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AP CM N. Chandrababu Naidu calls for promotion of domestic consumption of Shrimp & fish; Urged Centre's support to the sector

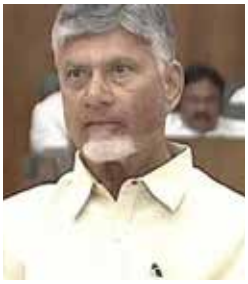
Surrogate Broodstock technology has great potential for stem cell treatment and reproductive medicine. To produce donor gametes from the surrogate male, donor spermatogonial stem cells are transplanted into the surrogate's testis.

Dear Readers,

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

The announcement of Andhra Pradesh Chief Minister Mr N. Chandrababu Naidu in the state Assembly to promote domestic consumption of Shrimp and Fish in Andhra Pradesh and in the country is a welcome sign that effective promotional works will be done in the interest of aquaculture development in the state and in the country. A chief minister and a politician like Chandrababu speaking in the Assembly about the nutritious and protein value of shrimp and fish, and to promote their domestic consumption is a positive gesture for aquaculture farmers in the state and in the country for better prospects. Chandrababu also said that shrimp and fish are good for health and he eats these products every day in lunch or in the dinner. Chandrababu Naidu flagged the difficulties faced by the aquaculture sector due to American tariffs that have dealt a heavy blow to the state's shrimp exports and urged the Centre's support to the sector. The Chief Minister's call to promote domestic consumption of shrimps and fish will bring the stakeholders of aquaculture sector together to work to promote domestic consumption of shrimp and fish. Government of Andhra Pradesh issued a G.O.Rt. No.70, Energy (Power.I) Department, giving power tariff concession for supply of power to aquaculture farmers by reducing the current unit rate to Rs 1.50 per unit with immediate effect.

At a regional meeting of the country representatives from Bay of Bengal region, India has demanded climate justice in global and regional fisheries governance, stressing that countries contributing least to climate crisis should not bear the heaviest costs.



Inaugurating the three day regional meet organised by the Food and Agriculture Organization of UN and the Bay of Bengal Programme Inter Governmental Organisation in Chennai, Union Fisheries Secretary Abhilaksh Likhi said the country is among the world's lowest fisheries subsidizers and one of the most disciplined in sustainability harnessing fisheries resources. "The principles of climate justice must apply. Those who contributed least to the problem should not be asked to pay the greatest price. In India, the fisheries sector is driven by small scale fishers who are the defenders of local economy, food security, nutrition and culture". The regional capacity building meet from September 17 to 19 was aimed at developing National Plans of Action for the small scale fisheries in the Bay of Bengal rim countries. The secretary also called for stronger regional support to protect small-scale fisheries, the backbone of the Bay of Bengal region's economy and food security. Mr Likhi said that "Extreme weather, coastal erosion, and warming seas are already undermining fish stocks and the safety of fishing communities in the Bay of Bengal, while the poorest fishers lack the capacity to adapt without international support. Small-scale fisheries in developing countries are the hardest hit, as the sector is under severe pressure from global crises, market forces and competition". He urged the Bay of Bengal nations to coordinate on early warning systems, climate adaptation strategies, and joint research programmes.

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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In a momentous development that would help the country's resilient seafood sector make deeper inroads in European markets and help cushion the impact of US tariffs, the European Union has approved 102 additional fishery establishments for the export of India's marine products to EU member countries. With this, the number of EU-approved Indian seafood export units has increased from 538 to 604 marking an enormous step forward in enhancing India's presence in the highly lucrative European seafood market. This landmark achievement came after a string of parleys Commerce Minister Mr Piyush Goyal and his senior ministry officials held with their EU counterparts, aimed at bolstering confidence in India's robust seafood control mechanisms. The Marine Products Export Development Authority and the Export Inspection Council also played a crucial role in this deal through their sustained and coordinated efforts in strengthening food safety standards across the seafood value chain. Welcoming the salutary development, MPEDA Chairman Mr D.V. Swamy said it is a significant milestone which underscores India's commitment to upholding the highest standards of food safety from primary production to export. The limitation in the number of EU-approved fishery establishments was a major impediment for our seafood exports to EU. The listing of more units gives a huge opportunity to our exporters to significantly increase their presence in the competitive European seafood market through quality and diversification of products.

Odisha's top seafood exporters urged PM to boost domestic market for shrimps. The Chairman of Odisha's top seafood exporter wrote to Prime Minister Narendra Modi urging him to create a robust domestic market for shrimps by including the product into the procurement and food supply systems of the armed forces and govt supported nutrition programmes to ease the effects of US tariff hike. Mr Tara Ranjan Patnaik, Chairman of Falcon Marine Exports, said the steep tariff hike by the US created a grave crisis for India's shrimp exports. This sudden escalation threatens the viability of a sector that not only emerged as a major foreign exchange earner for the country but also sustains the socio-economic fabric of our coastal states. Patnaik highlighted that shrimp is one of the healthiest sources of lean protein with clear advantages over other forms of animal protein. He stated that shrimps can enhance national nutrition security and protect farmers from global uncertainty. If the world's most advanced economies trust Indian shrimp for their populations, it is both logical and necessary that India itself begins to mainstream shrimp consumption for the benefit of our own citizens. He urged the Prime Minister to direct the incorporation of shrimp into the food supply chains of the armed forces, paramilitary forces, and govt supported nutrition and food distribution schemes. This will not only ensure stable domestic demand but also reduce dependence on volatile international markets and help drive Atmanirbhar Bharat. India produces over 9 lakh metric tonnes of shrimp annually, accounting for nearly 40% of global farmed shrimp trade, and directly supports the livelihoods of more than 15 million farmers and workers. This is not merely an industry it is a critical pillar of our Blue Economy, empowering rural households, creating employment, and contributing significantly to national growth. Mr Ramesh Mohapatra, Chairman of Magnum Sea Foods, said they are planning to cut 30 jobs in the first phase due to fall in production. We are now processing 25 to 30 tonnes per day, down from 80 to 90 tonnes earlier. More job cuts are likely to happen.

Union Fisheries Minister Mr Rajiv Ranjan Singh (Lalan Singh) says the move aims to promote the sustainability of these traditional fishing methods, providing market access and premium prices for eco-certified tuna products. In a major boost to India's seafood sector, the Centre has announced plans to secure global ecolabelling tag for Lakshadweep tuna fisheries using traditional fishing methods. The Minister said that global certification and traceability are the next major interventions in India's fisheries sector. The Government will take steps to obtain globally recognized ecolabelling certification for the pole-and-line and hand-line tuna fisheries of Lakshadweep which have low environmental impact and positive social benefits. He was interacting at a consultative meeting in Kochi on development of fisheries sector in Lakshadweep with a special focus on tuna fisheries, seaweed and ornamental fisheries. This move aims to promote the sustainability of these traditional fishing methods providing market access and premium prices for eco-certified tuna products. With proper certification and market access, Lakshadweep tuna can fetch premium prices, benefiting artisanal fishers in the archipelago, the Minister added. He also said that seaweed farming and ornamental fisheries are highly prospective in the Island, with a strong potential for women's participation and community-based livelihood enhancement.

In the Articles section, **"Revolutionizing Fisheries: The Power of Surrogate Broodstock Technology"**, authored by Inpent Campal E, Subanesam S, Hemamalini N, says surrogate Broodstock technology has great potential for stem cell treatment and reproductive medicine. To produce donor gametes from the surrogate male, donor spermatogonial stem cells are transplanted into the surrogate's testis. The use of surrogacy in research is defined as the use of one test species in place of another test or target species. Surrogate broodstock technology involves two main steps: isolating and enriching the precursors of gametes, germline stem cells (GSCs), and transplanting GSCs into sterile recipients. The transplantation of a testis or ovary cell solution containing germline stem cells into larvae right after hatching can enable this approach. Surrogate broodstock technology has wide applications in fisheries resource management and aquaculture. One practical reproductive biotechnology for preserving and multiplying fish genetic resources is the generation of surrogate broodstock using stem cell transplantation. The method's huge potential for stem cell treatment and reproductive medicine has drawn much interest. In order to produce donor gametes from the surrogate male, donor spermatogonial stem cells are transplanted into the surrogate's testis. Eventually, this technology might be used to help conserve species and make it easier to produce important fish commercially.

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

M.A.Nazeer
Editor & Publisher
Aqua International

Uni-President

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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

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India pushes for climate justice, stronger support for small-scale fisheries at FAO regional meet

Union Fisheries Secretary Abhilash Likhi, FAO International Fisheries Analyst Dr Lena Maria Westland, BOBP Director Dr P. Krishnan and other senior officials addressed regional meet at Chennai on September 17-19, 2025

Chennai, Sept 17: At a regional meeting of the country representatives from Bay of Bengal region, India has demanded climate justice in global and regional fisheries governance, stressing that countries contributing least to climate crisis should not bear the heaviest costs.

Inaugurating the three-day regional meet organised by the Food and Agriculture Organization (FAO) of UN and the Bay of Bengal Programme Inter-Governmental Organisation (BOBP-IGO) in Chennai recently, Union Fisheries Secretary Mr Abhilaksh Likhi said the country is among the world's lowest fisheries subsidizers and one of the most disciplined in sustainability harnessing fisheries resources.

"The principles of climate justice must apply. Those who contributed least to the problem should not be asked to pay the greatest price. In India, the fisheries sector is driven by small-scale fishers who are the defenders of local economy, food security, nutrition and culture", the Secretary said.

The regional capacity building meet from September 17 to 19 was aimed at developing National Plans of Action (NPOA) for the small-scale fisheries in the Bay of Bengal rim countries.

The secretary also called for stronger regional support to protect small-scale fisheries, the backbone of the Bay of Bengal region's economy and food security.

"Extreme weather, coastal erosion, and warming seas are already undermining fish stocks and the safety of fishing communities in the Bay of Bengal, while the poorest fishers lack the capacity to adapt without international support. Small-scale fisheries in developing countries are the hardest hit, as the sector is under severe pressure from global crises, market forces and competition", Mr Likhi said. He urged the Bay of Bengal nations to coordinate on early warning systems, climate adaptation strategies, and joint research programmes.

"India is considering NPOAs for small-scale inland and marine fisheries, with FAO and BOBP-IGO expected to play key roles in shaping and implementing these plans.

The country stands committed to inclusive and sustainable growth in fisheries through collaborative and coordinated efforts and climate-resilient fisheries in the Bay of Bengal", the Union Fisheries Secretary said.

Calling NPOA for small-scale fisheries a collective response to challenges ahead, the Secretary said FAOs guidelines would be vital in creating country-specific roadmaps.

Highlighting India's growth in fisheries, Abhilaksh Likhi said fish production rose to 195 lakh tonnes in 2024-25 with over 100% in a decade since 2013-14. According to him, the Central government's flagship programmes such as the the Pradhan Mantri Matsya Sampada Yojana (PMMSY) with an outlay of Rs. 20,050 crores have empowered women in fisheries, expanded insurance to over 31 lakh fish farmers and created modern infrastructure.

FAOs International Fisheries Analyst Dr Lena Maria Westlund said small-scale fisheries provide nearly half of Asia's fish production and employ over 46 million people. Resource management, social and economic development, value chain, gender equality and empowerment, disaster risks and climate change are some of the components in the FAO's guidelines for preparing the action plan for the sector.

"BOBP is committed to assist the small-scale fisheries in the region and has already started exercise to help the countries to move forward developing country-specific action plans for improving the small-scale fisheries sector", said Director Dr P Krishnan.

Senior officials from FAO and BOBP, policymakers, marine scientists and fisherfolk representatives from India, Sri Lanka, Bangladesh and Maldives attended the meeting.

A view of participants in the three day regional meet organised by FAO of UN and the Bay of Bengal Programme Inter Governmental Organisation in Chennai on September 17-19.

Major Boost for Indian Seafood Exports: EU Approves 102 New Fishery Establishments

Kochi, September 11: In a momentous development that would help the country's resilient seafood sector make deeper inroads in European markets and help cushion the impact of US tariffs, the European Union has approved 102 additional fishery establishments for the export of India's marine products to EU member countries.

With this, the number of EU-approved Indian seafood export units has increased from 538 to 604 — marking an enormous step forward in enhancing India's presence in the highly lucrative European seafood market.

This landmark achievement came after a string of parleys Commerce Minister Shri Piyush Goyal and his senior ministry officials held with their EU counterparts, aimed at bolstering confidence in India's robust seafood control mechanisms.

