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Inside ...

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ICAR-CIBA study says India's top shrimp-producing state, Andhra Pradesh emerged as the epicentre of aquaculture-related economic distress caused by disease outbreaks

The importance of feed efficiency in aquaculture, noting that feed costs can account for up to 70% of production expenses. It explores how additives such as enzymes, probiotics, amino acids, antioxidants, lipids, and minerals can enhance growth, improve feed conversion, and support sustainability. The key takeaway is that incorporating these additives can lower costs, improve animal health, and promote more profitable, eco-friendly operations.

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

Andhra Pradesh, India's top shrimp-producing state, has emerged as the epicentre of aquaculture-related economic distress caused by disease outbreaks. A study by the ICAR-Central Institute of Brackishwater Aquaculture, Chennai conducted between 2021 and 2023 estimates the state suffers annual shrimp-related losses of about Rs 3,975 crore. Beyond monetary losses, the state also records the country's highest productivity drop per metric tonne / hectare / crop. Average productivity losses reach 4.69 mt / ha / crop for EHP and 4.5 mt / ha / crop for WSSV, well above the national averages of 1.8 and 2.58 mt / ha / crop, respectively. Combined infections of EHP and WSSV further exacerbate losses for farmers in Andhra Pradesh with affected farms averaging 4 mt / ha / crop, compared to Tamil Nadu's 3.43 mt / ha / crop and Gujarat's 2 mt / ha / crop.

To combat the recurring threat of disease outbreaks in shrimp farming, the state has designated State Institute of Fisheries Technology (SIFT), Kakinada, as its nodal agency. SIFT undertakes periodic sample collection across all districts and reports disease incidence to ICAR-NBFGR. Complementing this initiative, the state has established 35 labs to routinely test water, soil and shrimp samples. Field-level fisheries officers also conduct regular inspections of shrimp ponds, identify clinical signs of infection and recommend immediate remedial measures.

Unremunerative prices and weak demand in the export market for brown shrimp have raised concerns among mechanised boat operators in Andhra Pradesh. In 2021, brown prawns fetched Rs 450 per kg, but the price has since dropped to 400.

The Aquaculture sector is suffocating the price has fallen day by day for ten months. Further fall on the pretext of recent US import duty hike. Discount of Rs 20 to Rs 40 per 20-50 count kg. The price of 50-100 count which is not exported to America is also over. Buying companies lowering rates. Export of fishery products worth Rs 60,000 crores in 2023-24. Aquaculture sector will be in crisis if current situation continues.

In a desperate attempt to recover from severe losses in shrimp farming, thousands of aqua farmers across Andhra Pradesh turned to murrel (snakehead) fish cultivation, hoping it would be a profitable alternative. However, this shift has now led to another crisis, as a steep fall in market prices has left many farmers in financial distress. Encouraged by the high retail prices of murrel—once reaching Rs 700 per kg—farmers across the coastal belt, especially in the Godavari districts, invested heavily in murrel fish cultivation.

Strengthening the aquaculture ecosystem in Andhra Pradesh demands active private sector participation and innovation," said B. Rajasekhar, special chief secretary, AHDD & Fisheries department, at a national conference on fisheries and aquaculture organised by CII-FACE in Vijayawada. In his keynote address, Rajasekhar

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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emphasised that private sector-led investments in technology, infrastructure and value chain integration are crucial to overcome bottlenecks, expand capacity and connect farmers to the markets. We must encourage innovation, reduce inefficiencies and build forward linkages if we are to scale up the sector sustainably. Themed "Fostering sustainable growth & competitiveness in fisheries and aquaculture," the conference brought together industry leaders, govt officials, and development organisations. Discussions centred on growth strategies, conservation, and innovations in marine, brackish water and inland fisheries. Rama Shankar Naik, Commissioner of Fisheries, highlighted the state's efforts to modernise cold chains and logistics. "Our policy framework welcomes long-term private investment," he noted. Dr S Kannappan of NFDB reiterated the importance of aligning state efforts with the national vision of Viksit Bharat@2047.

Efforts to secure organic territory status for Lakshadweep and promotion of seaweeds, vegetables and fruit cultivation were instrumental for the recognition. Lakshadweep Krishi Vigyan Kendra (KVK) of ICAR-Central Marine Fisheries Research Institute has won the Best KVK-National Award by the National Academy of Agricultural Sciences (NAAS), New Delhi Dhanuka for excellence in agricultural extension.

The severity of the retaliatory tariffs imposed by the US has directly affected the aquatic sector in the state. Diseases are already prevalent in shrimps. Trump's latest restrictions on shrimp farmers, who are struggling due to the burden of cultivation costs, have turned into a storm. The 27% tariff imposed by the US government on Indian seafood exports will come into effect from the 9th of this month. However, within hours of the tariff announcement, the price of shrimp started to fall. The stakeholders of the aquaculture sector are expressing concern that if the central and state governments do not intervene, the seafood export industry will fall into crisis.

The government will bring enabling framework for sustaining harvest of fisheries sector in exclusive economic zones and high seas **Telangana's Blue Revolution** sets new milestones in inland fisheries. The previous BRS government's strategic interventions included the free distribution of fishlings and shrimp worth Rs 436.81 crore and Rs 85.02 crore respectively over 10 years period between 2014-15 and 2023-24.

The 3-day Chennai Seafood Show organized by the TNFDC, **Fisheries Department, Government of Tamil Nadu** in the first week of June 2025 was a big success to promote consumption of seafood products with large number of public visited the event.

Shrimp Improvement Systems (SIS) has announced its plans to get 75 % broodstock market share in India and support farmers technically to get success in shrimp farming.

If licensing system is made effective by the Government for feed supplements manufacturing, the problem will be solved, and the manufacturers will have fear when licencing system is there and government department should strictly implement it, said Mr Poornachander Rao, Managing Director, Padmaja Laboratories Pvt Ltd. There is a need of unity among manufacturer which is not happening due to competition in supply of healthcare products to the customers, and maintain business ethics, and everybody should follow it

In the Articles section, article titled **"Selection for salinity tolerance in an SPF P. vannamei balance genetic line"**, authored by Ms Natthinee, Mr Chotitat and Mr Craig says that the global shrimp industry is evolving rapidly with farming operations expanding from traditional coastal ponds to inland, brackish and even freshwater environments. Penaeus vannamei, a euryhaline species is well known for its ability to grow across a wide salinity range, from near-freshwater conditions to highly saline, arid regions exceeding 50 ppt.

Another article titled, **"UNCLOS and Global Fisheries"**, authored by Mr Mahesh Shetkar, says that United Nations Convention on the Law of the Sea (UNCLOS) as a comprehensive framework for addressing ethical and legal challenges in fisheries management. UNCLOS establishes crucial maritime zones from territorial waters to exclusive economic zones and the high seas each with specific implications for fisheries management and resource conservation.

Another article titled, **"Role of Feed Additives in Increasing Feed Efficiency in Aquaculture"**, authored by Mr K. Naveen Kumar says that the importance of feed efficiency in aquaculture, noting that feed costs can account for up to 70% of production expenses. It explores how additives such as enzymes, probiotics, amino acids, antioxidants, lipids, and minerals can enhance growth, improve feed conversion, and support sustainability. The key takeaway is that incorporating these additives can lower costs, improve animal health, and promote more profitable, eco-friendly operations.

Another article titled, **"Impact of Climate Change in Fisheries Sector"**, authored by Ms K. N. Krishnaveni, says that the climate change refers to long-term shifts in average weather patterns, primarily driven by human activities like burning fossil fuels. These changes include rising global temperatures, altered precipitation patterns, and more frequent extreme weather events. Climate change significantly impacts aquaculture through various channels, including shifts in water temperature, ocean acidification, changes in rainfall, and increased frequency and intensity of extreme weather events.

Another article titled, **"Harmful Algal Blooms Along the Indian Coast"**, authored by Ms V. Suryapraba says that the harmful algal blooms (HABs) threaten marine biodiversity, human health, and the economy along the Indian coast. Excess nitrogen and phosphorus from fertilizers and sewage fuel HAB growth. Notable HAB events include *Noctiluca scintillans* blooms in Goa (2016) and *Cochlodinium polykrikoides* fish kills in Kerala and Tamil Nadu. INCOIS monitors HABs using remote sensing and field sampling, providing regular advisories.

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

M.A.Nazeer
Editor & Publisher
Aqua International

Uni-President

AQUACULTURE PROBIOTICS EXPERT

Nu Ri

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Probiotics for water treatment

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* STORAGE:

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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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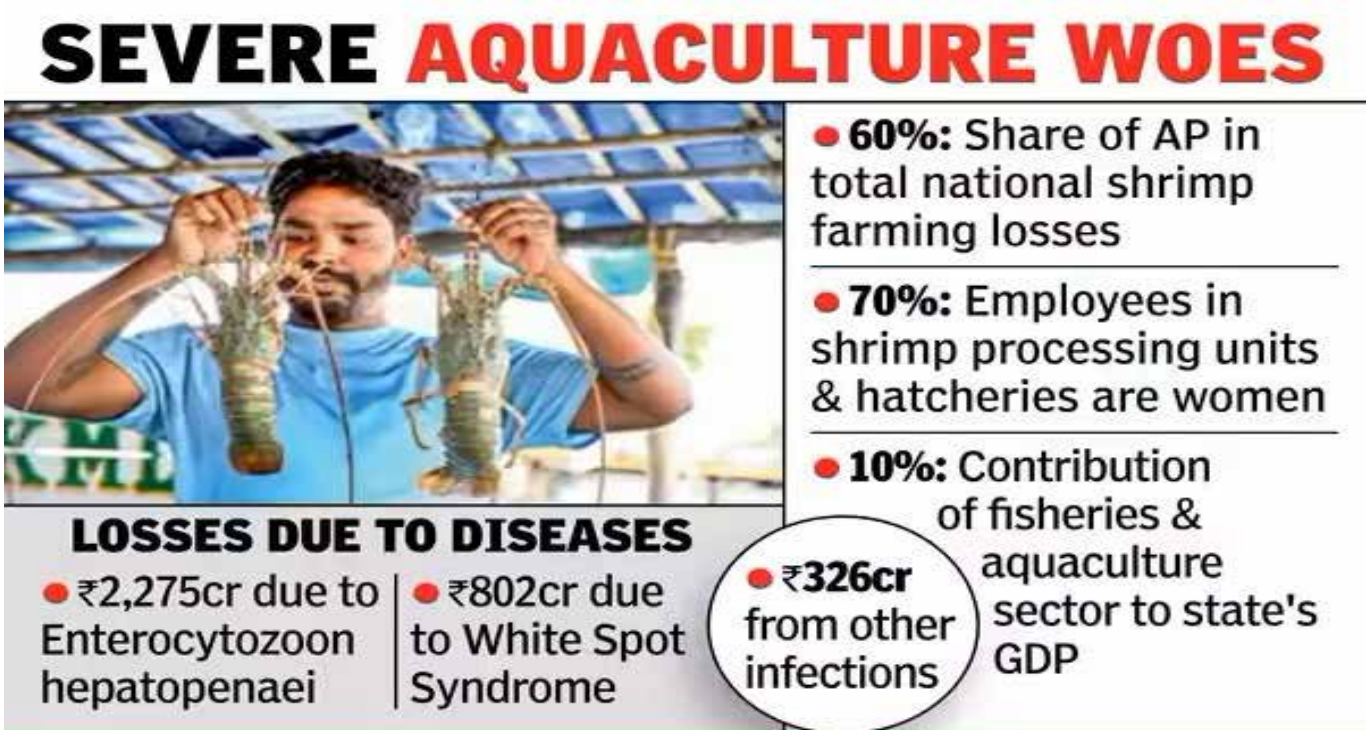
'Facing diseases year after year':

Andhra Pradesh faces aquaculture crisis as shrimp diseases trigger Rs 4000 crore annual loss; suffers massive yield declines



Visakhapatnam: Andhra Pradesh, India's top shrimp-producing state, has emerged as the epicentre of aquaculture-related economic distress caused by disease outbreaks. A study by the ICAR-Central Institute of Brackishwater Aquaculture (Chennai) conducted between 2021 and 2023 estimates the state suffers annual shrimp-related losses of about 3,975 crore. Beyond monetary losses, the state also records the country's highest productivity drop per metric tonne/hectare/crop. Average productivity losses reach 4.69 mt/ha/crop for EHP and 4.5 mt/ha/crop for WSSV, well above the national averages of 1.8 and 2.58 mt/ha/crop, respectively. Combined infections of EHP and WSSV further exacerbate losses for farmers in Andhra Pradesh, with affected farms averaging 4 mt/ha/crop, compared to Tamil Nadu's 3.43 mt/ha/crop and Gujarat's 2 mt/ha/crop.

