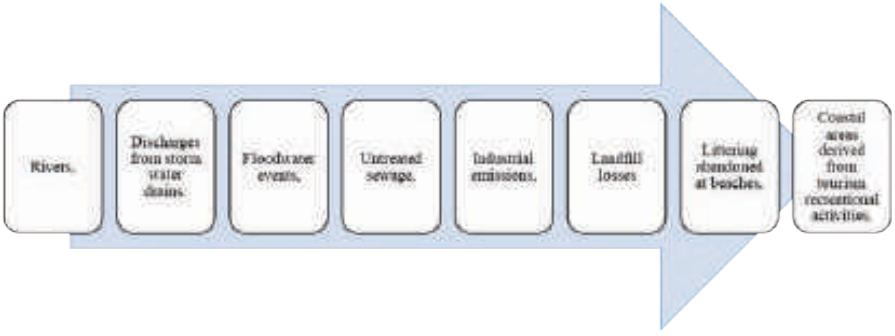
advocated for the establishment of satellite monitoring (Goddijn-Murphy et al. 2018;Garaba and Dierssen, 2018; Martínez-Vicente et al. 2019; Maximenko et al. 2019;Garaba et al. 2020). Davaasuren et al. (2018) used SAR images to become aware of herbal sea-slick surfaces as well as microbial bio-films exaggerated by the surfactants accumulation that would be related to plastic pollutants withinside the ocean. The abundance of plastics massive threat to aquatic species and ecosystems due to the fact they could deliver bioaccumulative toxic materials over long durations of time (Colton et al. 1974; Rezania et al. 2018).

What is marine litter?

Because of its abundance, longevity, and persistence in almost all of the world's oceans, marine litter is becoming major concernto marine ecosystems(Gall and Thompson, 2015; Ryan and Tura, 2019). It includes any non-biodegradable item discarded in the coastal or marine environment made of persistent manufactured materials such as metal, plastic, glass, wood, clothing, or paper, as well as rubber(UNEP, 2005; Galgani et al. 2010).Plastic litter is divided into two types based on particle size: macroplastics (large plastic particles of diameters greater than 5 mm) and microplastics (small plastic fragments of diameters less than 5 mm).Plastics can travel lengthy distances from their source due to ocean circulation patterns, wind, and surface currents, and they are abundant throughout the ocean, such as remote gathering areas or hotspots where they have a habit of accumulating in convergence zones, oceanic gyres, and eddies, forming "garbage patches" (Mace, 2012; Eriksen et al. 2014; Cozar et al. 2014; Lebreton et al. 2018; Van Sebille et al. 2020).Clothing, microbeads, and plastic pellets are all examples of microfiber sources (also known as nurdles). After entering the environment, secondary microplastics are formed when larger plastic products degrade (break down) due to natural weathering processes. As per a global estimate of the quantity of plastic litter, including MP, discarded into marine water, the river is solitary of the most significant sources of plastic pollution, carrying over 2 million tonnes of MP each year (Lebreton et al. 2017). Nearly 80% of marine litter is assumed to be land-based and comes from a variety of sources (Figure 1;Jambeck et al. 2015)

Remote sensing techniques for marine plastics detection

Floating marine litter has traditionally been discoveredin temporal and spatial sampling surveys, with the primary methods being visual census for macroplastics and trawl sampling for microplastics. Although in-situ methodologies will always be required to provide reliable information about the study area, they require a great deal of human effort, take a long time, and are inadequate on a global scale. Remote sensing technologies have been widely employed to address theseconstraints by providing a spatiotemporal synoptic assessment that can enhance the accuracy of long-term and global marine litter mapping.Satellites, aircraft, and Unmanned Aerial Vehicles (UAVs), also known as drones, are examples of remote sensing platforms with passive and active onboard sensors that can target the Earth's surface (Lebreton et al. 2018; Jim; Martínez-Vicente et al. 2019).



Assessing Marine Plastic Debris from Space

Synthetic polymers (i.e., plastics) typically make up the majority of the unwanted solid waste that enters the ocean each year (Cole et al. 2011; Bergman et al. 2015). This is reflected in surveys of marine debris, which frequently identify plastic as the major component contributing 60 - 80 percent of overall marine debris due to fluctuating polymer chemical configurations in a variety of marine environments (Gregory and Ryan, 1997; Barnes et al. 2009; Erni-Cassola et al. 2019).The effects on marine life are determined by the amount and size of plastic debris present, as well as the system's vulnerability (Clark et al. 2016; Law, 2017). Plastic production, which has grown significantly over the last 70 years, from 1.7 million tonnes in 1950 to 322 million tonnes in 2015, is linked to marine plastic debris. Plastics Europe (Plastics Europe, 2016).According to Jambeck et al. (2015), between 4.8 -12.7 million metric tonnes of plastic waste entered the ocean from terrestrial sources in 2010, with rivers making a contribution between 1.15 -2.41 million tonnes of plastic waste (Lebreton et al. 2017).However, only about 269 thousand metric tonnes of those inputs are found floating at or near the ocean's surface.Passive NIR to SWIR methods have newly been used to validate the potential for specific detection of marine plastic debris. These methods, which are similar to the hyperspectral features of hydrocarbons (Horin et al. 2001; Kuhn et al. 2004; Scafutto et al. 2017), are already in use in waste management for optical sorting of plastics. At about 1215 and 1732 nm, the reflectance characteristics of marine plastic debris have been documented (Garaba and Dierssen, 2018).Passive optical radiometers can be characterised further based on their spectral resolution as pan-chromatic (high-resolution optical imaging techniques that capture signals in the visible spectrum), multi-spectral (up to 20 spectral bands), and hyper-spectral (more than 20 spectral bands about 5-10 nm width).