The Marine Products Export Development Authority (MPEDA) and the Export Inspection Council (EIC) also played a crucial role in this deal through their sustained and coordinated efforts in strengthening food safety standards across the seafood value chain.

Welcoming the salutary development, MPEDA Chairman Shri D V Swamy said it is a significant milestone which underscores India's commitment to upholding the highest standards of food safety from primary production to export.

"The limitation in the number of EU-approved fishery establishments was a major impediment for our seafood exports to EU. The listing of more units gives a huge opportunity to our exporters to significantly increase their presence in the competitive European seafood market through quality and diversification of products," he pointed out.

The major markets for Indian marine products among EU member states are Belgium, Spain, and Italy. The India–EFTA Trade Agreement coming into force on 1st October 2025 is also expected to enhance market access to EFTA nations such as Norway and Switzerland.

MPEDA's initiatives for promoting marine food exports include field-level sensitization on the importance of Good Management Practices (GMPs) in aquaculture, implementation of traceability measures such as farm enrolment, residue monitoring through Pre-Harvest Testing (PHT), and adherence to HACCP protocols from production to processing.

The seafood exporting community greeted the news with jubilation.

Dr Manoj Sharma, MD of Mayank Aquaculture Private Limited (MAPL), Olpad, Gujarat, a leading shrimp farmer and restaurateur, tweeted, "Huge thanks to MPEDA for their tireless efforts in securing new EU approval for 102 shrimp processing plants. This achievement will undoubtedly boost India's shrimp exports to Europe, benefiting our industry."

Santhosh Prabu of Island Exports, Tuticorin, Tamil Nadu, said, "We've been trying to get EU approval through various platforms. The approval has now finally come through sustained efforts of MPEDA and EIC."

Vijay Gopal, of Basu International, Kolkata, said the tariff issues with USA was both a challenge and opportunity as it impelled us to venture into new markets such as the EU. "We thank MPEDA for giving us continuous guidance and support," he added.

"Back in 2023, we applied for EU approval and finally it has come. We are very excited to enter the EU with confidence and we look forward to strong business ahead, said Abdullah Mehta- Elaf Cold Storage, Taloja, Maharashtra.

Echoing similar sentiments, Mr Kesavan of S V Seafood, Tuticorin; Pavan Tiwari, Senior Executive, Ashadeep Aquaculture Pvt. Ltd., Bhubaneswar; Gnanaraja of Deva Seafood, Tuticorin: Niyas Koya, Frontline Exports; and Durgesh Khorava, Director, Nishiindo Foods Pvt Ltd, Veraval, Gujarat, lauded the efforts of MPEDA and EIC in helping their companies get listed in the EU.

India shipped 16,98,170 metric tonnes of seafood worth Rs 62,408.45 crore (US$ 7.45 billion) during 2024-25, with frozen shrimp sustaining its prominence as the top exported item in terms of quantity and value amid the USA and China turning out to be the major importers of the country's seafood.

The EU is the third-largest seafood export destination for India, accounting for 15.10% of India's total exports. The exports to the EU were 215,080 MT worth Rs. 9429.56 Crore (USD 1125.60 million) during 2024-2025 and showed a positive trend in quantity and value. The major items of export to the EU were shrimp, cuttlefish, and squid in frozen form.

The EU imported marine products worth USD 67.84 billion during 2024, of which India's share was 1.50% only. India has significant potential to improve the exports of frozen shrimp, frozen cephalopods, other prepared and preserved value-added products of shrimps, Tuna etc., and the listing of additional units will provide a boost to such trade trends.

Odisha's top seafood exporter urges PM to boost domestic market for shrimps

Tara Ranjan Patnaik

Bhubaneswar, August 30: Chairman of Odisha's top seafood exporter on Friday wrote to Prime Minister Narendra Modi urging him to create a robust domestic market for shrimps by including the product into the procurement and food supply systems of the armed forces and govt supported nutrition programmes to ease the effects of US tariff hike.

Tara Ranjan Patnaik, Chairman of Falcon Marine Exports, said the steep tariff hike by the US created a grave crisis for India's shrimp exports. "This sudden escalation threatens the viability of a sector that not only emerged as a major foreign exchange earner for the country but also sustains the socio-economic fabric of our coastal states," he added.

Patnaik highlighted that shrimp is one of the healthiest sources of lean protein, with clear advantages over other forms of animal protein. He stated that shrimps can enhance national nutrition security and protect farmers from global uncertainty. "If the world's most advanced economies trust Indian shrimp for their populations, it is both logical and necessary that India itself begins to mainstream shrimp consumption for the benefit of our own citizens," he added.

He urged the PM to direct the incorporation of shrimp into the food supply chains of the armed forces, paramilitary forces, and govt supported nutrition and food distribution schemes. "This will not only ensure stable domestic demand but also reduce dependence on volatile international markets and help drive Atmanirbhar Bharat," he added.

Patnaik also suggested launching a nationwide initiative to promote

Ramesh Mahapatra

shrimp as a healthy, lean and clean protein among domestic consumers. "Shrimp, which is rich in micronutrients, is a cleaner and safer protein option compared to red meat and poultry. It is essential for strength, stamina and recovery, while being low in calories and cholesterol," he added.

India produces over 9 lakh metric tonnes of shrimp annually, accounting for nearly 40% of global farmed shrimp trade, and directly supports the livelihoods of more than 15 million farmers and workers. "This is not merely an industry it is a critical pillar of our Blue Economy, empowering rural households, creating employment, and contributing significantly to national growth," said Patnaik.

Mr Ramesh Mohapatra, Chairman of Magnum Sea Foods, said they are planning to cut 30 jobs in the first phase due to fall in production. We are now processing 25 to 30 tonnes per day, down from 80 to 90 tonnes earlier. More job cuts are likely to happen, according to a news in Times of India.

Centre eyes global ecolabelling tag for Lakshadweep tuna fisheries using traditional fishing methods

Union Fisheries Minister Rajiv Ranjan Singh says the move aims to promote the sustainability of these traditional fishing methods, providing market access and premium prices for eco-certified tuna products

Kochi, September 20: In a major boost to India's seafood sector, the Centre has announced plans to secure global ecolabelling tag for Lakshadweep tuna fisheries using traditional fishing methods.

Union Fisheries Minister Shri Rajiv Ranjan Singh (Lalan Singh) said here on Saturday that global certification and traceability are the next major interventions in India's fisheries sector. The Government will take steps to obtain globally recognized ecolabelling certification for the pole-and-line and hand-line tuna fisheries of Lakshadweep which have low environmental impact and positive social benefits, the Minister said.

He was interacting at a consultative meeting in Kochi on development of fisheries sector in Lakshadweep with a special focus on tuna fisheries, seaweed and ornamental fisheries.

"This move aims to promote the sustainability of these traditional fishing methods, providing market access and premium prices for eco-certified tuna products.

"With proper certification and market access, Lakshadweep tuna can fetch premium prices, benefiting artisanal fishers in the archipelago", the Minister added.

Union Fisheries Minister Rajiv Ranjan Singh

Shri Rajiv Ranjan Singh also said that seaweed farming and ornamental fisheries are highly prospective in the Island, with a strong potential for women's participation and community-based livelihood enhancement.

Referring to the Government's plan on deep sea fishing, the Union Minister said legal instruments for enabling sustainable fisheries in the Exclusive Economic Zone (EEZ) and High Seas are underway in consultation with the coastal states and UTs.

The Central Government is committed to advancing the sector with a focus on sustainable harness of deep-sea resources, he added.

Representatives from various ministries and agencies, including NITI Aayog, Marine Products Export Development Authority, Indian Council of Agricultural Research (ICAR) institutes, and NABARD attended the meeting.

The event was jointly organised by the National Fisheries Development Board (NFDB) and Fishery Survey of India (FSI).

Lakshadweep Administrator Shri Praful Patel highlighted that 4000 square metre lagoon in Lakshadweep holds immense potential for seaweed cultivation, offering new avenues to improve the livelihoods of islanders. "The region can emerge as the global hub for seaweed farming", he added.

Union Minister of State George Kurian and Union Fisheries Secretary Abhilaksh Likhi among others spoke.

Govt. focuses on post-harvest techs, Union Fisheries Secretary tells fishermen

Earlier in the day, during his interaction with fishermen at the Cochin Fishing Harbour, Union Fisheries Secretary Abhilaksh Likhi said that government focuses on boosting fisher income through modern infrastructure and cutting-edge post-harvest technologies.

"Innovative technologies including modern cold chains, efficient packaging and value-added product units, will help reduce waste, improve quality of the catch and thus fetch better price in the market", he said.

He reviewed the ongoing modernization work at the harbour in Thoppumpady. The Secretary urged the port authorities to expedite work and complete the project in a strict and time-bound manner.

Bangladesh sending 1,200 tonnes of hilsa ahead of festive season as gesture of 'enduring friendship'

Bangladesh has traditionally sent the prized fish ahead of the Durga Puja and Dussera season

In a goodwill gesture, Bangladesh's interim government has announced that it will send 1,200 tonnes of hilsa fish to India ahead of Durga Puja later this month. An official notification issued on Monday (September 8, 2025) said that a decision had been taken in this regard "in principle", and called for fish exporters to submit applications by September 11.

"Ilish (hilsa) is coming! The Bangladesh government just decided to export the quintessential fish to India ahead of the festival season as a mark of enduring friendship," Bangladesh's High Commissioner to India Riaz Hamidullah said.

Bangladesh has determined that the hilsa, a prized fish during festivities in eastern Indian States, including West Bengal, Assam, and Tripura, will cost $12.5 or

around ₹1,100 per kg, which is significantly lower than the prevailing market rates for hilsa in India at present. Bangladesh has traditionally sent hilsa ahead of the Durga Puja and Dussera season.

The consignment of 1,200 tonnes of hilsa is expected to reach West Bengal. Although

The Hilsa will cost Rs 1,100 a kg which is lower than the present price in India

diplomatic sources said Bangladesh had attempted to send some additional consignments for Assam and Tripura, that initiative did not receive a response from local importers within the given time frame. The 1,200 tonnes is less than previous consignments for the same season. In 2024, the interim government led by Muhammad Yunus sent 3,000 tonnes of hilsa ahead of the Durga Puja season. A similar quantity was maintained during the Sheikh Hasina years.

The announcement coincided with the start of meeting that will take up river water sharing on Tuesday (September 9, 2025).

Hi-Tech Pharma MD N.V. Ramana Reddy Celebrates Son Sandeep's marriage with Bhanuja

Family Get-together: N.V. Ramana Reddy, Ms Sailaja, M. Pradeep Reddy (Santhu) and Ms M. Sravanthi with newlywed couple Sandeep Reddy and Bhanuja Reddy during wedding reception celebration on 28 September 2025 at Nellore, Andhra Pradesh.

Mr Nalubolu Venkata Ramana Reddy, Managing Director, Hi-Tech Pharma Group and his wife Ms Sailaja performed the marriage of their son Sandeep Reddy with Bhanuja Reddy, daughter of Reddybathula Mohan Reddy & Ms Sujatha, on 26 September 2025 at Guntur.

A grand wedding reception celebration was held by Mr N.V. Ramana Reddy at V.P.R. Convention Centre, Nellore, Andhra Pradesh on 28 September 2025. Politicians, business friends and relatives blessed the newlywed couple.

Aqua International Editor M.A. Nazeer and N.V. Ramana Reddy during wedding reception at Nellore.

Glimpses of Wedding Reception Celebration of Sandeep and Bhanuja at Nellore on 28 September 2025.

Newlywed couple welcomed at Reception Hall.

CMFRI to form committee to address concerns on shark fishing and fisher livelihood

CMFRI proposes a balanced and pragmatic approach in implementing the act, to ensure both biodiversity conservation and the livelihood security of coastal communities

Kochi, September 18: In a major attempt to address the growing concerns of the fishing community, the ICAR-Central Marine Fisheries Research Institute (CMFRI) has announced the formation of a special committee to scientifically study the issues on shark fishing and trade in India, arising from the amended provisions of India's Wild Life (Protection) Act, 1972.

The amendment, which came into force in 2022, has placed numerous species of sharks and rays under different schedules of the act, imposing strict regulations on their catch, trade, and export. This has led to widespread unease and operational difficulties for fishermen across the country's coastline, who often encounter these species as bycatch.

"The newly constituted committee will carry out a comprehensive study for a science-based solution to the issue. It will focus on biological and ecological aspects of the protected species, as well as the socioeconomic impact of the conservation laws on fisher livelihoods", Dr Grinson George, Director of CMFRI said.