Although WSSV has a higher national probability of occurrence (25%), EHP leads to greater economic losses in the state, primarily due to Andhra Pradesh's unusually high probability of disease occurrence (PDO) of 22% for EHP - almost three times its 8% PDO for WSSV. Farmers and fisheries officials note that the persistence of EHP is compounded by its ability to remain latent in pond sediment and its resistance to commonly used disinfectants, making eradication especially difficult in traditional grow-out systems. M Satyanarayana Raju, an aqua farmer from East Godavari, said that shrimp farmers are grappling with relentless disease pressures. "We are facing these diseases year after year., he said. Even when we follow recommended protocols, the parasites come back sometimes stronger. Most of us don't even know if it's EHP or white spot until it is too late. By then, the ponds are already wiped out".

Economic losses from EHP and WSSV were studied in detail across the country by ICAR-Central Institute of Brackishwater Aquaculture, Chennai, as part of the study. Though WSSV was previously considered the most lethal infection in shrimp farming, the analysis revealed annual national losses due to EHP amounted to 0.77 million tonnes (Rs 3,977 crore), while losses attributed to WSSV were limited to 0.33 million tonnes (Rs 1,670 crore). This disparity may stem from farmers' improved biosecurity practices and the greater difficulty in preventing and treating EHP outbreaks.

To combat the recurring threat of disease outbreaks in shrimp farming, the state has designated State Institute of Fisheries Technology (SIFT), Kakinada, as its nodal agency. SIFT undertakes periodic sample collection across all districts and reports disease incidence to ICAR-NBFGR. Complementing this initiative, the state has established 35 labs to routinely test water, soil and shrimp samples. Field-level fisheries officers also conduct regular inspections of shrimps ponds, identify clinical signs of infection and recommend immediate remedial measures.

Slump in marine brown shrimp price hits boat operators hard

Exporters shift Focus to farmed Vannamei Prawn

Visakhapatnam: Unremunerative prices and weak demand in the export market for brown shrimp have raised concerns among mechanised boat operators in Andhra Pradesh. In 2021, brown prawns fetched 450 per kg, but the price has since dropped to 400. Many fishing crews embarking on their first short voyages of the season — lasting six to 10 days — are returning with sizable catches of brown shrimp, while some manage to trap a smaller quantity of tiger shrimp. Fisherfolk report hauls of 200–250 kg of brown shrimp and 10–20 kg of tiger shrimp per boat. However, operators argue that current prices for brown shrimp remain unviable. Although the price improved slightly in 2025 from 360 in 2024 to 400 per kg, most boat operators and fishermen remain dissatisfied, according to Surada Satyanarayana, general secretary of the Visakha Dolphin Boat Operators Welfare Association. A decade ago, over 20 exporters actively procured brown shrimp for export. Today, that number has dwindled to just three or four, citing weak demand and a growing preference for farmed vannamei (whiteleg) shrimp. Exporters have fixed prices at 400 per kg for brown shrimp and 1,200 per kg for tiger shrimp. "If we get at least 500 per kg for brown shrimp, boat operators can survive," said Surada Satyanarayana, general secretary of the Visakha Dolphin Boat Operators Welfare Association. Andhra Pradesh is home to over 2,500 mechanized fishing boats spread across Vizag, Kakinada, Machilipatnam, Vadarevu, Kalingapatnam, and other coastal hubs. For each 12 to 15-day voyage, boat owners invest 4 to 6 lakh — mostly on diesel, groceries, ice, and other essentials. Around 70% of these vessels target shrimp during the crucial June to September window. Exporters are increasingly shifting focus to farmed vannamei shrimp, which offer uniform size, higher availability, and tender flesh. "Though brown shrimp are tastier and richer in minerals, the export demand favours vannamei," said P Lakshmana Rao, joint director of fisheries, Visakhapatnam.

Murrel fish farming fails to rescue aqua farmers after shrimp losses

Vijayawada: In a desperate attempt to recover from severe losses in shrimp farming, thousands of aqua farmers across Andhra Pradesh turned to murrel (snakehead) fish cultivation, hoping it would be a profitable alternative. However, this shift has now led to another crisis, as a steep fall in market prices has left many farmers in financial distress. Encouraged by the high retail prices of murrel—once reaching 700 per kg—farmers across the coastal belt, especially in the Godavari districts, invested heavily in murrel fish cultivation. Known for its minimal bones and rich taste, murrel gained popularity among consumers. But as cultivation expanded, supply soon outpaced demand, crashing prices. In Jan 2023, murrel fetched 650 per kg. By mid-2025, it dropped to around 300 per kg, causing widespread concern. Aqua farmer Bandaru Trinath Babu from Akividu shared, "We stopped shrimp farming after suffering major losses. Murrel seemed promising, but it takes eight months to grow and costs nearly 180 per kg. With the prices falling so low, we fear we won't recover our investment." According to the national fisheries development board, AP leads the country in aquaculture, with over 2.12 lakh hectares under cultivation. Vannamei shrimp, once dominant, declined after a viral outbreak in 2018, prompting farmers to explore options like murrel and seabass. Despite the initial hype around murrel's profitability, farmers are now wary. Many consumers, too, are sceptical. Some claim that farmed murrel lacks the rich flavour of wild varieties, and concerns about excessive pesticide use have dampened enthusiasm.

Private sector urged to help strengthen aquaculture

Vijayawada: Strengthening the aquaculture ecosystem in Andhra Pradesh demands active private sector participation and innovation," said B Rajasekhar, special chief secretary, AHDD & fisheries department, at a national conference on fisheries and aquaculture organised by CII-FACE in Vijayawada.

In his keynote address, Rajasekhar emphasised that private sector-led investments in technology, infrastructure, and value chain integration are crucial to overcome bottlenecks, expand capacity, and connect farmers to markets. "We must encourage innovation, reduce inefficiencies, and build forward linkages if we are to scale up the sector sustainably," he added.

Themed "Fostering sustainable growth & competitiveness in fisheries and aquaculture," the conference brought together industry leaders, govt officials, and development organisations. Discussions centred on growth strategies, conservation, and innovations in marine, brackish water, and inland fisheries.

Rama Shankar Naik, commissioner of fisheries, highlighted the state's efforts to modernise cold chains and logistics. "Our policy framework welcomes long-term private investment," he noted. Dr S Kannappan of NFDB reiterated the importance of aligning state efforts with the national vision of Viksit Bharat@2047.

CMFRI's Lakshadweep KVK selected as National Best for excellence in agri extension

Efforts to secure organic territory status for Lakshadweep and promotion of seaweeds, vegetables and fruit cultivation were instrumental for the recognition

Kochi: Lakshadweep Krishi Vigyan Kendra (KVK) of ICAR-Central Marine Fisheries Research Institute (CMFRI has won the Best KVK-National Award by the National Academy of Agricultural Sciences (NAAS), New Delhi Dhanuka for excellence in agricultural extension.

Among a range of works for the development of agriculture and allied sectors in the region, the KVK's pioneering efforts that led to declaring Lakshadweep organic territory were pivotal in securing this national recognition. The Kendra was instrumental in registering an impressive 7591 active farmers across 10 islands of Lakshadweep adopting organic farming practices. Following such initiatives with the support of Department of Agriculture, UT Administration of Lakshadweep, the archipelago was declared as the fully organic territory by the Union Government in 2021.

Seaweed promotion

Promotion of seaweed cultivation across different islands through popularisation of CMFRI's indigenous technology in the area also played a crucial role for winning the achievement.

A slew of extension activities in the area of coconut development, fisheries and aquaculture, under the leadership of Dr P N Ananth, Principal Scientist and Head of KVK-Lakshadweep were critical in uplifting the living standard of the Islanders, thereby contributing substantially to bagging this award. Through extensive skill development programmes, Lakshadweep KVK's 'Friends of Coconut' initiative created employment opportunities for 100 rural individuals.

Establishment of marine ornamental fish hatchery at Kavaratti helped fostering sustainable aquaculture in the region and providing new livelihood avenues. Efforts for wide-spread adoption of CMFRI's cage culture technology were critical in diversifying livelihood options among the fishing community. Vegetable and fruit cultivation were promoted covering about 2000 households every year with the support of CMFRI's Tribal Sub Plan scheme.

KVK introduced Barn Owls as a biological control method to combat rodent damage, which accounts for 40-50% yield loss in coconuts across the islands. The Kendra also set up an Automatic Weather Station (AWS) at Kavaratti, offering crucial meteorological data to farmers and contributing to more informed agricultural planning and disaster preparedness. Several flagship programmes are underway in tandem with the Department of Agriculture.

Shrimp Outcry

Immediate impact on exports from Andhra Pradesh

Price collapse that has already begun

40% of products from the country go to America.

The industry will lose more than Rs 600 crores

Awaiting for Central Government intervention

The severity of the retaliatory tariffs imposed by the US has directly affected the aquatic sector in the state. Diseases are already prevalent in shrimps. Trump's latest restrictions on shrimp farmers, who are struggling due to the burden of cultivation costs, have turned into a storm. The 27% tariff imposed by the US government on Indian seafood exports will come into effect from the 9th of this month. However, within hours of the tariff announcement, the price of shrimp started to fall. The stakeholders of the aqua sector are expressing concern that if the central and state governments do not intervene, the seafood export industry will fall into crisis. Andhra Pradesh is the leader in exports in the country. This sector is boosting the economy of the state. The share of shrimp industry in GSDP is 11 percent. However, the sector is mainly dependent on exports. 4.88 billion worth of shrimp exports from India in 2023-24. It is more than 66% of the total exports. The largest market for Indian shrimp is the United States of America, where more than 40% of shrimp are exported to the US from India. Now 27% on Indian marine products. Due to the imposition of tariff, our shrimp is not competitive in the US market.

Forget the market

The impact of US tariffs is not limited to shrimp exports to the UN. Secondary export routes will also be severely affected. 35 percent of the shrimp products are going from our country to China and Vietnam, which are second only to America. In turn, these two countries export most of their shrimp imports to the US. It is noteworthy that he is paying attention. However, Trump recently imposed tariffs of more than 30% on exports from China to the US. This will reduce our orders from those countries. Immediate intervention of central and state governments is imperative to avert this crisis. If the existing countervailing duty (CVD) of 5.76% and anti-dumping duties of between 1.35% and 3% are included, the duty burden could be as high as 33-35%. The Trump administration has imposed a mere 16% tariff on countries like Ecuador that export shrimp to her Rica. So in the future experts predict that Ecuador is in danger of becoming our main competitor. Immediately affected are shrimp products already in transit. About Rs 2,000 containers worth Rs 2,000 crores will now have to bear an additional cost of Rs 600 crores.

The Central government is the direction

During covid the government ran processing units promoting shrimp exports. But since the current crisis, no alternative markets have been seen. Prawn industry is giving impetus to employment in Andhra Pradesh. There are more than 450 shrimp hatcheries, more than 50 feed mills, more than 2,00,000 shrimp ponds, more than 250 processing plants, more than 6,000 boats and ships in the state and thousands of people are getting their livelihood. 70% of the annual production comes between April and September every year. But shrimp is a perishable product. There are no adequate cooling facilities to store irrigation water for some time due to tariffs. Due to this, processing will be difficult and lakhs of people will lose their jobs. In this context, the Aqua Partners are appealing to the Central Government to take immediate action.

Government will bring enabling framework for sustaining harvest of fisheries sector in exclusive economic zones and high seas

Telangana's Blue Revolution sets new milestones in inland fisheries

The previous BRS government's strategic interventions included the free distribution of fishlings and shrimp worth Rs 436.81 crore and Rs 85.02 crore respectively over 10 years period between 2014-15 and 2023-24.

Opinion: From pond to prosperity

Turning fish waste into fertilizer will enhance efforts to protect the environment and financially empower fisherfolk.

NCDC gives in-principle nod for TS Fisheries Development Scheme Phase II

TSFF chairman Mr Pittala Ravinder and vice-chairman Mr Diti Mallaiah called on NCDC executive director Mr Ashok Pillai and deputy director Mr Patil Nilesh Suresh at the NCDC headquarters in Delhi on Thursday.

1.94 cr fish seed to be released in water bodies in Warangal dist

Fisheries officials will release a total of 1.94 crore fishlings in the water bodies in the district during the current financial year.

Fisheries body to introduce hybrid boats for fishermen: Mr Pittala Ravinder

Federation chairman Mr Pittala Ravinder on Saturday held a discussion with the experts of BITS Pilani, Hyderabad

to understand the advantages of usage of hybrid fishing boats.

Telangana: New chief nominated for Fisheries Federation

Mr Pittala Ravinder nominated as chief of Fisheries Federation

Fisheries welfare is priority for centre: Union Minister

The Centre was also planning to encourage inland aquaculture as it proved a huge success.

'TS Govt to release 68 crore fish seedlings, 10 crore shrimp into water bodies'

Hyderabad: About 68 crore fish seedlings and 10 crore shrimp will be released into more than 27,000 water bodies in the State commencing from next month. Fisheries Minister Mr Talasani Srinivas Yadav said about Rs 113 crore will be spent for the purpose which will be beneficial to fishermen in the State. During a video conference.