What are active and passive sensors?
Active sensors are: The active sensor type generates its own energy to illuminate objects before returning to the instrument to measure the scattered signals (Liu and Wu, 2001). Among them are (LiDAR) light detection and ranging and radar systems (Veenstra and Churnside, 2012).Synthetic aperture radars (SARs) are side-looking image processing radar sensors that transmit microwave signals proficient of capturing surface quality. They're common on aircraft and spacecraft. Synthetic aperture radar sensors operate in all weather conditions, and their signals can penetrate clouds, fog, and smoke. As a result, changes in surface roughness derived from radar data would provide additional information about the reflectivity of materials to passive systems (Liu and Wu, 2001).Active sensors, which have their own energy source, illuminate the features to be explored. The active sensor collects the energy reflected from the target feature. As a result, active sensors have the ability to record energy at any time of day or season, which is one of their most significant advantages. Flash photography, for example, is active Remote Sensing as appeared differently concerning accessible light photography, which would be passive.Active sensors are made in such a way that they can detect wavelengths that the sun does not provide in sufficient quantities on the Earth's surface, such as microwaves. In addition, the active sensors can be controlled while the way a target is exposed for sensing is illuminated. Synthetic aperture radar (SAR) and light detection and ranging are active sensors (LiDAR).

Passive sensors are: Passive sensor detects how much sun energy is reflected or emitted by objects and have previously been used to track marine litter. Thermal imagers, multispectral, hyperspectral cameras and video sensors, are one of them (Veenstra and Churnside, 2012).The current enticing set of potential plastic identification bands is located in the NIR (890–970 nm) and three in the SWIR (1160–1250 nm, 1360–1440 nm, and 1680–1760 nm). Maximum absorption of marine-harvested plastics has been found at 931 nm, 1215 nm, 1417 nm, and 1732 nm (Garaba and Dierssen, 2018; Garaba et al. 2018).Passive remote sensing systems, also known as passive sensors, measure freely available energy. Passive sensors can detect energy when all displayed or reemitted solar energy is accessible on the Earth's surface during the sun's lighting time.At night, the sun's rays are not reflected. Both day and night, however, it is possible to detect naturally emitted solar energy such as thermal IR. Landsat, IRS, SPOT, IKONOS, Quickbird, and other passive sensors are examples of passive sensors.

Conclusion and work priorities in the future
Microplastics as emerging contaminants have received a lot of attention in recent years. Microplastics, a contaminant of emerging concern (CEC), can severely harm the biological system, particularly aquatic ecosystems, and have the potential to hamper inland and marine fisheries activities, so they should be thoroughly assessed, especially considering the millions of people who rely on capture marine and inland fisheries.As a result, there is a pressing need to investigate the impact of plastic pollution on marine and inland aquatic ecosystems. To assess the distribution and impact of microplastics in natural environments, the abundance of microplastics must be determined.Though, the nature of microplastics (such as size, colour, surface properties, and so on), as well as environmental conditions, is incredibly complicated. As a consequence, in order to correctly identify and enumerate microplastics, it is critical to assemble and progression environmental samples in the correct manner (Potthoff et al. 2017).

The important works should be pursued in the future to gain a better understanding of microplastics' environmental fate:

(1) Further survey investigations are necessary to add to the database of microplastic pollution, as well as data on microplastic distribution and abundance.

(2) The current sampling and identification methods for microplastics must be standardized. Microplastics should be detected in-situ using effective and appropriate methods.

(3)Microplastics' impact on microalgae, the marine environmental producer, has yet to be adequately studied, and more research is needed at all levels, from population to genetic.

(4) Investigation of terrestrial pollution as a source of marine microplastics is insufficient, particularly for the wastewater treatment plants (WWTPs) mentioned previously. As a result, more research into the fate and passage of microplastics in WWTPs is required, as is the development of microplastics-targeted methods of treatment to decrease the quantity of microplastics discharged into the environment.

(5) The risk of microplastics and other contaminants being transferred from seafood products to humans, in addition to low trophic level organisms, should be carefully considered.

(6) In order to investigate the development of the microplastics–contaminants complex, the chemicals adsorbed on environmentally collected microplastics should be analysed.

(7) The adsorption-desorption mechanisms of various compounds on microplastics must also be investigated through systematic research.

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More references can be provided on request.

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