He was speaking after inaugurating a stakeholder workshop on conservation of sharks-rays and fisher livelihood held by CMFRI on Thursday in connection with the World Manta Day.

CMFRI proposes balanced approach

At the workshop, CMFRI proposed a balanced and pragmatic approach in implementing the act, to ensure both biodiversity conservation and the livelihood security of coastal communities.

"Fishing is the lifeline of millions of coastal families. Unlike on land, bycatch in marine fisheries cannot be predicted or controlled until the net is hauled. Strict penal action for incidental catch of protected species often creates conflict, undermining both conservation intent and fisher livelihoods," Dr George said.

"The Institute recently intervened following an incident in Tamil Nadu's Kanyakumari district where the landing of thresher sharks sparked confusion among fishers and enforcement officials. CMFRI clarified that thresher sharks are listed under Schedule IV of WPA (aligned with CITES Appendix II), which regulates international trade but does not prohibit domestic fisheries and trade unless covered under Schedules I or II.

International trade regulations are subject to the advice of the CITES Scientific Authority in the country, and CMFRI has been notified by the Ministry of Environment, Forests & Climate Change as a Scientific Authority for Schedule IV (CITES-listed) species", Dr Grinson George said.

To support effective implementation, CMFRI suggested training programmes for enforcement agencies and stakeholders on species identification, community-based monitoring and self-regulation of landings, stakeholder-driven conservation plans, regular scientific assessments and preparation of Non-Detriment Findings (NDFs) to guide international trade decisions.

CMFRI scientists emphasised that the efficacy of conservation depends on cooperative action between scientists, policymakers, enforcement agencies, and fishing communities.

Representatives from fishing community, enforcement agencies and fisheries department engaged in discussions at the workshop.

Dr Shoba Joe Kizhakudan, Head of CMFRI's Finfish Fisheries Division, Anil Raj R, I.R.S., Deputy Commissioner of Customs, A M Noushad, President and M. Majeed, Secretary of the Longline and Gillnet Association spoke on the occasion.

Not easy to switch to domestic from global, say exporters

Trade experts / exporters say global market diversification is a more feasible option but can't happen overnight and will need govt. support

New Delhi: Multiple factors, such as low surplus absorption capacity and different specifications, severely in hibit a shift to the domestic market for exporters struggling to sell in the U.S. because of the 50% tariffs.

Trade experts and exporters believe international market diversification is a more feasible option, but even that cannot happen overnight and would need active support from the government.

Market Stress

"Diverting export products to the domestic market is not a big possibility as there is oversupply. Already, all domestic players are under stress, as you can see from their heavy discounts. International market diversification is definitely a solution, but it is not an immediate option," pointed out Sanjay Jain, Chairman, ICC National Textiles Committee.

Rationalisation of GST rates could expand the domestic market for some sectors such as footwear, but not for others like diamonds and jewellery, because for every product, the domestic market's capacity to absorb will be different, explained Ajay Sahai of FIEO. "For low value items like some handi crafts, there might be demand in the domestic market, but for high value items like carpets, the capacity to absorb may be limited due to high price and because it is not a fast moving item," he said.

Long Term Solution

Thirukkumaran Natarajan, Chairman of Tiruppur based Esstee Exports India Pvt Ltd, said diversifying to domestic markets can only be a long term solution. "The setup is different for exports and domestic (demand) as markets are different and over heads are also different, said Mr Natarajan, who is also the Secretary of Tiruppur Exporters Association.

Exporters need to keep supplying to their foreign markets to retain the major brands that source supplies from them, said Mithileshwar Thakur of AEPC.

"If exporters stop supplying to major foreign brands, they may just leave. So, exporters will try their best to retain them," Mr Thakur said.

The domestic market cannot substitute the export market for India, pointed out Biswajit Dhar from the Council for Social Development.

"India is a hugely import dependent country. We need the foreign exchange," he said. Mr Dhar added that the best way to deal with the loss of U.S. market would be to diversify to newer markets in Africa, Latin America and Central Asia and the Centre should provide all support.

Source: The Hindu Business

Kerala, EU Partner to hold Big-Ticket Meet on Blue Economy

Envoys from EU countries to attend Sept 18-19 meet at Kovalam

Thiruvananthapuram, August 30: In a significant collaboration to leverage Kerala's vast potential to emerge as a global blue economy hub, Kerala Government is hosting a two-day conclave in partnership with European Union here on September 18 and 19, focusing on a wide range of themes and areas of tie-up.

The conclave-- "Blue Tides-Two Shores One Vision"--, organised by the State Fisheries Department at The Leela Kovalam, will have extensive deliberations and interactions on synergising the strategic advantages of Kerala's blue economy with the EU's scientific and policy expertise to build a sustainable and resilient global model.

"A country first initiative, this partnership seeks to create a global model for sustainable development, ensuring thriving communities and a resilient ecosystem for generations to come," Kerala Fisheries Minister Shri Saji Cherian said.

"Blue economy is the strength and the promise of our nature. The upcoming conclave seeks to unite global expertise and local innovation to advance fisheries and aquaculture, modernise coastal infrastructure, nurture skills and local innovation and unlock investment opportunities", Shri Cherian added.

Mr Hervé Delphin, European Union Ambassador to India and Bhutan, and ambassadors to India from 20 European countries will be participating in the event, including the envoys from France, Italy, Spain, Denmark, Sweden, Finland, Hungary, Poland, Slovakia, Slovenia, Bulgaria, Austria, Cyprus and Malta.

Mr Abdul Nasar B, IAS, Special Secretary, Government of Kerala and Ms Chelsasini V, IAS, Director of Fisheries led the conclave.

Policy leaders, industry experts, investors, academics and innovators shared their ideas and perspectives in various sessions.

The key objectives of the meet include fostering sustainable development through ocean-based economic growth, enabling EU-Kerala partnership in marine logistics, aquaculture, coastal tourism, renewable marine energy, and green technologies, promoting skill development, academic collaboration, labour mobility, policy innovation, joint R & D and startup innovation.

The event had plenary sessions with experts, thematic discussions with global fisheries challenges and networking opportunities.

Besides featuring Kerala's unique traditions in blue economy and their socio-cultural impact. The meet also showcased Kerala as a vibrant hub for European investment.

Restoring American Seafood Competitiveness

By the authority vested in me as President by the Constitution and the laws of the United States of America, it is hereby ordered:

Section 1. Background. The United States controls one of the largest and most abundant ocean resources in the world, with over 4 million square miles of prime fishing grounds. With this vast resource and centuries of hard work from American fishermen, our Nation has the greatest seafood in the world.

Most American fish stocks are healthy and have viable markets. Despite these opportunities, seafood is one of the most heavily regulated sectors in the United States. Federal overregulation has restricted fishermen from productively harvesting American seafood including through restrictive catch limits, selling our fishing grounds to foreign offshore wind companies, inaccurate and outdated fisheries data, and delayed adoption of modern technology.

The United States should be the world's dominant seafood leader. But in addition to overregulation, unfair trade practices have put our seafood markets at a competitive disadvantage. Nearly 90 percent of seafood on our shelves is now imported, and the seafood trade deficit stands at over $20 billion. The erosion of American seafood competitiveness at the hands of unfair foreign trade practices must end.

Sec. 2. Purpose. The United States must address unfair trade practices, eliminate unsafe imports, level the unfair playing field that has benefited foreign fishing companies, promote ethical sourcing, reduce regulatory burdens, and ensure the integrity of the seafood supply chain. Previously, I signed Executive Order 13921 of May 7, 2020 (Promoting American Seafood Competitiveness and Economic Growth). That successful order — which remains in effect — enhanced the competitiveness of United States seafood, streamlined regulations, supported maritime jobs and coastal economies, and improved data collection. During the past 4 years, our fishermen were once again crushed under the pressure of unnecessary regulations and unfavorable policies. It is vital that we now build upon our previous hard work with new, additional measures to promote domestic fishing.

Sec. 3. Policy. It is the policy of the United States to promote the productive harvest of our seafood resources; unburden our commercial fishermen from costly and inefficient regulation; combat illegal, unreported, and unregulated (IUU) fishing; and protect our seafood markets from the unfair trade practices of foreign nations.

Sec. 4. A New Era of Seafood Policy. (a) The Secretary of Commerce, in consultation with the Secretary of Health and Human Services and with input from the United States fishing industry, shall immediately consider suspending, revising, or rescinding regulations that overly burden America's commercial fishing, aquaculture, and fish processing industries at the fishery-specific level. Within 30 days of the date of this order, the Secretary of Commerce shall identify the most heavily overregulated fisheries requiring action and take appropriate action to reduce the regulatory burden on them, in cooperation with the Regional Fishery Management Councils, interagency partners, and through public-private partnerships, as appropriate. This process shall include the following actions:

(i) The Secretary of Commerce shall request that each Regional Fishery Management Council, within 180 days of the date of this order, provide the Secretary of Commerce with updates to their recommendations submitted pursuant to Executive Order 13921, to reduce burdens on domestic fishing and to increase production. Building upon the earlier goals, identified actions should stabilize markets, improve access, enhance economic profitability, and prevent closures. The Regional Fishery Management Councils will commit to a work plan and a schedule for implementation to ensure these actions are prioritized.

(ii) The Secretary of Commerce shall solicit direct public comments, including from fishing industry members, technology experts, marine scientists, and other relevant parties, for innovative ideas to improve fisheries management and science within the requirements of the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1801 et seq.); the Endangered Species Act of 1973 (16 U.S.C. 1531 et seq.); the Marine Mammal Protection Act (16 U.S.C. 1361 et seq.); and other applicable laws.

(iii) The Secretary of Commerce shall pursue additional direct public engagement to ensure executive departments and agencies (agencies) are focusing core fisheries management and science functions to directly support priority needs that strengthen our Nation's seafood supply chain.

(b) Upon completion of the process described in subsection (a) of this section, the Secretary of Commerce shall consider updating the Department of Commerce's contribution to the Unified Regulatory Agenda. The Secretary of Commerce shall resume submission of annual reports to the Director of the Office of Management and Budget, the Assistant to the President for Economic Policy, the Assistant to the President for Domestic Policy, and the Chairman of the Council on Environmental Quality pursuant to these activities as described in Executive

Order 13921.

(c) The Secretary of Commerce shall direct the National Marine Fisheries Service to incorporate less expensive and more reliable technologies and cooperative research programs into fishery assessments conducted pursuant to 16 U.S.C. 1867. As soon as practicable, the Secretary of Commerce shall expand exempted fishing permit programs to promote fishing opportunities nationwide. Further, the Secretary of Commerce shall take all appropriate action to modernize data collection and analytical practices that will improve the responsiveness of fisheries management to real-time ocean conditions.

(d) The Secretary of Commerce, in consultation with the Secretary of Agriculture, shall develop and implement an America First Seafood Strategy to promote production, marketing, sale, and export of United States fishery and aquaculture products and strengthen domestic processing capacity. This program shall accelerate the Department of Agriculture's efforts to educate American consumers about the health benefits of seafood and increase seafood purchases in nutrition programs.

(e) Within 60 days of the date of this order, the Secretary of Commerce and the United States Trade Representative, in consultation with members of the Interagency Seafood Trade Task Force, shall assess seafood competitiveness issues and jointly develop a comprehensive seafood trade strategy. The strategy shall be based upon the Seafood Trade Strategy of November 3, 2020, that improves access to foreign markets and addresses unfair trade practices — including IUU fishing and unjustified non-tariff barriers — while ensuring a fair and competitive domestic market for United States seafood producers.

(f) The United States Trade Representative shall examine the relevant trade practices of major seafood-producing nations, including with regard to IUU fishing and the use of forced labor in the seafood supply chain, and consider appropriate responses, including pursuing solutions through negotiations or trade enforcement authorities, such as under section 301 of the Trade Act of 1974 (19 U.S.C. 2411).

(g) The Secretary of Commerce, in consultation with the Secretary of Health and Human Services, the Secretary of Homeland Security, and other relevant agencies, shall immediately consider revising or rescinding recent expansions of the Seafood Import Monitoring Program to unnecessary species and further improve the program to more effectively target high-risk shipments from nations that routinely violate international fishery regulations. The Secretary of Commerce, the Secretary of Health and Human Services, and the Secretary of Homeland Security shall use cost savings to improve thorough checks at United States ports to prevent IUU seafood from entering the market. The Secretary of Commerce shall further consider options to use improved technology to identify foreign fishery-related violations.