Telangana bags fisheries award

Hyderabad: Telangana bagged the best award in freshwater fish production. Union Minister for Fisheries Mr Parshottam Rupala presented the award to State Animal Husbandry Secretary Ms Anita Rajendran and Fisheries Commissioner Mr Latchiram Bhukya received the award at a programme organised by National Fisheries Development Board in Bhubaneswar on Sunday on the occasion of World Fisheries Day.

Telangana rides blue revolution

Hyderabad: After ushering in the green revolution post Statehood, Telangana is now riding the wave of blue revolution with the State surging ahead in fisheries, thanks to several key interventions by the government to strengthen production factors including stabilising Water Spread Area (WSA), free fingerling stocking and welfare schemes for the fisher folk. Not only have

Telangana scripts success story in fisheries

Hyderabad: Telangana success story in fisheries came about following various measures taken by the State government. Subsequently, the seed stocking activity rose by 350 per cent from 3,939 water bodies in 2016-17 to 17,684 water bodies in 2020-21. In the initial years, the focus was on large water bodies with stable WSA and then as [...]

PM Narendra Modi assures 'FAST' development of Kerala

"The time has come for FAST development in Kerala- F for fisheries and fertilisers, A for agriculture and Ayurveda, S for skill development and social justice and T for tourism and technology," PM Modi said

More fishermen societies on cards, says Andole MLA

Fisheries Department had planned to release 30 lakh shrimp fishlings into Singur and seven lakh seedlings were released on Wednesday

Sustainable Prawn Aquaculture Driving Growth in Rural India and Initiatives by USSEC

It was a great opportunity for me to attend the 3-day Chennai Seafood Show organized by the TNFDC, Fisheries Department, Government of Tamil Nadu. My session titled 'Sustainable Prawn Aquaculture Driving Growth in Rural India and Initiatives by USSEC' and my participation in the panel discussion provided me the opportunity to present USSoy's work in the region. This platform gave me the chance to learn and share the success stories of U.S. Soybean farmers through their adoption of technologies, commitment, and sustainable practices. Participants were also eager to learn about USSEC's Right to Protein initiative, and they had positive interactions with our on-ground team regarding the Protein-O-Meter. Domestic marketing of prawns in India is gaining momentum, and the efforts by the Government of Tamil Nadu have come at the right time to promote this through sincere initiatives like the Chennai Seafood Show. The involvement of senior officials was highly commendable, and the contributions from AISHA and the Shrimp Farmers Associations were notable.

Turnout was extremely high, and the expert

handling of the event made it smooth and successful. Hats off to the organizers for the wonderful arrangements, and special thanks for recognizing USSEC South Asia at this great event.

By
Chandrasekar,
Head Aquaculture Utilization South Asia, USSEC

District Shrimp Farmers facing on the issues

In the district Shrimp Farmers facing on the issues 2018V year from Shrimp Farmers Community Brightness District Convening Committee under the auspices of Shrimp Farmers unity done many fights drive problems solution for effort doing it happened.

2023 December 19V on the date Ongole in National, State Shrimp Farmers Community Presidents both of them in the presence of District General Assembly Celebrate Community District President, Chief Secretaries as Mr D. Gopinad, Mr K. Subba Reddy and another 10 with people district the committee arrangement having done In the district Shrimp Farmers facing every on the problem power to the extent working It happened.

1. In 2023, 13,50,000 shrimp fry were given free of cost to farmers who suffered losses due to Mono Tiger Seed.
2. CAA officials were invited to the district and within a week, licenses were renewed for the entire district and new licenses were issued to farmers.
3. 2023 in the district processing plants they syndicate yes farmers at original Shrimp purchase undone. In case National, State Leaders in collaboration in the state important Exporters to Ongole Invited 1000 people Shrimp With farmers Conference after on exporters pressure bring district total our district farmers at from Shrimp purchase to make it happened.
4. 2024 Nasal type Mono Tiger Shrimp children because of lost for farmers our Community fight by Hatchery owner on top pressure bring for farmers seed Re place to do persuasion happened (March 25 from for farmers Mono Tiger seed supply to do while some people Hatchery to the owner phone by complaint doing because of for farmers to be given seed stopped, with them currently community. In the beginning consultation we are celebrating, coming soon for farmers seed (can be given)
5. Madagascar Tiger seed Nu PCR Quality Certification with for farmers giving in a way District Collector Gary by un buy them persuasion it happened.
6. In the year 2023, when most of the farmers in the district were ineligible for electricity subsidy for various reasons, our association put pressure on the Fisheries Department officials and MLAs at the district and state levels and simultaneously registered 980 farmers in the subsidy eligibility list.
7. A proposal has been made by the Petty Irrigation and Fisheries Departments to open the creek sluices to allow the sea tide water to flow properly into the creeks.

On top problems apart from in the district and more Shrimp Farmers in cultivation facing many personal problems district authority in collaboration solution done for them support standing It happened.

Currently Exporters Syndicate as formed Shrimp Prices Reduce purchase doing this Loot future in and more It will be, we unitedly alertly should be.

Soy prices kg for Rs.100 increased 2 years ago feed prices raised, currently High Protein Soy prices for Rs.36 decrease feed prices kg to Rs.25 to decrease. If feed companies they as a pledge MRP on top Rs. 4s only reduced.

This under the circumstances Shrimp Farmers and more United National, state at the level big Height Fight to do need whatever there is.

Farmers Unity Yes their Problems Solution to do unwilling some people Processing Plants they, feed Companies, Tiger Seed Hatchery they stay back. Their Business Partners by some people on farmer's pressure bring our Shrimp Unity to tear apart competition. The community arrangement to make effort doing.

This under the circumstances brightness in the district very years later Unity Yes Organized who Shrimp Farmers without splitting Unity and more prestige done future. In coming our Shrimp Farmers problems jointly solution let's do it that we inform you.

Processing Plants, Tiger Hacharya Conspiracies Shrimp Farmers Unity Yes to repel we are asking.

They our Shrimp Farmers how many in various ways Rivets done Robbery to do seen, to do tried our Shrimp Farmers Community Shrimp Farmers unity done now until how? However fights by turned did we hit? Future in also their conspiracies repelling we will work. we inform you.

Aquaculture sector is suffocating

The price has fallen day by day for ten months

- Further fall on the pretext of recent US import duty hike
- Discount of Rs 20 to Rs 40 per 20-50 count kg
- The price of 50-100 count which is not exported to America is also over
- Buying companies lowering rates
- Export of fishery products worth Rs 60,000 crores in 2023-24
- 35 percent to America, 19 percent to China.
- 20,000 crore products in America alone
- Aqua sector in crisis if current situation continues

The same price was maintained for at least 15 days irrespective of the international market prices. Once the price was fixed there was no possibility of going down except for increase within 15 days. But in the last ten months, when the farmers are complaining that they cannot tell when the price will be, like a palm nut fell on a barking fox, the increase in tariffs on food products imported from India by the Trump administration in America is shaking the aqua sector in the state. The aqua farmers are worried that the companies that buy shrimps on the pretext of US tax have become syndicates.

The shrimp buying center has become deserted in Amalapuram

35 percent exports to America

At the national level, in 2023-24, 84 crore tonnes of fishery products were recorded, while Andhra Pradesh with a production of 51.58 lakh tonnes. First position in the country. Andhra Pradesh accounts for 76 percent of nationally produced shrimp and 28 percent of fish. Aqua sector accounts for 9.15 percent of the gross income of agricultural allied sectors in 2023-24, 17.82 lakh tonnes worth Rs 60,000 crores will be exported from the country, of which almost 35 percent (Rs 20,000 crores) of products were exported to America alone. After that 19 percent are exported to China. On the other hand, one-third of the fish products exported at the national level are from Andhra Pradesh. If the yield of prawns in Andhra Pradesh is 10 lakh tonnes, 3.27 lakh tonnes (2023-24) are being exported to America.

Suspension of purchases of 20-50 count prawns

On the pretext of raising American tariffs, some companies have turned into syndicates and are committing exploitation, but those who care or the farmers are making noise.

Area of Aqua Cultivation in Andhra Pradesh - 5.75 lakh acres

Yields are 10 lakh tonnes

Prawn Cultivation Farmers 1.5 lakhs

Companies that buy shrimp 25

Prawn traders 100-150

Exports to America count 20-50

Exports are 2.5-3.27 lakh tonnes

In just two days, they reduced it from Rs 20 to Rs 40 per count. On the other hand, they have stopped buying 20-50 count (shrimps per kg) shrimp exported to the US. Some companies have become syndicates and are open to exploitation, while others are splitting up incorrect, they suggest that the prices fixed on the 1st of this month should be continued for the next ten days. Moreover, it suggests that buyers in America should bear the burden of this import duty. Farmers are worried that if the domestic prices are reduced, the aqua farmers will go into further crisis.

Farmers' resentment of companies

The companies are reducing the prices of shrimps rapidly after the change in the American tax policy. Nine months ago in the name of green revolution, although the taxes on the products added to the shrimp feed were greatly reduced, not even a single rupee has been reduced domestically. Aqua farmers are questioning this matter. Five years ago, when the rate of soya was Rs 85 per kg, the price of fodder was increased to Rs 15,000 per ton. But even though the same price of soya is available at Rs 23 per kg today, the cost of fodder has not gone down even a paise. Only 20-50 counts of shrimp are exported to the US. In such a case, it is questioned how reasonable it is to reduce the prices by 50-100 count.

Count	Prev yr price	Price as on April 1	Friday Rate
100	280	240	220
90	290	250	230
80	310	270	250
70	350	300	280
60	360	330	---
50	390	360	---
40	420	375	---
30	490	450	---
25	520	440	---
20	620	540	---

The Aqua sector is suffocating

The decision taken by the US to increase the excise duty on food products imported from India is shaking the aqua sector in Andhra Pradesh. Aqua farmers are worried about the US decision as the prices are already falling day by day.

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ANTIBIOTICS	✗✗✗

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ONE HEALTH APPROACH

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- ***Vibrio alginolyticus***
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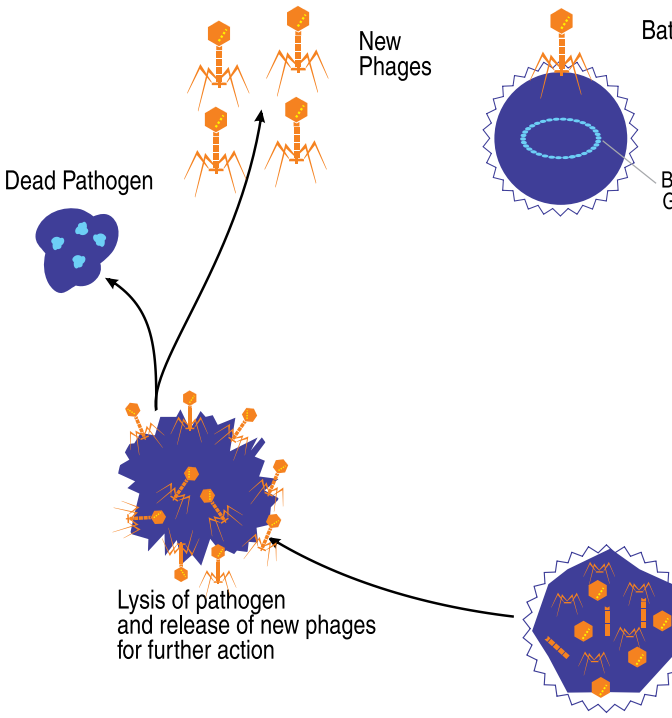
ILLUSTRATION OF ACTION OF PHA



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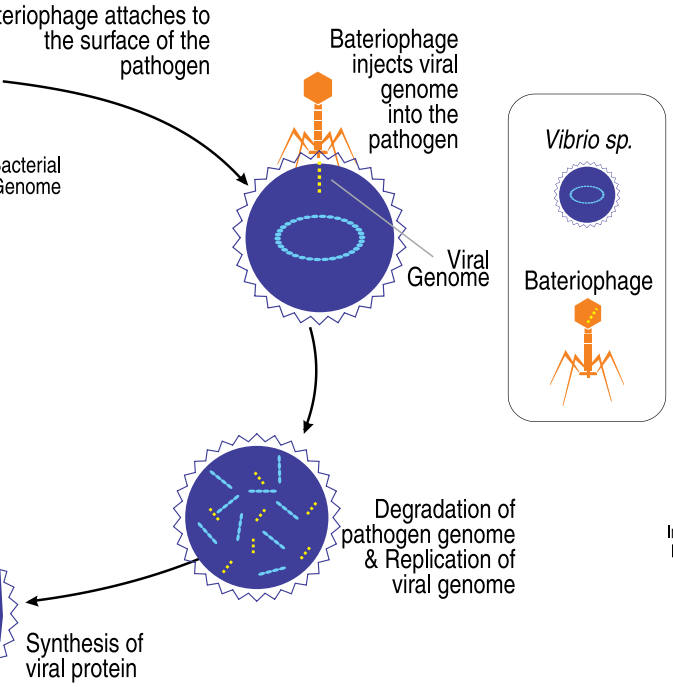

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- Prevents sudden crop loss and extends Life of Pond during critical profit-making period.
- Enhances Probiotic performance.