(h) Within 180 days of the date of this order, the Secretary of Commerce, in consultation with the Secretary of the Interior, shall review all existing marine national monuments and provide recommendations to the President of any that should be opened to commercial fishing. In making these recommendations, the Secretary of Commerce will consider whether the opening of the monuments to commercial fishing would be consistent with the preservation of the historic landmarks, historic and prehistoric structures, and other objects of historic or scientific interest originally identified in the proclamations establishing the marine national monuments.

Sec. 5. General Provisions.

(a) Nothing in this order shall be construed to impair or otherwise affect:

(i) The authority granted by law to an executive department or agency, or the head thereof; or

(ii) The functions of the Director of the Office of Management and Budget relating to budgetary, administrative, or legislative proposals.

(b) This order shall be implemented consistent with applicable law and subject to the availability of appropriations.

(c) This order is not intended to, and does not, create any right or benefit, substantive or procedural, enforceable at law or in equity by any party against the United States, its departments, agencies, or entities, its officers, employees, or agents, or any other person.

TARS 2025:

Shrimp Aquaculture focused on precision farming & nutrition and developed metrics to manage farm performance towards profitability

Asia does not see Ecuador as a competitor but to learn from on the business model

China's e-commerce demand is the future market for Asian shrimp

The new generation's business strategies are transforming shrimp farming in Thailand, Indonesia, India and Vietnam.

Chiang Mai, Thailand, September 1, 2025: On August 21, the two-day 14th Aquaculture Roundtable Series (TARS) concluded successfully. It brought together 284 participants representing the shrimp supply chain in Asia, speakers, panellists, moderators, and industry leaders from 22 countries in the largest edition to date.

This seventh TARS on shrimp aquaculture centred around precision farming for higher productivity and profitability. It provided a platform to examine Asia's shrimp industry at a critical turning point, marked by low prices, rising costs, frequent disease outbreaks, and poor success rates.

The program featured 10 sessions with 52 international and regional speakers, panellists and industry players who shared trends and insights.

"It is imperative for farms and businesses to adopt smarter and more precise farm technologies to remain competitive. Today, we are seeing how data tools, AI and automation are transforming how we manage water quality, disease prevention and feed optimization," said Dr. Thitiporn Laoprasert, Deputy Director-General, Department of Fisheries (DOF) during her opening address. "At this TARS, let us harness the power of collaboration and innovation to navigate the challenges and opportunities that lie ahead and build a sustainable and prosperous industry together."

TARS 2025 started with an assessment on State of the Global Shrimp Supply and Demand. It explored how Asia can better respond to shifting market needs. Thailand's Klomsuwan sisters, shared data-driven approaches that boosted yields by 60%.

Key takeaways:

- While the Asian model is not broken but misunderstood, excessive intensification raises disease risk and undermines long-term sustainability in Asia.
- In Ecuador, vertical integration and process optimisation deliver efficiency and resilience. It is also seen as transitioning from selling a product to meeting a need.
- China is still considered a promising market for Asian producers, but current demand is shifting towards lower volumes and higher quality.
- Consumers increasingly demand sustainability and traceable, consistent, premium-quality seafood with no soaking, and that are antibiotic-free. E-commerce is becoming a key market channel.
- Success comes with adopting precision farming practices. Data-driven monitoring, strong biosecurity, and clear SOPs are critical to productivity and market alignment.

Participants learnt how Ecuador has a competitive shrimp industry by leveraging on its professionalism, promoting investments and brand development. It showed that sustainable growth is possible through scale, innovation, and integration. Ecuador's distinct geography, politics, and business environments shape its unique model. The learnings from Asian producers on intensification are for Ecuador not to push the limits of carrying capacity. The message was not to see Ecuador as a competitor but to learn on its fundamentals in genetics, hatchery and nursery management and in production planning.

At Hard Talk, business leaders along the value chain from genetics, hatcheries, feeds in Asia and Latin America, and processing and marketing discussed shrimp aquaculture dysfunction in Asia. Asia's fragmented system, with 70% of production from small farms, limits cooperation; meanwhile, Ecuador's integrated model encourages collaboration between farmers and processors. Members agreed small farmers are resilient during challenges and stressed that increased collaboration — with added value tailored to target markets—is necessary, rather than full integration.

"For the long-term sustainability of the industry, it is the second generation of farmers who are stepping up, forming strong peer networks to support one another and driving the transition from founder-led enterprises to modern, science-driven shrimp farming businesses," said Zuridah Merican, Chair of TARS and Editor of AquaCulture Asia Pacific.

At the pond side chat, second generation shrimp business leaders, Rizky Darmawan (Indonesia), Chodpipat Limlertwatee (Thailand), Hai Nguyen (Vietnam), and Mayank Sharma (India) showed how they are leading with science, technology, and resilience, ensuring continuity and growth for the industry.

The takeaways included:

- Family business succession requires balancing respect for tradition with openness to innovation, where younger generations must earn trust to take calculated risks.
- Integrated nursery systems present opportunities for efficiency but demands careful logistics, biosecurity, and seamless transfer protocols to avoid losses.
- Black tiger shrimp farming can be profitable with product segmentation targeting larger sizes and disciplined farm protocols to mitigate

disease risks.

- Innovation and risk-taking should be framed as structured, data-driven pilots that complement existing practices, demonstrating value without undermining the stability of legacy operations.

The Interactive Roundtable Breakouts session focussed on precision shrimp aquaculture and the new deal. "We cannot improve on what we cannot measure. Delegates co-developed metrics for precision shrimp farming, reinforcing TARS' hallmark of inclusive and solution-driven dialogue," added Merican.

The technical sessions provided the following takeaways:

- Precision farming and production planning noted that genetics drive ~50% of performance, but hatchery management and robust post larvae delivery determine field success. Science-based SPF breeding programs remain the standard in Asia compared to Ecuador's APE advances. Nursery systems improve survival, inventory control, and profitability, but transfer logistics are critical. Integrated systems are proving viable in Vietnam.
- Precision nutrition promoted the use of functional additives for gut health, immunity and health interventions. Awareness of negative effects of mycotoxins and endotoxins in shrimp production is critical. In terms of feed sustainability. fishmeal replacement with the same performance at the same cost is the goal. Independence from the marine ingredients in feeds is with non-animal-based sensory additives. Real-time monitoring and acoustic feeding, show promise but adoption varies by region and farm scale.
- Disease mitigation and control of transparent post larvae disease (TPD) in Vietnam requires modular biosecurity to reduce spread and functional additives. Lessons on Vibrio control also led to functional additives to support gut health, microbiome and immune modulation. Early disease diagnostics, multi-pathogen management and lower stocking densities remain key to reducing disease risk.

The future proofing session emphasised on how the retail sector is increasingly influencing shrimp farming practices, focusing on provenance and health benefits. In securing post-harvest product quality, time and temperature control and an optimized supply chain from producers to exporters are critical.

For a sustainable feed strategy, the industry requires lower crude protein feeds with high digestibility. Asia tends to use higher crude protein compared to Latam. There is big opportunity for growth with mathematical modelling to assess impacts of key factors, identifying solutions, formulating to reduce marine ingredient and no marine oils and more sustainable protein/energy levels.

TARS 2025 recognised the role of startups in advancing pond management, disease prevention, and climate adaptation - critical for farmers facing repeated crop failures.

Organizers, Aqua Research PL, publisher of Aqua Culture Asia Pacific and Corporate Media Services acknowledged the hard work, insights, and dedication of all the presenters, moderators, industry panellists, roundtable and group leaders who contributed to the success of TARS 2025.

TARS 2025 was made possible with the strong support of Thailand's Department of Fisheries, along with industry partners including **dsm-firmenich, U.S. Grains Council, Jefo Nutrition, Auranta, Adisseo, ADM, SyAqua, Alltech, BioMar, Veramaris, Lucta, and Motiv**. See more details on the program at www.tarsaquaculture.com

As TARS continues to grow, it is helping shape a future where shrimp aquaculture is more resilient, efficient, and aligned with the needs of both producers and consumers worldwide.

TARS 2026 will focus on AQUAFEEDS and will be held August 19-20, 2026.

About TARS

The Aquaculture Roundtable Series® (TARS) started in 2011 to help the industry grow by sharing information and experiences. It brings together stakeholders from the public, private sector, academia, government, and non-government organizations to discuss and improve aquaculture sustainability. Over the last 13 years, TARS has focused on specific sectors: Aquafeeds (2011, 2015, 2019, 2022), Shrimp Aquaculture (2012, 2014, 2016, 2018, 2021, 2023), and Finfish Aquaculture (2013, 2017, 2024). More information is available at www.tarsaquaculture.com.

About the Organizers

AQUA CULTURE ASIA PACIFIC: AQUA Culture Asia Pacific (AAP) is a regional trade magazine focused on the aquaculture industry, available in print and online. It is published by Aqua Research PL six times a year since 2004. Founded by Zuridah Merican, AAP provides information about the regional aquaculture industry and serves as a platform for industry discussions and self-regulation. AAP strives to be the beacon the regional aquaculture industry, a window to the world for aquaculture producers in Asia Pacific, and the doorway to the market for international suppliers. www.aquaasiapac.com

CORPORATE MEDIA SERVICES: An award-winning communications agency established in 1992 by Irene M Gomez, Corporate Media Services (CorpMedia) has more than 30 years of experience in marketing, public relations, publishing and event management. CorpMedia works with a diverse group of clients from corporate, government and nongovernment organizations, investment, hospitality, food, agriculture, health, science and technology sectors. CorpMedia strives to bring global perspectives to an ever-changing world of communication dynamics. In April 2025, CorpMedia launched cmXp2, a strategy services firm with deep marketing, communications, brand, engagement and advocacy expertise – designed to serve organizations operating in highly regulated sectors, namely life sciences, food & nutrition, agriculture & agri-food (including aquaculture), global banking & markets, corporate & institutional banking.

Andhra Pradesh Government gives Power tariff concession for supply of power to Aquaculture farmers in the state by reducing the current unit rate to Rs 1.50 per Unit

GOVERNMENT OF ANDHRA PRADESH
ABSTRACT

Energy Department – Power tariff concession for supply of power to the Aquaculture farmers by reducing the current unit rate to Rs.1.50ps per Unit - Orders – Issued

ENERGY (POWER.I) DEPARTMENT

G.O.Rt.No.70 Dated: 02.7.2019

Read the following:

1. G.O.Rt.No.119, Energy, I&I (Power.I) Dept., dated: 5-9-2018.
2. G.O.Rt.No.136, Energy, I&I (Power.I) Dept., dated: 10-10-2018

ORDER:

1. 1. In the G.O.1st and 2nd read above Government have issued orders for power tariff concession for supply of Power to the Aquaculture farmers by reducing the current unit rate from Rs.3.86ps to 2.00ps for a period of one year.
2. Government according to its policy intends to reduce the unit rates for power for aquaculture to Rs.1.5 per unit from APERC notified rates.
3. The CMDs of DISCOMS informed that if aqua farms are supplied power at Rs.1.50ps per unit, the additional subsidy requirement for one year would be around Rs.720 Crores.
4. Government after careful examination of the matter announces power tariff concession to aqua farmers by reducing the current unit rate from the rate notified by APERC to Rs.1.50ps per unit with immediate effect.
5. DISCOMs will collect the power charges from Aquaculture farmers at the rate of Rs.1.50 per unit and the Energy Department would transfer the subsidy amount to the DISCOMs on the basis of details submitted by them.
6. The expenditure shall be met from the following Head of Account:
   2801- Power
   05 - Transmission and Distribution
   800 - Other Expenditure
   SH (16) - Assistance to Transmission Corporation of Andhra Pradesh for Providing subsidy to Aquaculture farmers.
   330 – Subsidies / 332 - Subsidies to Organisations.
7. The CMD., APTRANSCO, CMD., APEPDCL and CMD., APSPDCL, shall take further necessary action accordingly.
8. This order issues with the concurrence of Finance Department vide U.O. Note No. FIN01-FMU0BES(IIE/1/2019-IIE,dated:1-7-2019.

(BY ORDER IN THE NAME OF THE GOVERNER OF ANDHRA PRADESH)

SRIKANT NAGULAPALLI
SECRETARY TO GOVERNMENT

To
The Chairman & Managing Director, APTRANSCO, Vijayawada.
The Managing Director, APGENCO,Vijayawada.
The Chairman & Managing Director, APSPDCL, Tirupati.
The Chairman & Managing Director, APEPDCL, Visakhapatnam.
The Secretary, APERC, Hyderabad.
The Managing Director, AFCOF&EO Commissioner of Fisheries, Vijayawada
(Shall take further necessary action accordingly.)
The Special Chief Secretary to Govt, Animal Husbandry, Dairy Development & Fisheries Department, AP Secretariat.