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

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SIS plans to get 75% broodstock market share in India and support farmers technically to get success in farming

M. A. Nazeer, Editor, Aqua International, had an interview with Mr Nanang Hindarto, Technical Head, Mr Siva Prasad, Sales Manager and Dr Rushi R.K., Technical Manager, Shrimp Improvement Systems. Excerpts:

Nanang Hindarto
Technical Head,
Shrimp Improvement Systems

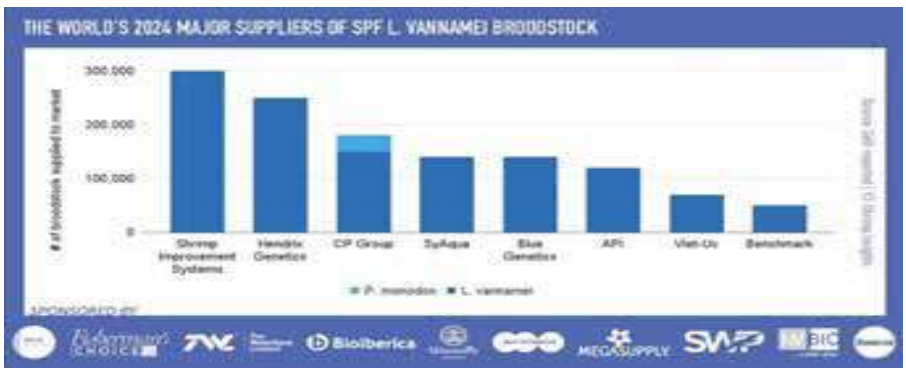
Mr Nanang Hindarto and Mr Siva Prasad, please tell us about yourself, academic background, career in aquaculture sector etc.

Nanang Hindarto, from Indonesia. Graduated from Marine Science of Diponegoro University, Indonesia in 2001. I have been in this industry for more than 20 years. My career in aquaculture started in 2002 when I joined CP Indonesia as a shrimp feed researcher. Then I moved to Singapore and was in charge of SIS BMC in 2009 until it was closed in 2019. Then from 2019, I have been managing the SIS technical teams that are distributed in our customers' countries, such as India, Vietnam, China and Indonesia.

Siva Prasad Mallipudi, a postgraduate in Coastal Aquaculture and Marine Biotechnology from Andhra University in 1996, spent 19 years in the aquatic feed marketing sector at CPF/Cargill/CP Prima. Joined SIS in 2018 as the Sales and Marketing Head for the South Asia market.

Dr. Rushinadha Rao Kakara, completed Ph.D entitled "*Biochemical, Heavy metal and Fatty acid profiling studies on some selected deep-sea fishes along the continental slope (200-1200 m depth) of Indian Exclusive Economic Zone*" at the age of 29 years from ICAR-CIFT (Indian Council of Agri cultural Research – Central Institute of Fisheries Technology). Since 2017, I am working in Aqua Industry. I am working in SIS (Shrimp Improvement Systems), Singapore since 1st January 2020 as Technical Manager and representing for Indian market for

Siva Prasad
Sales Manager,
Shrimp Improvement Systems



Source from Shrimp Insights

Dr Rushi R.K.
Technical Manager,
Shrimp Improvement Systems

Shrimp Broodstock sales & technical service in hatcheries and farms until harvest the pond. I am having several publications national & international and also work as reviewer for many SCI Journals.

Who are the promoters and owners of Shrimp Improvement Systems ? When was the company started ? What is the nature of its business activity? Where is the headquarters and production facilities of SIS ?

Shrimp Improvement Systems (SIS), founded by Dr Edward Scura in 1998, is a global leader in genetic improvement and Specific Pathogen Free (SPF) Pacific white shrimp broodstock production. With a Nucleus Breeding Centre (NBC) in Florida and Broodstock Multiplication Centres (BMCs) in Florida and Hawaii, SIS also operates a shrimp hatchery in India.

Do you have R & D facilities ? If so give its details in brief, what is the size of your investment in R&D ? How are the results of R&D ?

Yes, we have. Our Florida-based R&D facility led by Dr Harris Wright, features a cutting-edge disease lab, Miami Disease Lab, where we rigorously test our shrimp products against various pathogens and

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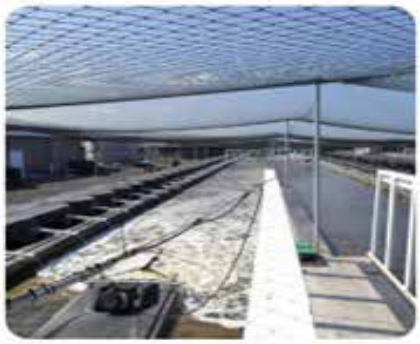

Production and R&D facilities

environmental stressors. Our R&D team conducts genetic selection based on various traits, developing shrimp breeds that thrive in different weather conditions, farming systems, and disease challenges, ultimately enhancing performance, resilience, and sustainability for farmers. We also partner with CP-Prima Indonesia to conduct field trials in real-world farming conditions. Our portfolio includes four commercially successful lines: SIS Superior, SIS Growth, SIS Hardy and SIS Robust, which contributed to our position as the world's top broodstock supplier last year, 2024.

Which are the top five basic Shrimp Broodstock Companies globally ? What is the market size and position of SIS in the world shrimp culture sector with regard to shrimp Broodstock production and supply ?

Top 5 in 2024: 1) SIS with total 300k BS, 2) Hendrix Genetic, 3) CP Group, 4) Syaqua, 5) Blue Genetic.

What is the role and importance of Broodstock in shrimp aquaculture sector ?

Broodstock is crucial in shrimp aquaculture as they provide the genetic foundation for the entire production cycle, influencing the quality and characteristics of the offspring. They are used to produce high-quality post-larvae, and their health and disease resistance directly impact farm productivity and sustainability. By selecting and breeding high-quality Specific Pathogen Free (SPF) broodstock, the industry can improve traits like growth rate, disease resistance, and overall performance.

What is the name of your shrimp seed ?

SIS offers four commercial products: SIS Superior, SIS Growth, SIS Hardy, and SIS Robust. In India, we have SIS Growth (known as SIS Growth Line Plus), SIS Hardy as the main product, and SIS Robust (also known as SIS Hardy Line Plus).

What is needed to be done at basic brooding project level and at broodstock importers level to ensure quality shrimp seed supply to farmers ?

Hatcheries must implement good hatchery practices and biosecurity, start from using SPF broodstock, proper water treatment and sterilization, using SPF polychaeta for broodstock feed etc. to produce good quality PLs. They have to monitor properly the growth (PL stage and length) and quality of PLs during culture. And the PLs have to be free from disease before they send to farmers (PCR test) and also must pass the stress test (salinity stress test or formalin stress test) to ensure that the hatchery only send strong and fit PLs. By adhering to these standards, hatcheries can provide farmers with healthy, high-quality shrimp PLs, reducing disease risks and improving farm productivity.

How many hatcheries are using SIS Shrimp Broodstock in India? What is the estimated size of shrimp Broodstock market in India and what is your supply / share in it ?

Almost all hatcheries in India are importing SIS Broodstock. Estimated broodstock market for India is around 180,000 pcs per year. The last year 2024, SIS' market share was around 55%.

How many countries you are exporting your broodstock worldwide ?

India, China, Vietnam, Indonesia, Thailand, Philippines, Thailand, Malaysia, Taiwan, Korea, Oman and Srilanka.

How is the satisfaction level of your products from the customers globally and in India ?

They are very satisfied. As SIS offers proven products for sustainable shrimp farming, providing consistent, stable, and predictable performance across various conditions, meeting farmers' needs for successful and reliable harvests.

What is the role / importance of seed in aquaculture ?

The selection of PL quality is very important to get successful crops in the farms which is like PLs can be strong in weather fluctuations, water quality changes and disease challenges. To make sure good quality PLs, farmers should select SPF (specific Pathogen Free) PLs from CAA approved hatcheries in India with good quality by assessment in aquatic labs before packing in hatcheries.

In your view, what is needed to maintain the best quality of seed to ensure optimum results and performance ?

Hatcheries must implement good management practices and biosecurity, start from using SPF broodstock, proper water treatment and sterilization, using SPF polychaeta for broodstock feed, etc. to produce good quality PLs. They have to monitor properly the growth (PL

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

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PRESENTATION: 500 gms &1 kg

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Nanang Hindarto, Siva Prasad, Dr Rushi R.K., and other executives
Shrimp Improvement Systems

stage and length) and quality of PLs in LRT's during culture. The PL's have to be free from disease (PCR test) before they send to farmers and also must pass the stress test (salinity stress test or formalin stress test) to ensure that the hatchery only send strong and fit PL's. By adhering to these standards, hatcheries can provide farmers with healthy, high-quality shrimp PL's, reducing disease risks and improving farm productivity.

What are your future plans and targets ?

Mr Nanang Hindarto: Stay and grow with SIS. I want to see SIS grows bigger and bigger. And have my own farm for retirement.

Dr Rushi: I want to make SIS dominant in India to get atleast 75% broodstock market share in India as well as I would like to support farmers technically to get more farming success to sustain aquaculture in India.

Would you comment on the present issues and trends in aquaculture industry in India and other parts of the world ? What solutions you suggest for sustainable growth and development in aquaculture sector globally and in India ?

Our main problem right now is disease. It's all because of our greediness that only aim for profit. We only think short term profit without thinking about the impact on the environment. The aquaculture industry has to shift towards sustainability requires adopting practices that minimize environmental damage, effectively manage waste, significantly reduce the use of chemicals and antibiotics, and prioritize the protection of aquatic ecosystems, ultimately ensuring the long-term viability and food security of this sector while mitigating the risks associated with disease outbreaks.

Do you have any message to the shrimp farmers to get better performance and production from the shrimp seed, and also to the hatcheries who import your broodstock ?

To shrimp farmers: Adopt best management practices and strict biosecurity, ensure optimal water quality, and follow recommended stocking densities to maximize performance and production from high-quality shrimp seed. Farmers should consider their pond carrying capacity before plan for stocking PLs.

To hatcheries: Source SPF broodstock from reputable suppliers, maintain strict biosecurity, use SPF polychaeta, and produce robust and healthy shrimp seed.

To both: Let's collaborate, share knowledge, and invest in sustainable practices to drive industry growth and resilience.

SIS has four successful lines like
SIS Superior,
SIS Growth,
SIS Hardy,
SIS Roburst
which contributed to SIS position as the world's top broodstock supplier in 2024.

Most of Quality Issues in Healthcare products segment in Aquaculture sector will be solved if the Industry has Effective Licensing system by Govt: Mr T. P. Rao

Vijayawada: There is a need of unity among manufacturer which is not happening due to competition in supply of healthcare products to the customers, and maintain business ethics, and everybody should follow it, said Mr T. Purnachander Rao, Managing Director, Padmaja Laboratories Pvt. Ltd.

Feed supplements, B-complex and vitamin products should be manufactured as per pharmacopeia standards to ensure quality of the products, he stated. If companies stop credit system, entire system will be repaired and everything will be streamlined, said T. P. Rao.

Bad storage conditions will lead to deteriation of drugs and the products. Manufacturing segment should work on long term perspective, he stated.

If licensing system is made effective by the Government for feed supplements manufacturing, the problem will be solved, and the manufacturers will have fear when licencing system is there and government department should strictly implement it, said Mr Poornachander Rao.

Mr Poornachander Rao worked as Marketing Manager in Wockhardt veterinary division during 1975 - 1985, and in 1985 he started Padmaja Laboratories with manufacture of drugs and feed supplements for Poultry, Aquaculture and Veterinary sectors.

Padmaja Laboratories has 7 senior executives looking after Poultry and Aquaculture products sales in Odisha, West Bengal and Tamil Nadu (Peddappa). Karnataka and Andhra Pradesh has 4 executives in sales.

Through our approach and commitment in the industry, we created a brand value for Padmaja

T. Poornachander Rao, Managing Director, Padmaja Laboratories Pvt Ltd

I started with zero and made Padmaja Laboratories a Rs 100 crore company and providing direct employment to 300 people, and made Padmaja Labs a reliable brand in the industry, said Mr T. Poornachander Rao, Managing Director, Padmaja Laboratories Pvt Ltd. Poultry Fortune Editor M.A. Nazeer had an interview with Mr Poornachander Rao. Excerpts:

Labs. We are marketing our products in 23 states in India, including Jammu & Kashmir. In some states we do trade business of veterinary and poultry products, he informed.

He started pellet poultry feed manufacturing in 2015 with 5000 tons production per month and was supplying in West Godavari, East Godavari, Krishna and Chittoor districts in Andhra Pradesh. Due to transportation issue, he is not supplying to other states. He later closed. If given credit, lot of business can be done all over, but there is no point of giving credit, he stated.

He started Emu farming and a processing plant for Emu birds along with a group of 40 farmers for Emu oil and exporting the oil to USA market.

Avitone Feeds LLP was stared to manufacture and supply poultry feed, drugs as well as feed supplements on the name of Padmaja Laboratories Pvt. Ltd.

Mr T. P. Rao had setup Padmaja Life Sciences, a separate project to manufacture for probiotics and enzymes culture. Instead of buying probiotic and enzymes, we are producing our own for Aquaculture and Poultry products manufacturing requirement, he stated.

Mr Poornachander Rao's son Mr T. Shiva Kumar, M.S (Pharmacology) from Glasgo University, London, has joined the company as Director and taking care of business promotion.

The office and production facilities are located in the Industrial area, Gannavaram, 25 kms to Vijayawada on Kolkata highway, all within a radius of 10 kms.

Padmaja Group has a business turnover of Rs 100 crores. Mr T. P. Rao has future plans to focus on drugs export.

Recently, Government of India changed the Drugs Act with WHOGMP standards and we are going to upgrade our production facilities to this standards, and we are spending 10 crores for upgradation. This process will be completed before December 2025, he told.

Selection for salinity tolerance in an SPF P. Vannamei balance genetic line

Natthinee, Chotitat and Craig

Chotitat

Introduction

The global shrimp industry is evolving rapidly, with farming operations expanding from traditional coastal ponds to inland, brackish, and even freshwater environments. Penaeus vannamei, a euryhaline species is well known for its ability to grow across a wide salinity range, from near-freshwater conditions to highly saline, arid regions exceeding 50 ppt.

However, shrimp farming at lower salinities introduces physiological challenges. Shrimp must expend energy on osmoregulation, maintaining internal salt balance especially when external salinity deviates from their optimal range. The ideal salinity balance point for P. vannamei is approximately 24.7 ppt (Castille and Lawrence, 1981; Li et al., 2015). As external salinity shifts away from this value, more energy is diverted from growth and feed utilization toward maintaining internal homeostasis.

Importantly, the efficiency of osmoregulation is under genetic control. Some shrimp families regulate internal salt balance more effectively, allowing them to grow faster and convert feed more efficiently, even in challenging low-salinity environments. This makes broad salinity tolerance a highly valuable trait when developing genetically improved shrimp lines.

Recognizing this need early, SyAqua committed to developing a genetic selection strategy incorporating breeding for broad salinity tolerance and consistent performance. Applying our balance selection strategies SyAqua simultaneously measures and improves performance for multiple traits while minimizing inbreeding and potentially negative interactions. This article highlights how exclusive R&D and large-scale farm validation demonstrate that SyAqua genetics provide accurate, precise, and stable outcomes across a wide variety of salinity zones, with minimal performance variation between environments.

Craig

Natthinee

Selection and Laboratory Testing for Salinity Adaptability

Starting in 2017, SyAqua launched a dedicated breeding program targeting shrimp performance under both high salinity (~30 ppt) and low salinity (~5 ppt) conditions. Rather than selecting for salinity-specific lines, SyAqua focused on building robust, versatile genetics capable of thriving across environments.

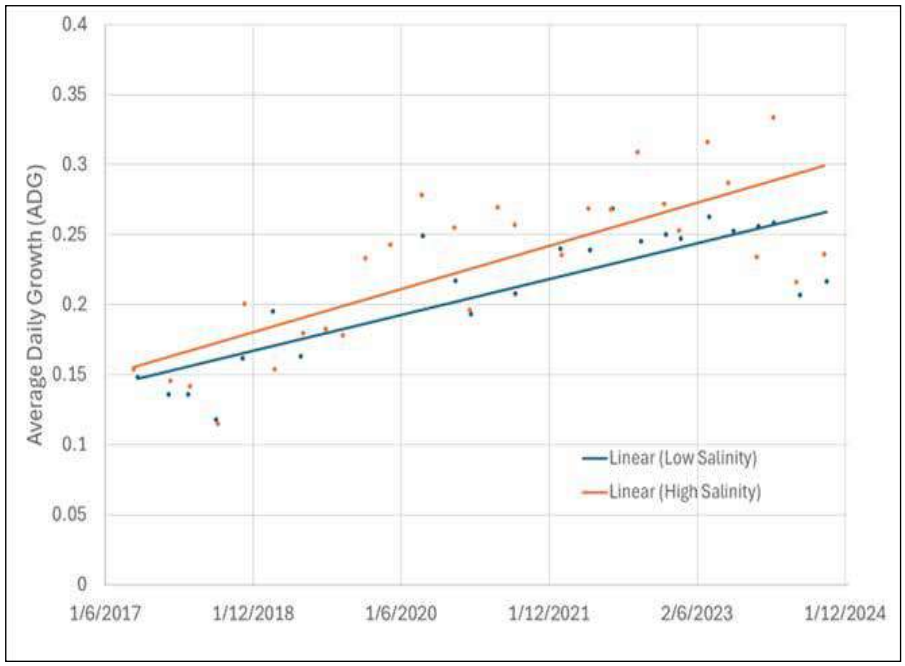

Figure 1: Average daily growth of SyAqua genetics tested in high and low salinity tested from multiple batched across 9 generations during 2017 – 2024.

Table 1: Average performance across 3 salinity ranges in commercial farms.

Salinity Level	Number of ponds	Days of Culture	Stocking density (PL/m²)	Final ADG (g/day)	Yield (Kg/m²)	Survival Rate (%)	FCR
>25 ppt	28	88 days	78	0.20	1.13	80%	1.33
16–25 ppt	52	87 days	85	0.21	1.28	79%	1.29
6–15 ppt	12	90 days	88	0.22	1.51	86%	1.19

Key outcomes from internal trials include:

44% improvement in ADG under low salinity conditions across 9 generations.

22% increase in survival rates under low salinity conditions.

High phenotypic (0.55–0.75) and **genetic correlations (0.75–0.93)** between growth traits at high and low salinities — ensuring genetic stability and predictability.

These strong genetic linkages provided the basis for selection decisions assuring that the selected families could deliver consistent improvements and high performance across multiple salinity environments, without the need for specialized or segmented shrimp lines.

Commercial Validation: Consistent Outcomes Across 98 Commercial Ponds

In 2024, SyAqua tested this breeding philosophy at scale, analyzing real-world performance across 98 relatively well performing ponds spanning high (>25 ppt), medium (16–25 ppt), and low (6–15 ppt) salinity ranges. Only ponds with normal harvest cycles and no acute health issues were included in the dataset for performance analysis.

Key Observations:

Average Daily Growth (ADG) remained remarkably consistent across salinity levels, ranging narrowly from 0.20 to 0.22 g/day, reflecting strong stability in SyAqua's genetic line.

Yield were highest in low salinity ponds due to slightly higher stocking densities and survival rates. However, all salinity groups showed comparable and reliable production outcomes.

Survival rates stayed high and stable across conditions (79–86% range).

Feed Conversion Ratios (FCRs) varied somewhat between farms but remained efficient in all environments.

Performance variation across different salinity levels was minimal, confirming that SyAqua balance line animals maintain stable and profitable performance levels under diverse salinity conditions as designed by the genetic selection strategy.

Bridging Laboratory Models to Real-World Success

The direct alignment between internal controlled trials and commercial farm outcomes provides strong evidence for the effectiveness of SyAqua's balanced genetic approach.

- **The stability and consistency of performance** of SyAqua balance line across salinities was confirmed over many ponds across many farms in 2024.
- Laboratory tests correlating performance between high and low salinity environments enabled selection of the fast-growing strains. Pond data confirmed that laboratory-based predictions were **accurately reproduced on farms**.
- **No major trade-offs** were observed in growth, survival, or feed efficiency across the salinity gradient in well managed farm ponds.
- **Farmers across different geographies** can expect predictable, high-quality results with SyAqua balance line in well managed ponds.

In short, SyAqua genetics deliver what they promise: stable, adaptable, and profitable shrimp performance across all salinities.

Practical Advantages for Farmers

For shrimp producers, this consistency translates into major operational benefits:

- Broader farming flexibility: Stock shrimp in freshwater, brackish, or seawater ponds with confidence.
- Reduced production risk: Stable survival and growth minimize the impact of environmental changes.
- Higher and more predictable returns: Efficient feed usage and strong yields across salinities improve profitability.

As global shrimp farming continues to diversify, SyAqua is committed to providing a leadership role in development and application of reliable genetics across environmental extremes.

Conclusion

Through a combination of effective R&D, well managed and consistent breeding strategies and large-scale, real-world validation, SyAqua has developed shrimp genetics capable of delivering consistent high performance across the full range of salinity conditions. By measuring and selecting for multiple traits simultaneously using advanced genomic techniques, gains can be achieved steadily and consistently even for traits which may be negatively correlated. The key is a focused, data driven, disciplined and consistent approach applied across many generations. With minimal variation in growth, survival, and FCR across high, medium, and low salinity environments, SyAqua shrimp offer unparalleled consistency, flexibility and reliability for today's farmers.

"Wherever your farm is, SyAqua shrimp are ready to thrive."

UNCLOS and Global Fisheries: Legal and Ethical Insights

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- **United Nations Convention on the Law of the Sea (UNCLOS) as a comprehensive framework for addressing ethical and legal challenges in fisheries management.**
- **UNCLOS establishes crucial maritime zones from territorial waters to exclusive economic zones and the high seas each with specific implications for fisheries management and resource conservation.**
- **UNCLOS convention establishes detailed frameworks for determining allowable catch limits, managing straddling and highly migratory fish stocks, and protecting marine mammals.**
- **UNCLOS establishes a graduated system of maritime zones extending outward from a coastal state's shoreline, with differing rights and responsibilities applying in each zone.**

Introduction

Covering around 70% of Earth's surface, the world's oceans are among humanity's most vital shared resources. They serve as major trade routes, sources of food and energy, carbon sinks that help combat climate change, and strategic naval corridors. However, the vastness that gives the oceans their value also complicates their governance. Balancing coastal states' territorial rights with global interests in free navigation, determining who may exploit offshore resources, and protecting marine ecosystems are all longstanding challenges.

These issues have shaped maritime law over centuries, culminating in the United Nations Convention on the Law of the Sea (UNCLOS) - often called the "constitution for the oceans." Adopted in 1982 and in force since 1994, UNCLOS provides a comprehensive legal framework for ocean use. It defines maritime boundaries, balances national and international rights, regulates activities like fishing and shipping, and includes mechanisms for environmental protection and dispute resolution.

This article examines UNCLOS's historical development, core principles, and institutional structures, highlighting its role in transforming maritime governance and addressing the growing pressures on the world's oceans today.

Historical Development

The modern law of the sea has its conceptual foundations in the 17th century, when two competing principles emerged to govern maritime activities. The first, articulated by Dutch jurist Hugo Grotius in his seminal work "Mare Liberum" (The Free Sea), proposed that the oceans beyond national boundaries should remain open to all nations as common international property. This principle was counterbalanced by the practical acknowledgment that coastal states required some measure of control over adjacent waters. The "cannon shot rule," formulated by another Dutch jurist, Cornelius van Bynkershoek, established that a nation's sovereignty extended to the distance a cannonball could reach from shore approximately three nautical miles. This limited territorial sea became widely accepted, with the waters beyond remaining international waters subject to freedom of navigation.

For centuries, this relatively simple framework sufficed for international maritime relations. However, by the early 20th century, technological advancements in resource extraction, fishing capabilities, and naval warfare began to strain the traditional three-mile limit. Nations increasingly sought to extend their jurisdictional claims over offshore resources and adjacent waters.

The Path to Codification

The first significant attempt to codify international maritime law came in 1930 when the League of Nations convened the Hague Conference to address territorial waters. Despite considerable effort, the conference failed to reach binding agreements, leaving maritime boundaries in a state of ambiguity as nations pursued divergent policies.

A watershed moment came in 1945 when U.S. President Harry Truman issued what became known as the "Truman Proclamation," unilaterally extending United States control to all natural resources on its continental shelf. This precedent-setting action initiated a cascade of similar claims by other coastal nations. Between 1946 and 1950, several Latin American nations, including Chile, Peru, and Ecuador, extended their maritime claims to 200 nautical miles to include valuable fishing grounds off their coasts.