Copy to:
The Prl., Advisor to Chief Minister
The P.S., to Hon'ble Chief Minister.
The P.S., to Hon'ble Minister for Energy.
The OSD to Chief Secretary.
The P.S., to Secretary, Energy, I&I Dept.

Forwarded:: By Order SECTION OFFICER

DSM-firmenich opens new Animal Nutrition & Health plant in Jadcherla, India

DSM-firmenich Animal Nutrition & Health (ANH) inaugurated a new feed additive plant in Jadcherla, Hyderabad, India on 29th August 2025. The strategic investment aligns with the Government's "Make in India" initiative and strengthens ANH's market leading position and growth strategy in India and the Asia-Pacific region.

The new facility features a manufacturing line for the world's leading solutions in Mycotoxin Risk Management and a new warehouse, covering an area of 11,200 square meters. The new state-of-the-art feed additive plant is equipped with advanced Bühler technology and adheres to the highest international standards in quality, safety and environment. It is built adjacent to ANH's Jadcherla Premix Plant, which has been operating since 2018. Together, the two facilities form an integrated "Super Site", enabling greater efficiency and faster service for customers.

Ivo Lansbergen,
BU President Animal Nutrition & Health, DSM-fermenich

Local manufacturing of Mycofix® Secure and Mycofix® Shield helps Indian farmers and feed producers in tackling increasingly complex mycotoxin challenges arising from climate change and improper harvesting conditions. Mycofix® solutions protect animal health and food safety by deactivating a broad spectrum of mycotoxins that contaminate farm animal feed.

Lu Yuan, Vice President Greater APAC, Animal Nutrition & Health dsm-firmenich, commented: "This new plant is a strategic milestone for ANH in Greater APAC — our first feed additive plant

DSM-firmenich team inaugurating the new feed additive plant in Jadcherla, Hyderabad, India

Fredrik Hjelmqvist,
Head of Supply & Commercial Operations,
DSM-fermenich

in India, and a powerful step forward in serving our customers with speed, efficiency, and innovation. By producing Mycofix® locally in India, we enhance our ability to serve customers across the Asia-Pacific region, supporting our growth strategy and meeting growing demand. This is our vision in action: customer at the heart, sustainability in our DNA, and leading through innovation for the future of animal farming."

"This new plant brings us closer to our customers and strategic partners in India. We are very proud to serve our customers with feed additives made in India that meet the highest international standards in quality and safety," said Mr Puneet Pokhriyal, Director, OU West, Animal Nutrition & Health dsm-firmenich.

About ANH

In 2024, dsm-firmenich shared its plan to find a new owner for the Animal Nutrition & Health (ANH) business, including vitamins.

ANH, a dsm-firmenich company, is a global leader in animal nutrition and health, as well as vitamins, carotenoids, and aroma ingredients. ANH is the world's essential solution provider and innovation partner, offering more than 100 nutritional products, precision services, and operating 51 premix sites worldwide. At ANH, more than 7,800 people in over 60 countries work together to improve farm productivity and enhance animal and human health, while reducing the environmental footprint of the animal farming industry.

Headquartered in Kaiseraugst, Switzerland, ANH is an innovation leader with a legacy of groundbreaking innovations, from the world's first production of vitamins, aromas, and mycotoxin deactivators to gut health eubiotics and AI-driven farm management software. In 2024, ANH increased its sales to € 3,3 bn, driven by its strong

Lu Yuan,
Regional Vice President of Greater APAC Animal Nutrition & Health, DSM-fermenich

purpose: feeding the planet without costing the earth. Together, we make it possible. www.dsm-firmenich.com/ANH

About dsm-firmenich

As innovators in nutrition, health, and beauty, dsm-firmenich reinvents, manufactures, and combines vital nutrients, flavors, and fragrances for the world's growing population to thrive. With our comprehensive range of solutions, with natural and renewable ingredients and renowned science and technology capabilities, we work to create what is essential for life, desirable for consumers, and more sustainable for the planet. dsm-firmenich is a Swiss-Dutch company, listed on the Euronext Amsterdam, with operations in almost 60 countries and revenues of more than €12 billion. With a diverse, worldwide team of nearly 30,000 employees, we bring progress to life every day, everywhere, for billions of people.

DSM-firmenich team during plant inauguration

A view of participants in the feed additive plant inauguration at Jadcherla

Count 366 – This Is a Real Investment for Your Pond

A feature article on AquagenixPro and its flagship platform COUNT 366

Gopi Krishna Saladi (Left), Founder & CEO and Sri Ram Pappu, Founder & CFO, AquagenixPro

Executive Summary

Aquaculture has become one of India's most dynamic rural industries, anchoring livelihoods and foreign exchange earnings. But the difference between a profitable crop and a painful loss is often decided at night—when dissolved oxygen crashes, ammonia spikes, or a slow pH drift goes unseen. AquagenixPro's COUNT 366 platform brings industrial-grade sensing, dynamic aeration control, and an IIoT-enabled mobile app together to change that equation. By turning real-time pond data into timely action, COUNT 366 shifts technology from a discretionary expense into a resilient, compounding investment in each pond.

A E Vara Prasad, Head - Sales & Marketing, AquagenixPro

India's Shrimp Aquaculture: The Opportunity and the Stakes

India is a global aquaculture powerhouse. In FY 2023–24, the country exported an all-time-high 1.78 million metric tons of seafood valued at US$ 7.38 billion (₹60,523.89 crore), with frozen shrimp as the leading item and the United States and China as the top markets. State-wise vannamei culture data show 1,08,526 ha under culture across nine maritime states in 2020–21, generating 8,15,745 MT—an all-India average productivity of about 7.52 MT/ha/year, with Andhra Pradesh leading in both area and output. Beyond trade, aquaculture is livelihood: national estimates indicate more than 20 million fishers and fish farmers at the primary level and roughly twice as many supported along the value chain. Globally too, aquaculture crossed a symbolic milestone—surpassing capture fisheries as the main source of aquatic animal production in 2022—underscoring both its potential and the operational discipline it demands.

On the farm, day-to-day risks remain practical and local: night-time DO dips, post-feeding ammonia accumulation, rapid weather shifts during monsoon weeks, and inconsistent record-keeping for audits and buyers. In this environment, systems that stabilize water quality, provide early alerts, and automate aeration deliver disproportionate returns: fewer shocks, more stable growth curves, and lower cost per kilogram.

About AquagenixPro and COUNT 366

AquagenixPro (AquagenixPro Private Limited, Bhimavaram, Andhra Pradesh) is a blue-tech company focused on sustainable, data-driven aquaculture. After two years of product development and rigorous testing of 655 pond days, followed by fine-tuning for Indian aquaculture conditions, COUNT 366 was commercially launched in April 2024.

Procut Installation

COUNT 366 integrates ruggedized sensors, machine-to-machine (M2M) IIoT connectivity, and a secure mobile application to help farmers with data-backed insights, enabling them to manage animal stress conditions, reduce input costs, and improve survivability. The solution is organized around three pillars: real-time monitoring of critical water parameters, dynamic aeration aligned to dissolved oxygen, and predictive analytics with actionable alerts and digital records that support traceability and BAP-style best practices.

AquagenixPro Team with progressive farmer Mr Rambabu Raju Garu

AquagenixPro Tean with Key Farmers Mr Ranga Raju Garu and Mr Sandeep Varama Garu

About the Founders

Gopi Krishna Saladi (Gopi) and Sri Ram Pappu (Sri) hail from the aquaculture capital region of West Godavari. Their shared vision to support the communities they grew up in brought them together during their Masters at the University of Chicago, Booth School of Business. Gopi brings his extensive experience in manufacturing, factory automation, and technology as the CEO and CTO, while Sri draws on his background in finance and insurance to oversee the company's financial operations.

Integral to their journey are their childhood friends, veterans in the aquaculture industry whose education and careers have been dedicated to serving farmers. Together, they have strengthened the product and built a robust team, making it what it is today. Through strategic alliances with global tech partners and a commitment to excellence, the team continues to empower aquaculture farmers with innovative solutions.

Contributor Profile: Field Leadership in Andhra Pradesh

This feature was prepared with inputs from A. E. Vara Prasad, business leader at AquagenixPro, who works closely with farmers in Andhra Pradesh. His work spans farmer education on power-efficient pond operations, deployments of COUNT 366 devices across key ponds, and multi-device installations for progressive farmers covering about 4,358 acres across India and West Africa. Adoption has extended to nurseries, earthen ponds, bioflocs, IPRS, and IMC cultures across varied salinity conditions and water sources.

Exploratory pilots with the Department of Fisheries, Government of Andhra Pradesh, have successfully yielded results, showing efficiencies in aeration runtime. Early adopters have shared their experiences of the technology's benefits in making informed choices in farm and animal management. Several farmers expressed their shock at the difference between real pond conditions and their assumptions.

The COUNT 366 Platform

1. COUNT 366 – An Integrated Aquaculture Operating System

   The COUNT 366 app provides a secure, encrypted window into each pond's status. Farmers can compare day-over-day performance, review trendlines, receive predictive alerts, and maintain digital logs for buyer audits and

Explaining to District Collector Mrs Naga Rani Garu

Product installed at Biofloc Nursery

best-practice programs such as BAP. The user interface is designed for quick checks and rapid action from anywhere.

2. STREAM / STREAM MAX — Industrial-Grade Sensing Sensors continuously measure Dissolved Oxygen (DO), pH, Temperature, Ammonia (NH_4^+ and NH_3), Nitrates, Electrical Conductivity (EC), and ORP (oxidation-reduction potential). Data are recorded and streamed in real time, enabling farmers to keep ponds within optimal ranges, reduce stress, and avoid the trigger conditions that precede disease outbreaks.
3. AERO — Dynamic Aeration Control
   Instead of fixed schedules, AERO automates aerator operation based on live DO. That means oxygen is supplied when biology needs it most—especially through the night—reducing energy overuse while improving survival and growth.

Product installed in earthern pond

What Makes the Technology Different

- True Machine-to-Machine IIoT: Sensors, aerators, and the app operate as a coordinated system: monitor → decide → act. Automated control closes the loop between data and response.
- Ruggedized for Pond Conditions: Hardware selection emphasizes accuracy and stability in outdoor environments, with modular components for easier field service and upgrades.
- Data Security and Availability: Encrypted data on dedicated servers, built for precision, reliability, and seamless retrieval—supporting traceability and compliance with non-tamperable data sources.
- Serviceability and Modularity: Design choices make it straightforward to add parameters, integrate with existing aeration hardware, or expand coverage as farms scale.

Value Proposition: How COUNT 366 Pays for Itself

- COUNT 366 typically pays back through four compounding effects:
  - Higher Survival & Yield: Continuous monitoring and DO-aligned aeration reduce stress events that drive mortality and growth checks.

Stall at Aug 15 celebrations at the District Collectorate in Bhimavaram

- Lower Energy Costs: Dynamic aeration curbs unnecessary runtime—often the single largest controllable expense line—especially overnight.
- Better Feed Efficiency: Steadier oxygen supports consistent appetite and better FCR, reducing feed waste
- Fewer Crisis Events: Predictive alerts on ammonia spikes, pH swings, or impending DO dips allow interventions before small deviations become major losses.

Proactive Services: Beyond Hardware

COUNT 366 is delivered as a proactive, farmer-first service. Typical inclusions are: installation and commissioning; onboarding and safety training for farm staff; remote monitoring and alerts via the app; periodic sensor calibration and firmware checks; and guidance on using digital records for audits and buyer communication. These elements keep the data decision-grade and the automation responsive throughout the crop cycle.

On-Farm Use-Case Snapshots

- Night-time dissolved oxygen protection during overcast monsoon weeks
- Early detection of ammonia accumulation post-feeding; corrective aeration and water exchange
- Power discipline—optimizing aerator runtime to lower kWh per kg produced
  - Compliance-ready logs that make audits faster and improve buyer confidence

Practical ROI Guidance

Start where risk is highest—ponds with chronic night-time DO dips or repeated ammonia issues. Track four KPIs before and after deployment: survival %, kWh per kg, FCR, and daily weight gain variance. Within one to two crops, most farms will have enough data to quantify avoided losses (from early alerts) and savings (from optimized aeration and feed use). Larger farms may see outsized rupee benefits on the energy line even if percentage gains are modest.

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World Aquaculture India 2025

World Aquaculture India 2025: Plenary Speaker Announced and WAS-APC Awards Program Launched

World Aquaculture India 2025 Announces Plenary Speaker, Abstract Deadline Extension, and WAS-APC Awards Program.

The World Aquaculture Society and the National Organizing Committee of World Aquaculture India 2025 is honored to announce Dr Modadugu Vijay Gupta as a plenary speaker at World Aquaculture India 2025 (WAI 2025), to be held at the Novotel Hyderabad Convention Centre, Hyderabad, India, from November 10–13, 2025.

Dr Gupta has been a global leader in aquaculture research and development for over 50 years, with a strong focus on improving food and nutritional security in developing countries. He has implemented projects and programs across more than 20 countries in Asia, Africa, and the Pacific, with particular emphasis on empowering rural women and landless communities through aquaculture.

Over his distinguished career, Dr Gupta has served with UN-ESCAP, FAO, the WorldFish Center (CGIAR), and ICAR, and coordinated the International Network for Genetics in Aquaculture (INGA). He also consulted leading international organizations including the World Bank, ADB, UNDP, USAID, and

Dr M.V. Gupta

the Commonwealth Secretariat. His many accolades include the Padma Shri (Government of India), the World Food Prize, the Sunhak Peace Prize, and an Honorary Life Membership of the World Aquaculture Society.

At WAI 2025, Dr Gupta will deliver a keynote address on "Aquaculture Opportunities, Options, and Optimism," highlighting key challenges and opportunities for the sector.

Abstract Submission Deadline Extended

To allow broader participation, the abstract submission deadline has been extended to September 30, 2025. Student submissions will also be eligible for the Asian Pacific Chapter (APC) Awards.

WAS-APC Awards Program

WAS-APC is proud to introduce its Awards Program for WAI 2025, recognizing excellence in aquaculture research, innovation, and engagement with a particular focus on students and women in the field.

This year features the launch of a new Professional Merit Award, presented alongside the established Student and Women's Participation Awards. All awards follow the global WAS framework to ensure fairness, consistency, and recognition across regions.

Award Categories:

- Pre-conference Student Travel Awards (Best Abstracts): 3 awards of $400 USD each Deadline: September 30, 2025.
- Student Presentation & Poster Awards (During the Conference): Prizes ranging from $400 – $600 USD.
- Women's Participation Travel Awards: 2 awards of $600 USD each – Deadline: September 30, 2025.
- Professional Merit Award (New in 2025): Honoring up to two individuals for outstanding contributions to aquaculture in Asia – Deadline: September 30, 2025.

General Eligibility:

Applicants must be current WAS or WAS-APC members. Abstract submission is required for Student Travel Awards. Past winners are not eligible.

More Information can be found out at WASAPC website Asian Pacific Chapter | World Aquaculture Society.

These awards and plenary sessions reflect our commitment to nurturing the next generation of aquaculture professionals, recognizing women's leadership, and honoring excellence across the industry.

About the Event

World Aquaculture India 2025 (WAI 2025) will be held November 10–13, 2025 at the Novotel Hyderabad Convention Centre, Hyderabad, India. The event will feature plenary sessions, technical presentations, an international trade show, and networking opportunities with industry leaders from around the world. Sponsorship and exhibition opportunities are available for organizations wishing to showcase their products, services, and innovations to a highly engaged aquaculture audience.

Event Sponsor Partnership

WA 2025 is proud to recognize the generous support of our premier sponsors: Blue Aqua, Devee Group, DSM-Firmenich, INVE Aquaculture, Merck MSD, SyAqua, Zeigler, Aker QRILL Company, DNV, ICC Brazil and Avanti. Their commitment plays a vital role in the success of this global event and in advancing sustainable aquaculture practices.

Revolutionizing Fisheries: The Power of Surrogate Broodstock Technology

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Introduction:
One practical reproductive biotechnology for preserving and multiplying fish genetic resources is the generation of surrogate broodstock using stem cell transplantation. The method's huge potential for stem cell treatment and reproductive medicine has drawn much interest. In order to produce donor gametes from the surrogate male, donor spermatogonial stem cells are transplanted into the surrogate's testis. Eventually, this technology might be used to help conserve species and make it easier to produce important fish commercially.

Surrogate Broodstock:
The word "surrogate" comes from the Latin word "surrogatus," which means "a replacement or substitute." In general, surrogacy speaks of "the act of acting as a surrogate mother." In terms of research, surrogacy is defined as "the use of one test species in place of another test or target species."

An egg is taken from the intended mother (donor) and fertilized with the sperm of the intended father (donor) in mammalian gestational surrogacy. The fertilized egg, or embryo, is then transferred to a surrogate (receiver) who carries the child to term. Live offspring are produced when recipient primordial germ cells (PGCs) are transformed into functional gametes. One technique that can expeditiously prepare surrogate males and females for fish breeding is surrogacy. Adult fish receivers that can host implants and quickly produce surrogate sperm and egg cells from them can be created using thermo-chemical procedures.

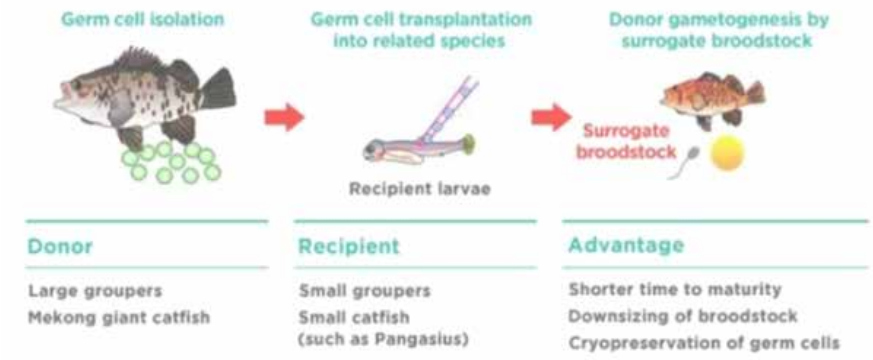
Highlight Points

- **Surrogate Broodstock technology has great potential for stem cell treatment and reproductive medicine.**
- **To produce donor gametes from the surrogate male, donor spermatogonial stem cells are transplanted into the surrogate's testis.**
- **The use of surrogacy in research is defined as the use of one test species in place of another test or target species.**
- **Surrogate broodstock technology involves two main steps: isolating and enriching the precursors of gametes, germline stem cells (GSCs), and transplanting GSCs into sterile recipients.**
- **The transplantation of a testis or ovary cell solution containing germline stem cells into larvae right after hatching can enable this approach.**
- **Surrogate broodstock technology has wide applications in fisheries resource management and aquaculture.**

When immature germ cells from one species are transferred to another, the target species' sperm and eggs can be produced (Yoshizaki *et al.*, 2002). The grafting of testicular fragments into isogeneic fish resulted in donor-derived spermatogenesis in the initial attempts to perform GCT in fish, which were done on Rainbow trout.

Smaller host species are more efficient since they require less room and food to maintain. Furthermore, little fish can be used to accelerate the maturation process (big fish often take longer). One study looked at the Yellowtail Kingfish (*Seriola lalandi*) (YTK) as a potential tuna host in the Perciform order.

Methods to produce surrogate broodstock:
Creating donor-derived gametes in a surrogate fish (recipient individual) involves grafting donor germ cells onto a recipient belonging to a different strain or species. This technique is known as surrogate broodstock technology. The transplantation of a testis or ovary cell solution containing germline stem cells, which will eventually develop into sperm or eggs, respectively, into larvae right after hatching, can enable this approach. Rejection can be prevented even when recipients receive transplants of allogeneic or xenogeneic donor cells since freshly hatched larvae cannot reject foreign substances due to their immature immune systems (Takeuchi *et al*. 2004; Okutsu *et al*. 2007). Furthermore, recipient larvae do not require transplanting donor-derived germline stem cells into their ovary or testis. Following their transplantation via a tiny glass pipette into the intraperitoneal cavity, they move independently to the immature testis and ovaries, where they are incorporated and start the corresponding processes of spermatogenesis and oogenesis (Okutsu *et al*. 2006). Moreover, the germline stem cells used in transplants don't need to be purified. Only germline stem cells move to the recipient's genital



ridges for incorporation when testis or ovary tissues are fragmented by proteinase to prepare the cell solution for transplantation; the remaining cells eventually die in the abdominal cavity (Okutsu *et al*. 2006). Therefore, germline cell transplantation is an extremely simple microscopic procedure with a stereomicroscope and a coarse motion micromanipulator.

Steps Involved in Surrogate Broodstock Technology:
Surrogate broodstock technology comprises two main steps: a) isolation and enrichment of the precursors of gametes, germline stem cells (GSCs), and b) transplantation of GSC into sterile recipients.

1) Isolation and enrichment of donor germ cells:
Primordial germ cells and gonial cells are the two basic types of GSCs that can be separated and injected into surrogate hosts. While the latter can be separated from sexually differentiated animals, the former can be isolated from embryos.
The process of applying surrogate broodstock technology begins with the isolation of these GSCs; the techniques for isolating, cultivating, and transplanting these cell types are described below.

1.1) Primordial germ cells (PGCs):
PGCs are determined by maternal germplasm and set aside during the cleavage stage in the primary groupings of aquaculture species, which include teleost fish, Bivalvia, and the majority of Crustacea (Extavour and Akam, 2003; Yamaha *et al*., 2010). During development, the PGCs then migrate into the gonadal anlagen, where they combine with gonadal somatic cells to produce gametes. PGCs are usually labelled (either permanently or temporarily) with reporter proteins and sorted according to the reporter signals in order to isolate and enrich PGCs from embryos. PGCs have been effectively extracted from transgenic rainbow trout (*Oncorhynchus mykiss*) expressing green fluorescent protein (GFP), which is driven by the vasa gene promoter (vasa is uniquely expressed in animal germ cells) (Takeuchi *et al*., 2004). Reporter labelling has made it possible to examine GSC transplantation in great detail, particularly in salmonid fish, and shows promise for the mass isolation of PGCs. Nonetheless, there are alternate techniques for PGC labelling available for certain species, and the creation of transgenic lines presents difficulties. The most popular method involves injecting chimeric mRNA into the cytoplasm of zygote cells, which combines a reporter protein (like GFP) with the 3'UTR of germline-specific genes (like vasa or nanos3). The reporter gene is only produced in PGCs because of the usage of the germline-specific regulatory sequence (the construct is destroyed in somatic cells) (Yoshizaki *et al*., 2005; Saito *et al*., 2008).

The main limitation to the use of PGCs for surrogate technology in several teleost fish is that each embryo has on average only 13–43 PGCs (based on studies including zebrafish (*Danio rerio*), pearl danio (*Danio albolineatus*), loach (*Misgurnus anguillicaudatus*), goldfish (*Carassius auratus*), medaka (*Oryzias latipes*) and ice goby (*Leucopsarion petersii*) (Saito *et al*., 2006). Although a single transplanted PGC can generate germline chimera across species, genus and families (Saito *et al*., 2008), the low number of PGCs impedes large-scale surrogate production and genetic manipulation. In this case, PGC development and culture in vitro would be required to make further applications possible. It is still challenging to consistently culture PGCs in the majority of teleost species; hence, further research in this crucial field is needed. Making PGCs in vitro from an embryonic stem cell (ESC) line is also an option (Robles *et al*., 2017).

1.2) Gonial Cells:
Spermatogonia and oogonia, or gonial cells, can also be transferred and settle in the gonads or gonadal ridges of sterile surrogate species. Even though their gonads are sexually distinct, they exhibit sexual bipotency, producing either sperm or eggs based on the recipient surrogate animal's phenotypic sex (Hamasaki *et al*., 2017). The primary benefit of gonial cells over PGCs is their number; sexually developed fish can yield hundreds or even thousands of gonial cells. This abundance offers another benefit for cryopreservation: complete ovaries or testes can be preserved, and recipient fish can create functional gametes from thawed gonial cells. Although PGCs can also be cryopreserved, they require a lengthy procedure, and the low number of cells is a limitation (Robles *et al*., 2017). Although labelling of gonial cells would be useful for isolation and monitoring of the transplanted germ cells, gonial cells can be isolated without labelling procedure from testes or ovaries using their physiochemical and biochemical properties such as size, density and specific receptors (Xie *et al*., 2020). Gonial cells are a better option for donor germ cells than PGCs because 1) they can be separated in large enough numbers to allow the use of surrogate broodstock even in the absence of a culturing stage, and 2) their in vitro culture is easier, and more optimized than that of PGCs.