By 1967, the fragmentation of maritime claims had reached a critical point. Only 25 nations still adhered to the traditional three-nautical-mile territorial limit, while 66 nations had established twelve-nautical-mile zones, and eight had claimed jurisdiction out to 200 nautical miles. This inconsistency highlighted the urgent need for a comprehensive international agreement to standardize maritime boundaries and rights.

The UNCLOS Conferences

Responding to this growing legal fragmentation, the United Nations convened its first Conference on the Law of the Sea (UNCLOS I) in 1958 in Geneva, Switzerland. This initial conference successfully produced four separate conventions:

1. The Convention on the High Seas (entered into force September 30, 1962)
2. The Convention on the Continental Shelf (entered into force June 10, 1964)
3. The Convention on the Territorial Sea and Contiguous Zone (entered into force September 10, 1964)
4. The Convention on Fishing and Conservation of Living Resources of the High Seas (entered into force March 20, 1966)

While representing significant progress in codifying various aspects of maritime law, UNCLOS I notably failed to resolve the crucial question of the breadth of territorial waters. This unresolved issue prompted the convening of a second conference (UNCLOS II) in 1960, which, despite six weeks of negotiations, concluded without reaching new agreements. A significant shortcoming of these early conferences was the limited voice given to developing nations and third world countries, which primarily participated as clients, allies, or dependents of the United States or the Soviet Union rather than as equal stakeholders in oceanic governance.

The decisive push for a more comprehensive maritime legal framework came in 1967 when Malta's Ambassador to the United Nations, Arvid Pardo, raised the issue of varying territorial claims before the UN General Assembly. This initiative ultimately led to the convening of the Third UN Conference on the Law of the Sea (UNCLOS III) in New York in 1973. After nine years of complex negotiations involving unprecedented participation from developing nations, UNCLOS III culminated in the adoption of the United Nations Convention on the Law of the Sea in Montego Bay, Jamaica, on December 10, 1982. The convention finally entered into force on November 16, 1994, after receiving the required number of ratifications.

This historic agreement established a 12-nautical-mile maximum breadth for territorial seas, finally resolving the longstanding dispute over territorial water limits. More importantly, it created a comprehensive framework delimiting various maritime zones, including internal waters, territorial seas, archipelagic waters, contiguous zones, exclusive economic zones, and continental shelves. The convention also introduced detailed provisions governing navigation rights, innocent passage, marine environmental protection, scientific research, and created mechanisms for settling disputes arising from maritime activities.

Maritime Zones Under UNCLOS: A Graduated System of Rights and Responsibilities

1. **Baselines and Internal Waters:** Maritime zones start from the baseline, the low-water line along the coast. Waters landward are internal waters, under full sovereignty of the coastal state. Foreign vessels need permission to enter.
2. **Territorial Sea (up to 12 nm):** Coastal states have full sovereignty, including over airspace, seabed, and subsoil. Foreign ships enjoy the right of innocent passage, which prohibits activities like threats, military exercises, surveillance, pollution, and unauthorized loading/unloading. Passage can be temporarily suspended for security
3. **Contiguous Zone (12–24 nm):** This is international waters, but coastal states may enforce customs, fiscal, immigration, and sanitary laws. Navigation and overflight are permitted; military and surveillance activities allowed. No foreign fishing or mining is allowed.
4. **Exclusive Economic Zone (EEZ) (up to 200 nm):** Coastal states have sovereign rights over natural resources, energy production, artificial islands, research, and environmental protection. Other states retain navigation, overflight, and cable-laying rights. Coastal states manage resource use, allow foreign access to surplus stocks, and must cooperate on shared and migratory species

Maritime zones defined by UNCLOS
(Source: House of Lords, 2024)

5. **Continental Shelf (up to 200 + nm)** Coastal states have exclusive rights to explore/exploit seabed and subsoil resources, including sedentary species. Foreign ships may navigate and lay cables; drilling and similar activities require coastal state consent.
6. **High Seas (beyond EEZ)** Open to all for navigation, overflight, fishing, scientific research, and laying cables. No state can claim sovereignty. States must cooperate to conserve resources, combat piracy, and ban slave trade. Warships have immunity.
7. **The Area** Refers to the seabed beyond national jurisdiction. It is the common heritage of mankind. Managed by the International Seabed Authority for exploration, exploitation, and environmental protection.
8. **International Straits** Used for international navigation; transit passage allows free, continuous, and expeditious navigation/overflight. States cannot suspend this. In straits connecting high seas/EEZ to territorial seas, innocent passage applies and cannot be suspended.
9. **Archipelagic States** Comprise archipelagos and may define archipelagic waters.

Innocent passage is allowed, but may be temporarily suspended for security. Designated sea lanes allow archipelagic sea lane passage with continuous, normal-mode navigation/over flight within 25 nm of the axis line.

Environmental Protection and Scientific Research

UNCLOS emphasizes the dual importance of environmental protection and marine scientific research (MSR), establishing obligations for states to protect and preserve the marine environment through pollution control, sustainable resource use, regulation of harmful technologies and species, international cooperation, damage notification, contingency planning, and the development of science-based standards. MSR must be conducted exclusively for peaceful purposes, using appropriate scientific methods that do not interfere with legitimate sea uses or violate environmental regulations. While all states have the right to undertake MSR, it cannot serve as a basis for resource or territorial claims, and the Convention encourages transparency, cooperation, and the open sharing of research findings to advance global scientific understanding of marine ecosystems.

Institutional Framework: Implementing and Enforcing UNCLOS

1. **International Whaling Commission**
   Although established before UNCLOS, the International Whaling Commission (IWC) plays a vital role in conservation efforts that align with the Convention's environmental provisions. Its mandate includes conserving whale stocks while ensuring the orderly development of the whaling industry, protecting cetaceans from hunting, capture, captivity, disturbance, and trade, and enhancing environmental conditions for whales and other cetaceans.

2. **International Maritime Organization**
   The International Maritime Organization (IMO) serves as the United Nations' specialized agency dedicated to enhancing the safety and security of international shipping, preventing marine pollution from vessels, and formulating strategies to ensure clean waterways. Through regulatory frameworks, conventions, and global cooperation, the IMO plays a crucial role in promoting sustainable maritime practices and protecting the marine environment.

3. **International Tribunal for the Law of the Sea**
   Established directly by UNCLOS, the International Tribunal for the Law of the Sea (ITLOS) adjudicates disputes concerning the interpretation and application of the Convention, with jurisdiction covering the delimitation of maritime zones, navigation, conservation and management of marine resources, protection and preservation of the marine environment, and marine scientific research. ITLOS ensures compliance with international maritime law, fostering peaceful dispute resolution and sustainable ocean governance.

4. **International Seabed Authority**
   Also created by UNCLOS, the International Seabed Authority organizes and controls mineral resource activities in "the Area" (seabed beyond national jurisdiction). Its responsibilities include ensuring effective protection of the marine environment from potential harms associated with deep-seabed activities.

Global Participation and Notable Exceptions

As of this writing, UNCLOS has achieved widespread international acceptance, with 169 member parties (168 states plus the European Union). This broad participation underscores the Convention's status as the preeminent legal framework governing maritime activities globally.

The membership process involves multiple steps. Signing indicates agreement with principles and intent to examine domestically before ratification but is not legally binding. Ratification represents formal approval making the treaty legally binding. A country becomes a full party to the Convention when it completes all requisite steps and becomes fully bound by its terms.

India, for example, signed UNCLOS on December 10, 1982, and ratified it on June 29, 1995, becoming a full party to the Convention. However, some notable exceptions to membership exist. The United States, despite playing a key role in the negotiations that shaped UNCLOS, has refused to join due to concerns over sovereignty implications, particularly regarding deep seabed mining provisions. This stance remains a significant anomaly in an otherwise broadly accepted international legal framework.

Conclusion

The United Nations Convention on the Law of the Sea (UNCLOS) stands as a landmark achievement in international law, creating a comprehensive legal framework that governs the world's oceans through clearly defined maritime zones and a balanced system of rights and responsibilities. It successfully reconciles coastal state sovereignty with the shared interests of the global community, establishing enduring principles for navigation, resource management, environmental protection, and marine scientific research. With mechanisms for cooperation and peaceful dispute resolution, UNCLOS has proven adaptable to evolving challenges, from environmental threats to new technologies. Its broad acceptance, including adherence to many of its principles by non-parties like the United States, reflects its evolution into customary international law. As ocean pressures grow in the 21st century—through increased exploitation, climate change, and technological advancements—UNCLOS remains a dynamic, living framework, often referred to as the "constitution for the oceans," offering stability and adaptability for current and future maritime governance

References:

*References can be given on request**

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Role of Feed Additives in Increasing Feed Efficiency in Aquaculture

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This article highlights the importance of feed efficiency in aquaculture, noting that feed costs can account for up to 70% of production expenses. It explores how additives such as enzymes, probiotics, amino acids, antioxidants, lipids, and minerals can enhance growth, improve feed conversion, and support sustainability. The key takeaway is that incorporating these additives can lower costs, improve animal health, and promote more profitable, eco-friendly operations.

Introduction:

Maximizing feed efficiency is a critical objective in modern aquaculture, essential for increasing fish and shrimp production while minimizing operational costs and environmental impacts. One of the most effective strategies to achieve this is incorporating feed additives specialized ingredients that enhance the nutritional profile of aquafeeds, improve growth performance, and optimize feed utilization. The feed conversion ratio (FCR), a key metric for assessing feed efficiency, can be significantly improved through the strategic use of these additives. As global demand for seafood continues to rise, the aquaculture industry must adopt more sustainable and cost-effective practices. Feed additives not only promote healthier and faster growth in aquatic species but also reduce nutrient waste and the ecological footprint of farming operations.

Why Feed Efficiency is Important in Aquaculture?

Feed accounts for approximately 50-70% of total production costs in aquaculture, depending on the species being farmed and the composition of the feed. Feed efficiency is measured using the Feed Conversion Ratio (FCR), which quantifies the amount of feed required to achieve a unit of weight gain. Improving feed efficiency through additives can:

- Reduce Feed Costs: Efficient feed usage leads to less waste and decreased reliance on expensive ingredients.
- Enhance Growth: Feed additives can positively impact the growth rate of aquatic animals, resulting in faster production cycles.
- Improve Environmental Sustainability: More efficient feed conversion minimizes environmental impact by reducing the amount of unused feed and waste entering the aquatic system.

Categories of Feed Additives and their role in Feed Efficiency:

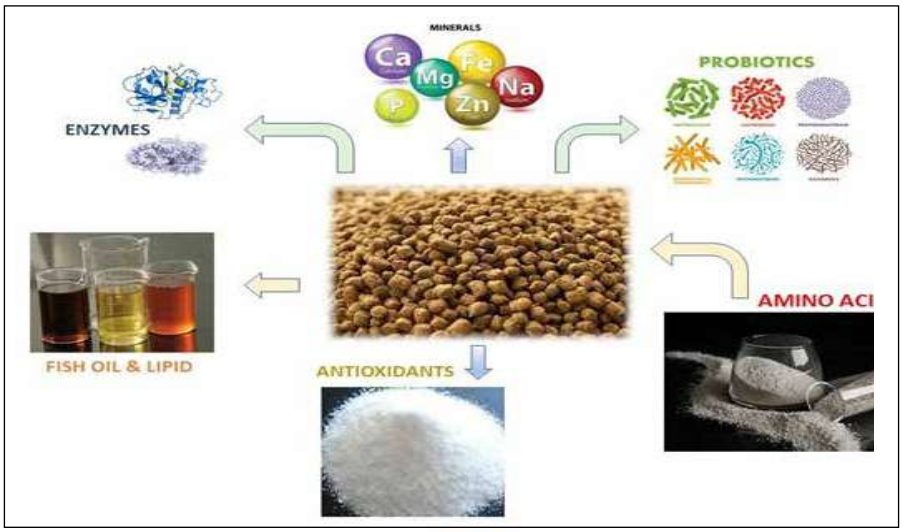
Feed additives can be broadly categorized based on their specific roles in enhancing feed efficiency. Below, we examine each category in more detail.

1. Enzymes

Enzymes play a crucial role in breaking down nutrients in feed that aquatic animals find difficult to digest. By incorporating enzymes such as phytase and cellulase, we can enhance the digestibility of plant-based ingredients, thereby improving feed efficiency and reducing dependence on costly animal-based proteins. This enhancement results in better protein and energy digestibility, leading to improved growth rates and reduced feed costs.

Common Enzymes:

- **Phytase:** Breaks down phytate, a form of phosphorus present in plant ingredients. By allowing fish and shrimp to access this valuable nutrient, phytase reduces dependence on inorganic phosphorus sources and improves



Categories of Feed Additives

phosphorus utilization.

- **Protease:** Assists in breaking down proteins into amino acids, making the proteins in feed more digestible, particularly when using plant-based proteins.
- **Cellulase:** Degrade cellulose and hemicellulose found in plant cell walls, enhancing the digestibility of plant-based feed ingredients.

Impact on Feed Efficiency:

- **Improved Digestibility:** Enzymes promote better digestion of plant-based ingredients, minimizing undigested feed particles.
- **Reduced Feed Waste:** Enhanced nutrient absorption translates to less feed wasted as fecal matter.
- **Cost Savings:** By improving the availability of plant-based proteins, enzymes decrease the need for expensive animal protein sources.

2. Probiotics and Prebiotics

Probiotics are live beneficial microorganisms, while prebiotics are substances that promote the growth of these beneficial microbes in the gut. Together, they help maintain healthy gut flora, improve digestion, and enhance immune function. Improved gut health leads to better nutrient absorption and a lower incidence of disease, resulting in more efficient feed utilization. Probiotics positively influence gut microbiota, enabling animals to digest feed more effectively. Prebiotics are non-digestible food components that stimulate the growth and activity of beneficial gut microorganisms, supporting the action of probiotics.

Impact on Feed Efficiency:

- **Enhanced Gut Health:** The combination of probiotics and prebiotics improves intestinal flora, facilitating more efficient digestion and nutrient absorption.
- **Reduced Disease Incidence:** Probiotics help maintain a balanced microbiota, preventing pathogenic bacteria from establishing themselves, which reduces the need for antibiotics and enhances growth performance.
- **Optimized Nutrient Utilization:** A healthy gut microbiome can break down complex carbohydrates and fibers that the host cannot digest, making more nutrients available.

3. Amino Acids

A balanced amino acid profile enhances protein utilization, promoting optimal growth rates and reducing nitrogen waste, which ultimately improves feed conversion. To achieve this balance and support growth, synthetic amino acids such as methionine, lysine, and threonine are often added to fish feeds. Since amino acids are the building blocks of proteins, providing aquatic animals with an adequate supply of essential amino acids is crucial for maximizing their growth.

Common Amino Acids:

- **Methionine, Lysine, Threonine:** These essential amino acids are often deficient in fish and shrimp diets, particularly those relying on plant-based proteins.

Impact on Feed Efficiency:

- **Improved Protein Utilization:** A balanced amino acid profile in feed enhances protein conversion efficiency, reducing the need for excess protein and minimizing nitrogen waste.
- **Growth Promotion:** Supplementing with amino acids enables aquatic species to maximize their growth potential.
- **Environmental Benefits:** By lowering excess protein waste, there is a decrease in nitrogen released into the environment, reducing the risk of eutrophication.

4. Antioxidants

Antioxidants, such as vitamin E and selenium, are added to feed to protect against oxidative stress, which can hinder growth and immune function.

Impact on Feed Efficiency:

- **Health Maintenance:** Antioxidants protect cell structures and strengthen the immune system, allowing fish and shrimp to efficiently convert feed into body mass.
- **Improved Feed Utilization:** Healthier aquatic animals convert feed into growth more effectively, as they experience less stress and fewer diseases.
- **Reduced Disease Risk:** By enhancing the immune system, antioxidants help animals resist infections that could compromise nutrient absorption and growth.

5. Fish Oil and Lipid Additives

Incorporating specific fats and oils into feed increases its energy density. Omega-3 fatty acids are commonly used in aquaculture for their health and growth benefits.

Impact on Feed Efficiency:

- **Increased Energy Density:** Lipid additives enhance the energy content of the feed, making it more calorie-dense and supporting faster growth rates.
- **Improved Growth Performance:** A proper balance of omega-3 fatty acids is crucial for optimal growth and immune function in fish and shrimp. Supplementing with fish oils improves feed conversion.
- **Enhanced Health and Survival:** Omega-3 fatty acids are essential for maintaining cell membrane integrity, immune system function, and overall health.

6. Minerals and Vitamins

Essential minerals (such as zinc, copper, and iron) and vitamins (including vitamins A, D, and C) are added to ensure proper metabolic function, growth, and disease resistance.

Impact on Feed Efficiency:

- **Metabolic Support:** Adequate supplementation of vitamins and minerals ensures proper metabolic function, reducing stress and promoting optimal feed conversion.
- **Bone Health:** Minerals like calcium and phosphorus support skeletal development in fish and shrimp.
- **Reduced Wasting:** A well-balanced mix of vitamins and minerals prevents deficiencies that could lead to inefficient feed use and increased mortality.

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Feed Additives and Environmental Sustainability:

A primary goal of feed additives is to enhance the sustainability of aquaculture systems. Improved feed efficiency directly correlates with reduced environmental impacts, as better feed conversion leads to:

- Less Feed Waste: Minimizing undigested feed decreases nutrient discharge into the environment, which can contribute to eutrophication.
- Reduced Carbon Footprint: Optimizing feed conversion and minimizing waste lowers the carbon footprint associated with feed production and transportation.
- Improved Water Quality: Feed additives that promote health and digestion help reduce excess nutrients (such as nitrogen and phosphorus) in water, thereby maintaining optimal water quality.

The Effect of Feed Additives on Feed Conversion Ratio (FCR):

- Feed Conversion Ratio (FCR) is a key indicator of feed efficiency, representing the amount of feed needed for an animal to gain one unit of body weight. A lower FCR indicates greater efficiency in converting feed into body mass. Feed additives can significantly enhance FCR by improving digestion, nutrient absorption, and growth performance. For instance, in a trial with tilapia, the use of probiotics and prebiotics improved FCR by up to 10%. Similarly, adding enzymes to shrimp feed has shown a 15% improvement in FCR, reducing feed waste and increasing profitability.

Table 1. Here's the globally available feed additives and their uses

Sl. no	Product	Company	Uses
1	Ronozyme (Enzyme blend including phytase, protease, carbohydrase)	DSM	Improves digestibility of plant-based feeds, reducing reliance on fishmeal and enhancing nutrient absorption.
2	AquaStar® (Probiotic for aquaculture)	Biomin	Contains beneficial bacteria like Lactobacillus to promote gut health and improve disease resistance.
3	MacroGard® (Beta-glucans)	Biorigin	Boosts immune responses and protecting against bacterial and viral infections.
4	Sel-Plex® (Organic selenium supplement)	Alltech	Mitigates oxidative stress and improves resilience in stressful environments like fluctuating temperatures.
5	Carophyll® Pink (Astaxanthin for antioxidant and pigmentation)	DSM	Enhances stress resistance and skin pigmentation in shrimp and salmon.
6	Veramaris® (Algal DHA omega-3 oil)	Veramaris	Replaces fish oil in feeds, providing sustainable DHA.
7	Acidomix® (Organic acid blend)	Novus International	Improves nutrient retention and reduces nitrogen waste.
8	Aqua Biomega® (Functional feed additive with saponins and bioflavonoids)	Kemin	Improves growth rates and feed conversion in shrimp and fish.
9	Paramega DHA (Omega-3 fortification for growth and health)	ADM	Boosts growth and enhances meat quality in aquaculture species.
10	Mycofix® (Mycotoxin binder and detoxifier)	Biomin	Neutralizes mycotoxins in contaminated feed ingredients, ensuring safe consumption for fish and shrimp.
11	InnoGut® (Gut health enhancer and prebiotic)	Adisseo	Balances gut microbiota and improves nutrient uptake across multiple species.
12	ProAct® 360 (Protease enzyme for protein optimization)	DSM	Maximizes protein digestibility in feeds.

Conclusion:

Feed additives play a crucial role in enhancing feed efficiency in aquaculture by improving nutrient absorption, growth rates, and overall health. As the aquaculture industry continues to grow, adopting innovative feed additives will be essential to meet global seafood demand while maintaining environmental sustainability. Understanding the specific impacts of each feed additive enables aquaculture operators to optimize their feeding strategies, reduce costs, and enhance profitability. The role of feed additives in aquaculture is vital for improving feed efficiency, cutting costs, and increasing sustainability. By enhancing nutrient digestion, growth, and overall health, these additives enable aquaculture operations to optimize resource use, boost profitability, and minimize environmental impacts.

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Harmful Algal Blooms Along the Indian Coast: A Growing Concern

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Abstract
Harmful algal blooms (HABs) are increasingly affecting India's coastal ecosystems, driven by nutrient pollution, climate change, and anthropogenic activities. These blooms disrupt marine biodiversity, cause fish kills, and pose risks to human health through toxin accumulation in seafood. Economic losses in fisheries, aquaculture, and tourism further highlight the urgency of effective management. Government initiatives, including monitoring programs, nutrient control measures, and public awareness campaigns, aim to mitigate HAB impacts. Emerging technologies and bioremediation strategies offer potential solutions. A comprehensive, multidisciplinary approach is essential to safeguard coastal resources. Strengthening policies and research collaborations will enhance India's resilience to HABs.

Keywords:
Harmful algal blooms (HABs), marine ecosystems, nutrient pollution, climate change, eutrophication

- **Harmful algal blooms (HABs) threaten marine biodiversity, human health, and the economy along the Indian coast.**
- **Excess nitrogen and phosphorus from fertilizers and sewage fuel HAB growth.**
- **Notable HAB events include Noctiluca scintillans blooms in Goa (2016) and Cochlodinium polykrikoides fish kills in Kerala and Tamil Nadu.**
- **INCOIS monitors HABs using remote sensing and field sampling, providing regular advisories.**

Introduction

The Indian coastline, spanning over 11,098.81 kilometers, is a vibrant and dynamic ecosystem supporting diverse marine life and coastal communities. However, the increasing prevalence of harmful algal blooms (HABs) poses significant threats to marine biodiversity, human health, and the economy. Harmful algal blooms are characterized by the rapid proliferation of certain algae species that produce toxins or otherwise disrupt aquatic ecosystems (Anderson et al., 2012). These blooms can discolor the water, deplete oxygen levels, and release harmful substances, leading to widespread ecological and socioeconomic consequences. While algal blooms are natural phenomena, their frequency and intensity have escalated due to anthropogenic factors such as nutrient pollution, climate change, and coastal development (Glibert & Burford, 2017). The Indian coast has witnessed several notable HAB events, which have had profound ecological and economic impacts. Understanding the causes, consequences, and mitigation strategies for HABs is crucial for safeguarding India's coastal ecosystems and the livelihoods of millions dependent on marine resources. This article provides a comprehensive overview of the causes, impacts, documented cases in India, government measures, and possible mitigation strategies.

Causes of HABs

The causes of harmful algal blooms along the Indian coast are multifaceted. Nutrient enrichment from untreated sewage, agricultural runoff, and industrial effluents into coastal waters has led to eutrophication, fueling the growth of algae such as *Noctiluca scintillans*, *Karenia mikimotoi*, and *Cochlodinium polykrikoides* (Padmakumar et al., 2012). Excess nitrogen and phosphorus from fertilizers and sewage discharges create an ideal environment for HABs, disrupting the natural nutrient balance. Climate change exacerbates this issue as rising sea surface temperatures and altered precipitation patterns create favorable conditions for algal proliferation. Warmer waters enhance the growth rates of certain algae, while changes in ocean currents influence the distribution of blooms (Glibert & Burford, 2017). Ocean acidification further impacts phytoplankton composition, potentially favoring toxin-producing species over benign ones. Additionally, intensified aquaculture practices and the introduction of non-native algal species via ballast water from ships have further contributed to the prevalence of HABs (Subrahmanyam, 1954; Hallegraeff, 1993). The construction of coastal infrastructure and land reclamation projects also disturb natural water flow, exacerbating bloom occurrences.

Impacts of HABs

The impacts of harmful algal blooms are extensive, affecting marine ecosystems, human health, and the economy. Ecologically, HABs can cause hypoxia and anoxic dead zones, leading to mass mortality of fish and invertebrates. The decomposition of algae consumes oxygen, suffocating marine organisms and disrupting food web dynamics (Glibert & Burford, 2017). This can result in shifts in species composition, reducing biodiversity and impairing ecosystem resilience. Human health risks arise from algal toxins accumulating in shellfish, causing illnesses like paralytic shellfish poisoning (PSP), diarrhetic shellfish poisoning (DSP), and ciguatera fish poisoning (CFP). Aerosolized toxins can also trigger respiratory issues and skin irritations in coastal populations (Hallegraeff, 1993). Economically, fisheries and aquaculture sectors suffer significant losses due to fish kills and seafood contamination. The tourism industry also declines due to discolored, malodorous coastal

waters, reducing beachgoer and recreational activity revenue.

Indian Scenario

The Indian coast has experienced several significant HAB events, highlighting the pressing need for monitoring and management. One prominent example is the *Noctiluca scintillans* blooms, commonly referred to as sea sparkle, which have been observed in the Arabian Sea. These blooms cause fish mortality and disrupt food chains, with a notable outbreak reported in 2016 along the Goa coast (Padmakumar et al., 2012). Another species, *Cochlodinium polykrikoides*, has been implicated in fish kills in Kerala and Tamil Nadu, significantly affecting the livelihoods of local fishing communities (Padmakumar et al., 2012). Additionally, blooms of *Karenia mikimotoi*, known for their toxin-producing capabilities, have led to cases of shellfish poisoning in India's southeastern regions (Anderson et al., 2012). Reports of *Alexandrium* species, which cause PSP, and *Dinophysis* species, responsible for DSP, have also been documented in coastal waters, raising food safety concerns.