2) Transplantation into different life stages of sterile surrogate recipients:
Isolated germ cells can be

transplanted into the sterilized recipient animals at the different life stages: 1) blastula, 2) hatchlings and 3) adults. During the blastula stage, germ cells can be transplanted by inserting a graft of donor blastoderm containing PGCs between the blastodermal cells of the recipient (Yamaha *et al*., 2003) or injecting donor PGCs into the marginal region of the blastodisc (Saito *et al*., 2008). However, this method requires using PGCs isolated at the early somite stage to achieve migration into the host gonadal ridges (Saito *et al*., 2008), making this approach impractical for large-scale surrogate production due to the limited number of donor PGCs at early stages, and the difficulty in culturing them. At the hatchling stage of the surrogate host, germ cell transplantation is usually carried out. As more numerous gonial cells can be employed for transplantation and are more culturable, transplantation at this stage is more favourable to the large-scale creation of gametes from surrogates.

Furthermore, this strategy is less likely to result in immunological rejection of the transplanted germ cells than in adult recipients since newly formed embryos have a comparatively undeveloped immune system (Okutsu *et al*., 2006). However, in animals whose peritoneal cavity is too small for injection, it can be difficult, so in these animals, blastula stage transplantation may be preferable (Saito *et al*., 2008). In conclusion, the production of donor-derived germ cells can be accelerated by gonial cell transplantation at the adult stage of sterile recipient fish via urogenital papilla injection (Lacerda *et al*., 2013); however, the rate of germline transmission is reduced in comparison to transplantation at the blastula or hatchling stage. For species like zebrafish (Slanchev *et al*., 2005), medaka (Kurokawa *et al*., 2007), three-spined stickleback (*Gasterosteus aculeatus*) (Lewis *et al*., 2008), and Nile tilapia (*Oreochromis niloticus*) (Li *et al*., 2014), where PGC depletion induces masculinization, adult broodstock surrogates can be helpful. This is because it allows recipients of both sexes to be generated for the production of both sperm and oocytes.

Endogenous germ cells of recipient fish must be inhibited or ablated in order to improve surrogate production of donor-derived gametes, regardless of the surrogate's life stage, as they will outcompete the gametogenesis of donor-derived gametes. Sterilization methods are the knockdown of crucial genes for the formation of germ cells, such as dead-end 1 (*dnd1*), triploidy, and interspecies hybrids. Additionally, cytostatic medications and heat exposure can be used to sterilize adult fish.

Procedure:
Significant loss of germ cells occurs from the therapy that involves continuously raising the animals in water that is 30 degrees Celsius and injecting them with busulfan (40 mg/kg body weight) every two weeks. The testes shrink, and there are noticeably fewer oogonia in the ovarian regions. Male donor fish are killed by overdosing on anaesthesia, and their testes are removed and then cleaned in saline buffered with phosphate. After chopping, the testicular tissue is incubated for two hours at 22°C in a dissociating solution containing 0.5% Trypsin (pH 8.2), 5% Fetal Bovine Serum, and 1 mM Ca^{2+} in PBS (pH 8.2). The trypan blue (0.4% w/v) exclusion experiment was used to examine the cell viability of the targeted germ cells, which had been identified in initial trials based on cell size measurements.

Application in Fisheries Resource Conservation and Management:
Stem cell transplantation holds great potential for managing fisheries resources in open-water environments like lakes and reservoirs. Native fish populations may be declining due to invasive fish species in lakes and reservoirs that can potentially harm the ecology. A classic example is the introduction of African catfish (*Clarias gariepinus*) and Channel catfish (*Ictalurus punctatus*) into Asian water bodies, which have had such an impact that some of the region's valuable native fish species are in danger of going extinct. It is also true that these invasive fish species are very challenging to control in large water bodies; in this case, adopting the invasive fish species as surrogate parents could be a workable solution to stop the population of these fish species from growing farther than necessary. Many fish are listed as endangered species on the IUCN Red List as a result of overfishing in the oceans. Thus, it is urgently needed to develop technology that will support biodiversity conservation and improve, enhance, and restore the declining stocks. This technology ensures the production of transgenic animals. It is a powerful tool for preventing the biodiversity of indigenous ornamental fish. Surrogate broodstock technology is a shortcut to achieving conservation goals.

Application in Aquaculture:
Although surrogate broodstock technology is still in its early stages as far as practical uses go, it has enormous potential as a research tool and as a means of accelerating genetic improvement in aquaculture. Specifically, surrogate broodstock can support the use of genetic technologies and resources in aquaculture by (i) enabling genome editing research applications to overcome current limitations, (ii) reducing the effective generation interval in aquaculture breeding programs, (iii) facilitating the dissemination of customized and potentially edited production animals of high genetic merit for farming; (iv) retaining genetic resources of both commercially important and endangered species along with germ cell cryopreservation technology; and (v) producing gametes of difficult-to-raise in captivity in easier-to-breed recipient species.

Constraints:
Some constraints of the surrogate broodstock technology include the initial capital investment, the captive environment that induces behavioural

abnormalities in the animals, and the problem of hatchery-raised stock's survival in the wild.

Conclusion:

In conclusion, surrogate broodstock technology can facilitate the reproduction of high-value aquaculture species that would otherwise be challenging to raise in captivity and contribute to the conservation of important aquatic genetic resources. The combination of surrogate broodstock, genome selection, and genome editing has the potential to revolutionize aquaculture research and production in the following decades, even if more study is still needed.

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An account on culture of the snakehead Channa striatus in earthen ponds

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Stripped Murrel *Channa Striatus* – a new candidate species in aquaculture

In Souvenir of the National Seminar on Diversification of aquaculture through locally-available fish species', organized by ICAR-CIFE (Deemed University) Kolkata Centre in August 2010, Dr Dilip Kumar, the then Director of ICAR-CIFE mentioned in his article 'Diversification of Aquaculture – need of the hour' that freshwater aquaculture sector in India has been witnessing increased interest in diversification with inclusion of high-valued species, including medium and minor carps, catfishes, murrels and other small indigenous species. In recent years, attempts have been made to develop the culture of *Pangasius pangasius*, *Mystus seenghala*, *Mastacembelus pancalus*, *Wallago attu*, *Ompak pabda*, *Anabas testudineus*, and the murrel *Channa striatus*. The murrels get naturally recruited to the homestead/undrainable ponds. Dr N. Sarangi, Former Director, ICAR-CIFA, Bhubaneswar mentioned in his article 'New paradigm in freshwater aquaculture' published in Souvenir of National Seminar on Priorities in fisheries and aquaculture, organized by College of Fisheries, Rangeilunda, Odisha in March 2017 that in context of diversification, the species which are mostly named for commercial operations are medium and minor carps, catfishes, murrels, Scampi and ornamental fishes. With increased emphasis on species diversification, four species of murrels, along with few other fishes possess high potential for farming due to their high consumer preference and market price.

The Late Padma Shri Dr S. Ayyappan mentioned in his article 'IndFish To-2030', published in Book of

Male and female brooder of C. striatus

Abstracts of the 14th Asian Fisheries and Aquaculture Forum, held at Krishi Anusansandhan Bhaban, New Delhi, in February 2025 that in freshwater aquaculture, species diversification is an important aspect driven by market forces, yield rates, climate change, reduced availability in the wild open waters, that needs to be addressed in terms of richness and evenness. In India, with the practice being mainly carp-based, (over 80%), diversification in terms of both habitat and species is the priority. Dr S. Raizada, Former ADG (Inland Fisheries), ICAR, New Delhi has mentioned in his article 'Murrel farming: problems and strategies needed', published in Book of Abstracts of the 11th Indian Fisheries and Aquaculture Forum, organized by ICAR-CIFT, Kochi in November 2017 that murrels as a group constitute an important element of freshwater fishery in many parts of India and south-east Asia. They are in great demand as foodfish due to its appealing flavour, few intramuscular spines, medicinal importance and air-breathing nature. Poor seed survival of these species due to cannibalism is an issue, which can be addressed and overcome by taking certain strategies so that murrel farming can take a viable course for fish farming in India.

Polyculture of *C. striatus*

Back on 13/09/2016, I had an interaction with Late Kachiruddin Sarkar, progressive fish farmer and Group Leader, Mirzapur Azadia Fish Production Group, Mirzapur, Tapan CD Block, Dist. Dakshin Dinajpur, West Bengal who successfully did farming of the stripped murrel *Channa striatus* (stocked in small numbers) in association with *Amblypharyngodon mola* and major carps. In 2012, he started this farming in a 39 acre large freshwater body. Brood fishes of *C. striatus* were stocked in ratio 8F : 16M. According to him, spent fishes shouldn't be caught from pond after spawning as it exhibits parental care and safeguards its offsprings. Otherwise, the early stages of *C. striatus* will be devoured by adults of *C. punctatus*, whose presence in the water body is very much possible. The carnivorous and predatory fish *C. striatus* has been observed to control excessive production of *A. mola* effectively; its chasing impact as 'police fish' has a beneficial impact on growth of major carps whose larger fingerlings or stunted fingerlings (yearlings) of above 100gm are stocked in same water body. During April-June of next year, *C. striatus* was harvested at 500-700gm size when water table recedes. Different kinds of insects and grasshopper gather at the tips of aquatic grass 'Ghora ghaas' which are allowed to grow on pond periphery – growing *C. striatus* captured and devour the insects in live condition.

Features in *C. striatus* culture, as per AICRP on air-breathing fish culture, including murrel culture (1976-1980)

We come to know from the information brochure 'Murrel culture in ponds', published by ICAR-CIFRI, Barrackpore in April 1980 and written by Late Dr P. V. Dehadrai and Dr V. K.

Channa marulius

Murugesan, that murrels can occur in all types in inland water bodies throughout India. These possess additional respiratory organs to breathe atmospheric air directly and thus they are capable of living even in foul waters. They can be fed with fresh or dried trash fish from early stages. Rural ponds preferably of 0.1-0.2 hectare (75cm depth ideal) are ideally suitable for better management of *C. striatus*. Derelict ponds can be utilized for its culture, also done in well-managed clean ponds, yielding high production. Facility to replace pond water once a week ensures much higher production of the fish.

Fry of *C. striatus*, abundantly available in shallow areas of lakes and large ponds, has vermilion red body with a reddish golden band and a dark black band extending from eye to the caudal fin. As pre-stocking management measure, small and large predatory fishes are killed in the grow-out ponds, lime treatment is done when pond bottom silt is too heavy. Fingerlings of size 100mm, raised in nursery ponds, are stocked in grow-out monoculture ponds @ 40000nos/ hectare after given a dip in 200ppm formalin solution for 50 secs – this size is stocked to avoid cannibalism and ensure better survival. The fishes are trained to accept feed like smashed trash fishes small in size, *viz.*, *Esomus danricus*, *Osteobrama cotio*, *Puntius ticto*, *P. sophore*, *A. mola* @ 25% of the total biomass daily for about fifteen days. Growing fingerlings of *C. striatus* also accept cheaply-available dried marine trash fish soaked in water, provided @ 5kg/day in 1st month extending to 50kg/day in 8th month. Slaughter house waste and/or silk worm pupae also act as animal protein source and can be given in place of trash fish. *C. striatus* grows to 250-300gm in 7-8 months of culture, which is done normally during November to June avoiding monsoon months. At harvest, dewatering of ponds and hand picking are done for complete retrieval of the fish.

Adult Channa striatus in glass tank

Seed production in hatchery condition

Officers of Freshwater Fisheries Research and Training Centre, Kalyani (Directorate of Fisheries, Government of West Bengal), brought out a information brochure 'Planned farming of murrels in confined waters', and mentioned that breeding, seed production and scientific farming of *C. striatus* have been made possible in recent times. It gains maturity at one year in age, monsoon months are its breeding season. Dosages of Ovaprim injection (intramuscular), weight of brooders, sex ratio, maintenance of breeding tank, latency period, egg incubation period have been specified in this brochure published by the institute. *C. striatus* seeds get congregated in upper water layer of the tank. Both males and females exhibit parental care. Hatched-out larvae need not be fed for the first 3 days; thereafter zooplankton belonging to Copepoda and Cladocera groups are fed. The 10-days old stage is stocked in ponds.

According to the information pamphlet 'Breeding and seed production of stripped murrel', published by ICAR-CIFA, Bhubaneswar in 2016 and prepared by Dr R. Kumar and Dr U. L. Mohanty, the good growth rate, high consumer preference, high market price and the ability to withstand adverse weather conditions make the murrels suitable candidate species for freshwater aquaculture. The institute has developed induced breeding technology of *C. striatus* in hatchery condition which would help in spreading of its farming. The captive broodstock development, induced breeding in hatchery condition and seed rearing have been mentioned in detail in this pamphlet.