Government Measures to Control HABs

To address the growing threat of HABs, the Indian government and related organizations have implemented several measures. Monitoring and early warning systems have been established, with the Indian National Centre for Ocean Information Services (INCOIS) providing regular advisories on HAB occurrences using remote sensing tools and field-based sampling (INCOIS, 2022). Efforts to manage nutrient input include stricter regulations on agricultural runoff, wastewater treatment, and industrial effluent discharge (Glibert & Burford, 2017). Integrated coastal zone management (ICZM) programs promote sustainable development practices to mitigate human-induced stressors. Public awareness campaigns educate coastal communities, fishers, and aquaculture farmers about the risks of HABs and the importance of mitigation measures (Padmakumar et al., 2012). Collaborative research initiatives on HAB dynamics, toxin characterization, and mitigation technologies are fostering innovative solutions through partnerships between academic institutions, government agencies, and international organizations (Anderson et al., 2012). Emerging control technologies, such as algicidal bacteria, clay dispersal, and mechanical harvesters, are being explored, although their ecological safety requires further validation (Hallegraeff, 1993). Encouraging the use of bio-remediation strategies, such as seaweed farming and bivalve aquaculture, offers a natural way to absorb excess nutrients and mitigate bloom formation.

Conclusion

Harmful algal blooms are a pressing issue along the Indian coast, with far-reaching impacts on marine ecosystems and human livelihoods. Addressing this challenge requires a holistic approach that combines scientific research, community participation, and policy interventions. Strengthening monitoring programs, improving wastewater management, and investing in sustainable coastal development will be essential to mitigating the risks associated with HABs. Furthermore, fostering regional and global collaborations for data sharing, early warning systems, and HAB response strategies can enhance India's preparedness in managing these marine hazards. By prioritizing sustainable coastal management practices and leveraging scientific advancements, India can mitigate the adverse effects of HABs and safeguard its marine resources for future generations. Long-term commitment to environmental conservation and policy-driven solutions will be crucial in preserving the ecological and economic integrity of India's coastal waters.

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More references can be given on request*

Impact of climate change in fisheries sector

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- **Climate change refers to long-term shifts in average weather patterns, primarily driven by human activities like burning fossil fuels.**
- **These changes include rising global temperatures, altered precipitation patterns, and more frequent extreme weather events.**
- **Climate change significantly impacts aquaculture through various channels, including shifts in water temperature, ocean acidification, changes in rainfall, and increased frequency and intensity of extreme weather events.**
- **These changes can lead to decreased fish production, increased vulnerability to diseases and parasites, and overall damage to aquaculture infrastructure and ecosystems.**
- **To control climate change in aquaculture, focus on sustainable practices like improving fish welfare, diversifying species, and implementing innovative technologies like Integrated Multi-Trophic Aquaculture (IMTA) and Recirculating Aquaculture Systems (RAS).**
- **Additionally, consider climate-resilient infrastructure, species selection, and management strategies to enhance farm resilience to changing conditions.**

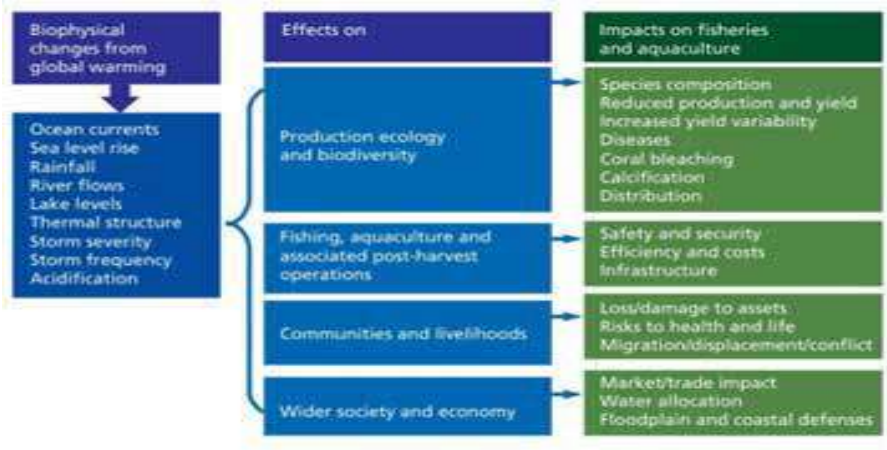

Figure .1. Climate variability change impact pathways in fisheries and aquaculture

Key words: Climate change, Impact, Aquaculture, Sea level and Fisheries sector

Introduction:

Climate change poses significant threats to the fisheries sector, impacting both marine and inland ecosystems through rising water temperatures, ocean acidification, and sea level rise. These changes affect fish distribution, abundance, and species composition, ultimately impacting livelihoods, food security, and the global seafood supply. The impacts on the fisheries sector include:

Physical changes

- Water surface temperature rise
- Sea level rise
- Increasing water salinity
- Ocean acidification

Biological changes

- Changes in primary production
- Changes in fish distribution

Physical Changes

1.Water Surface Temperature Rise

The oceans play a significant role in regulating global climate. Their heat capacity (and thus net heat uptake) is about 1000 times larger than that of the atmosphere (***Barange and Perry et al ., 2010***) and they therefore absorb significant amount of heat emitted globally. Such changes in ocean temperatures can change the dynamics of aquatic environments of the region. Changes in ocean dynamics could lead to changes in migration patterns of fish and possibly reduce fish landings, especially in coastal fisheries (***African Action et al ., 2007).***

2. Sea Level Rise

Globally, sea level has already risen by 10 to 20 cm during the 20th century, largely due to thermal expansion, and by 2100 a global rise in sea level of between 9 cm and 88 cm has been predicted, based on the Intergovernmental Panel on Climate Change's full range of 35 climate projection scenarios (***Church et al., 2001 in OECD, 2010***). In coastal areas, sea level rise may alter the salinity of estuarine habitats, inundate wetlands, and reduce or eliminate the abundance of submerged vegetation, adversely affecting those species which rely on these coastal habitats

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for reproduction and recruitment (***Hlohowskyjl et al., 1996).***

3. Increasing Water Salinity

Climate change can cause an increase or decrease in water salinity in multiple ways. While tropical oceans are increasingly becoming saltier, oceans closer to the poles have become fresher. This highlights that tropical oceans are very likely to suffer more from the potential impacts of increasing water salinity relative to waters in higher latitudes.

Changes in water salinity have different effects depending on the tolerance level of the organisms and the nature of their ecosystem whether freshwater, marine or estuarine. The salinity of some freshwater ecosystems are predicted to increase as a result of anthropogenic climate change (IPCC, 2001). Such physical changes will negatively impact the population of both plankton and bigger prey fish species by affecting the organisms' ability to osmoregulate. (***Schallenberg et al., 2003).***

4.Ocean Acidification

Oceans are believed to have the capacity to absorb most of the anthropogenic CO2 emissions (***Caldeira and Wickett et al.,2003).*** CO_2 is soluble in water and reversibly converts to carbonic acid. As a result of this chemical reaction, the world's oceans are acidifying at an alarming rate (***Dupont and Thorndyke., 2009***). While this has a positive impact in slowing down global warming, increased acidity as a result of dissolved CO2 in seawater has negative a impact on ocean ecosystems. The impact to the ecosystem is difficult to estimate as different species at different stages of life history respond differently to different pH changes.

Biological Changes

Climate change is already affecting the trends of some important biological processes, resulting in changes in primary production **(Taucher and Oschlies, 2011)** and changes in fish distribution (**Sumeila et al., 2011**). Climate induced changes in primary production and fish-stock distribution have negative implication on food security in many tropical coastal states in general and SSA in particular.

1. Changes in Primary Production

The relationship between climate change and future ocean primary production is likely to be a key constraint on fish and fisheries production (***Dulvy et al., 2010***). Survival of fish larvae during the planktonic stage is thought to depend strongly on the availability of sufficient and suitable food.

Therefore, in addition to effects of changes in production, climate induced changes in distribution and phenology of fish larvae and their prey can also affect recruitment and production of fish stocks (***Brander, et al ., 2010***).Even though there are multiple factors that affect primary production in aquatic environment, one of the main factors is surface temperature rise.(***O'Reilly et al.,2003***)

2. Changes in Fish Distribution

Change in fish distribution is among the most commonly reported ecological responses of marine species (***Sumaila et al., 2011***). Fish species are believed to respond to environmental changes such as warming water temperatures by shifting their latitudinal and depth ranges. Changes in ocean dynamics could lead to changes in migration patterns of fish and possibly reduce fish landings, especially in coastal fisheries of many African countries (***African Action, 2007 in Urama and Ozoet al ., 2010).*** Marine fisheries are an important food source, and therefore, changes in the total amount or geographic distribution of fish available for catch could potentially affect food security.

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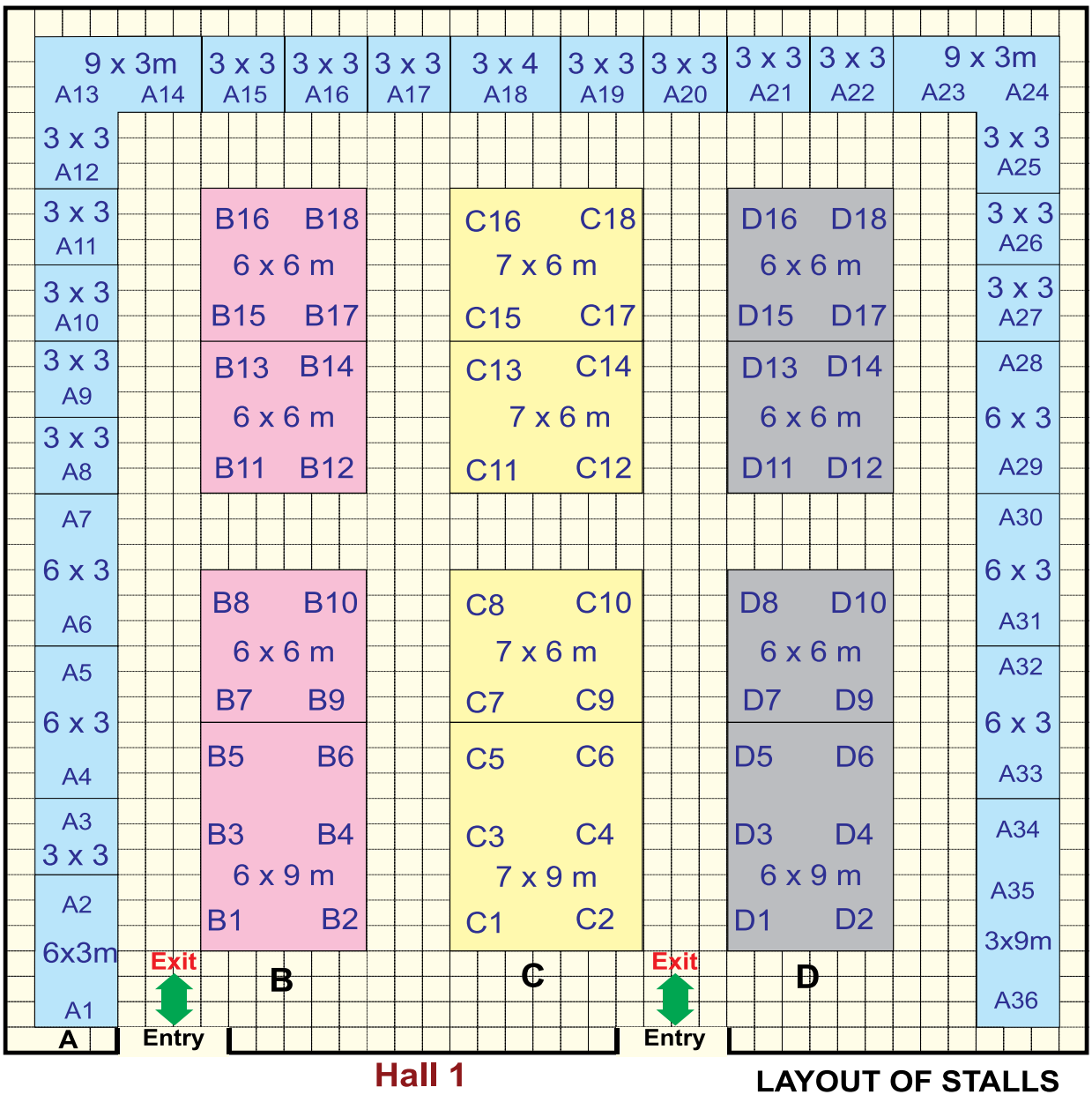

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