In the article 'Breeding of stripped murrel using concrete tank method in the Cangkringan Area, Region of Yogyakarta, Indonesia', published in Aquaculture Asia, January-March 2020, authors described a protocol used for controlled spawning and hatchery operations for the fish. Broodfish were at least 8-12 months old, weighed 150-200 gm/individual. These were released and maintained in a permanent concrete pond (3x3x1) m^3, filled with water hyacinth. *C. striatus* fertilized eggs hatched in this spawning pond, in 48 hours with aeration. First stage nursery of the fish was conducted in a semi-permanent pond sized (10 x 5) sq.mt, depth 1.5m for 45 days.

Features in *C. striatus* culture, according to technicians of Growel Feeds Pvt. Ltd.

Scientific and technical officers of Growel Feeds Pvt. Ltd., Eluru, Andhra Pradesh have manufactured 'Nutrila', a scientifically formulated and nutritionally balanced feed, applicable for murrels and prepared an information brochure on *C. striatus* farming. According to it, *C. striatus* has certain advantages of farming, can survive for month after month in small volume of water having low depth in ponds. For nursery and grow-out farming, pond area should be 0.25-0.50 acre and 1 acre respectively, with provision for draining out water. Very early stages should be stocked @10000-20000nos/0.5 acre water body, and fingerling stage @ 5000-10000nos/acre. All seeds should be of same size. Commercially-available pelleted feed with 40% and above protein content should be used, 2-3 times in every 24 hours. Weight at harvest is 800gm, culture duration 240 days, survivability rate 90%. Value-added products like *C. striatus* fillets, smoked *C. striatus* and its pickle have also good market demand in India.

It can survive at very low water level for a few hours in open containers in markets, sold in live condition, is gaining popularity as a good foodfish among customers and fish buyers in general. Aeration in ponds *via* paddle wheel aerators is not required. Injury, bruises, deep cuts on human skin due to sharp objects – *C. striatus* can help in healing of such wounds. People get relief from muscle pain and joint

pain in general, particularly old-aged people who are suffering from gout. Curry is prepared out of roundish cut body pieces of *C. striatus* – it can be smoked and consumed, or the boiled cut pieces may be smashed and softened, subsequently small pieces of garlic, onion and green chilli are mixed with it and eaten with rice at home.

Under 'Recent trends in aquaculture', scientists at the National Fisheries Development Board, Hyderabad has published an information brochure 'Murrel culture in ponds'. Grow-out culture may be done in 0.2 ha ponds, 60m x 35m, water depth 1.5m; can be done in small backyard shallow ponds also. Stocking size of *C. striatus* weaned fingerlings is 5-8cm, density 10000nos/ha. The expected growth 600-700gm in 8-10 months. Good quality protein-rich pelleted feed, which costs Rs 100/- / kg and has 40% crude protein, is fed @ 5-2% in initial and later stage of culture.

Another study on seed production and farming of *C. striatus*

In the article 'Recent advances in murrel (snakehead) fish farming in India', published in Acta Scientific Veterinary Sciences, November 2004, authors Laxmappa Boini and two others discussed about seed production and farming of *C. striatus*. Breeding sets ((F:M = 1:2) were kept in hapas or modern breeding enclosures (water depth 40-80cm); carp pituitary extract was administered @ 20-30mg/kg and 30-40mg/kg body weight (bw) to male and female brooders, respectively. Spawning occurred 16-18 hours after injection, fertilized eggs transferred to FRP tank for hatching, hatching time 16-18 hours, larval feeding done from 72nd hour. Spawn are reared till fry stage (2-3cm) in next 20-25 days in nursery ponds, weaning feed (finely chopped low market value fish) application rate for growing spawn was 8-10% of bw per day initially.

During raising of *C. striatus* fry to fingerling stage, 75% survivability was recorded (maximum) when fry were stocked in ponds @ 15000nos/hectare. Growing fry (about to turn to fingerlings) consume zooplankton and small insects, fed a combination of low market value fish and rice bran (3:1 - 8:1); feeding rate was 6-8% of body weight. Fishes are practiced to take floating feed having 40-45% protein. For grow-out culture, *C. striatus* fingerlings are stocked @ 10000-12000nos/hectare in culture ponds, fed @ 5% of body weight daily. It attains a marketable size in the oncoming summer months, production level of 8000-10000kg/hectare/year achieved upon application of supplementary feed.

C. striatus culture by farmers in Bangladesh – few instances

At Vill. Dumuria, Dist. Khulna, a farmer had stocked 3000nos of reddish *C. striatus* seeds, 0.5 inch in size, in 3.5 dec freshwater pond ('Doba') having 7 ft water depth. Small ponds surrounded by large trees are good, water bodies which are under shade. Seeds were collected from nearby freshwater canal, now it has grown to 4-5 inch in 1.5 months of culture. Adult *Tilapia* sp is boiled in water, softened, intramuscular spines are removed as much as possible and fed to growing *C. striatus*. June-July to August-September is main period of its farming. Another farmer had stocked 2700nos fry and obtained 1600kg marketable-sized *C. striatus* at harvest. Small-sized indigenous fish like *Puntius* sp, dead but fresh, bought and kept in lukewarm to hot water for 10mins, subsequently sun-dried for sufficient time and fed to *C. striatus* fry. Adults of *Tilapia* sp are bought in fresh condition, boiled, intramuscular spines removed, kept in deep freezer and fed to the fry later on when needed. It becomes a roundish solid mass when brought out from deep freezer, slowly is thawed under natural conditions and fry(s) are able to tear off meat slowly from the roundish mass in small bits. At times when *Tilapia* sp is not available, then sun-dried small *Puntius* sp are given as food. A total 30-35kg feed is required for 2700-3000nos of growing fry everyday. Minnows like *P. ticto*, *P. sophore* and *Esomus danricus* (1.5-2.5 inch) can be bought from market at low price and the mass (two palm-full amount) is kept in deep freezer in raw state. Frozen mass is used as fish food by the farmers when needed.

C. striatus fingerlings (4-6 inches and above) and semi-adults jump out of water on or over embankments, so high erect split bamboo and net fencing is required on all sides. Potassium permanganate is applied in water once during culture @ 1ppm, 250-500gm *C. striatus* obtained by the farmer at harvest (total 2600nos fishes). Small-sized homestead ponds, derelict in nature, may be used, high survivability is achieved. Shoal of *C. striatus* early stages (normally offsprings of one mother) are collected from natural water bodies like large ponds old in age and wetlands ('beels'). Trash small-sized prawns and shrimps bought from market, small-sized fishes of less economic importance and low-priced may be fed to growing *C. striatus*. A total 3.5-4.0kg of such fishes is fed to get every 1kg *C. striatus* (Courtesy: M. Tofazuddin Ahamed, Bangladesh Fisheries Department and Ahamed Aquatechbd).

Channa striatus 600gm

A farmer at Vill. Aanghata, Khulna mentioned that while feeding the early stages stocked in ponds, initially, a good number of the small-sized *Puntius* sp, *E. danricus*, *Glossogobius giuris* is bought from market are pressed (crushed) wholly in raw state and softened, before feeding *C. striatus*. These fishes are available in good quantity during onset of winter. At low stocking density, he stocked 300nos *C. striatus* seeds in 2.5-3.0 decimal pond (Doba). It weighed 250-300gm in his pond, 5-months old stage, stocked previously at 0.5 inch size in May. It will be sold in coming April-May at about 1kg size. Stocking may be increased to 300-400nos per decimal. Cannibalism observed at 3-4 inch stage but not in older stages when feeding is done properly.

The live fry (1-2 inch) of *Labeo bata* and *Hypophthalmichthys molitrix* raised in carp nursery ponds separately can be fed to growing *C. striatus*. Another farmer has obtained 1kg size in 7-8 months of culture, total 950-1000kg produced from 6 decimal pond (experienced farmer) and 4000-5000kg (4000nos survived) from 50dec pond (new farmer), when stocked at 1-2 inch size. Dead but fresh

Buddhadeb Maity holding two C. striatus in hand

small-sized fishes used as food. On the 115th day of culture, *C. striatus* growth rate in a farmer's pond observed to be 200-250gm (Courtesy: Deepto Krishi, Bangladesh). Ant eggs are also accepted by the fish in ponds. March-April to August-September is the breeding period of *C. striatus* in large water bodies. Marketable-sized fishes are harvested and supplied to market after dewatering the ponds or Doba (Courtesy: Md. Jakir Hossain, Krishi Khamar, Bangladesh).

C. striatus may be reared in cement tanks till 100gm size. Very early stages are stocked in pond in 1st week of May, 4 inch size is harvested in December for stocking in bigger ponds. The more is the food given, faster is its growth rate. Indian major carps (5 inch) can be stocked and cultured in the same pond. On the 8th-9th month of culture, *C. striatus* has attained above 1kg body weight in a farmer's pond. He produced fry of *Puntius javanicus* and *H. molitrix* (1.5-2.0 inch) three weeks in age, meant to be fed to *C. striatus*. These are chopped into small pieces and fed @ 10-15% of bw everyday. He experienced that every 1kg fish grows up by consuming 3.0-3.5kg of the carp fry (Courtesy: A. S. Firdous, Dist. Satkhira, Krishi o Krishoker Golpo)

A farmer at Satkhira had stocked 1700nos *C. striatus* fry (collected from beel) in 4.0-4.5 decimal pond, which attained 50-100gm in 45 days. He fed boiled *Tilapia* sp to the fish, morning and evening time, after removing intramuscular spines manually as much as possible. According to the farmer, it will weigh 500-600gm (marketable size) in coming November (Courtesy: Ranjit Sardar, Dist. Satkhira. Krishi Songbaad). Adults of *Tilapia* sp are cut into small pieces (in raw state) with spines removed – it is readily accepted by *C. striatus* 200-300gm and above in size in ponds. According to farmer Sajjad Sikdar at Chattagram, Bangladesh, 500nos of *C. striatus* (100gm size) may be stocked in 3-4 dec pond, cultured for 6 months, fed 2kg sun-dried *Puntius* sp everyday, and 350kg marketable-size fish will be obtained, each weighing 700gm. Another farmer obtained *C. striatus* hatchlings in his 5-6 decimal pond on the 6th day of release of 1 pair of brood fish, 2500-3000 in number. He used raw duck eggs as food daily, 2-3 times a day for the first 4 days. Thereafter he used small-sized *Puntius* sp in boiled form, could be weaned within 2-3 days. After that, the wastage of sun-dried fish was used as food after boiling. It feeds more in quantity in comparison to major carps. Ant eggs collected from wild trees may be used as food for growing *C. striatus* fingerlings, also small-sized fishes in raw and frozen form.

Controlled growth of water hyacinth and *Ipomoea aquatica* must be allowed in *C. striatus* culture ponds. A 5-feet high fencing on all sides of pond is important. It breeds in natural water bodies from the beginning of 3rd week of April, young ones (7-10 days old) move in a shoal which may be collected. Finely-pulverized fish meal or marine shrimp meal may be provided to the early stages. On the 15th day, it attains about 3 inch size - from when it starts to feed upon fry (about 1 inch) of the afore-mentioned carps. It may attain 700-1000gm in 6 months in mixed species culture (Courtesy: Bekar samasyaar samadhan, KrishiKotha, Bangladesh). Area of pond, everywhere in this write-up refers to 'effective water area'.

End note

C. striatus is the state fish of Andhra Pradesh and Telangana. The hardy *C. striatus* involves low culture cost. Earlier it was considered as a wild, naturally-occurring predatory fish, quite frightening appearance, living in foul muddy waters in swamps and Doba, less importance given. But presently it is considered as a new prospective fish for aquaculture, a good foodfish with essential nutrients, preferred for farming, sold at a high price in market with increasing consumer demand. In end of April 2025, fish farmer Buddhadeb Maity at Vill. Ghagra, GP Kismat-Naikundi, Mahishadal CD Block, Dist. Purba Medinipur has started *C. striatus* farming in ponds having concrete sides after procuring 5500nos of seeds from Andhra Pradesh. Initially the seeds 1.5-2.0 inch size were reared in concrete tank (12 x 8 x 4.5) cubic feet in size (having outlet in middle) for 20-25 days. Remarkably, in two ponds 6 dec and 12 dec (3 feet deep), it is having a fast growth rate, 250-300gm in first 2 months; adults will be sold @ Rs 350-400/- per kg in wholesale market. Fishes are 500-800gm in weight, as in September 2025 and will attain 1.2-1.5kg in March-April 2026. Commercially-available pelleted feed 0.8mm (kept soaked in water before applying), 1.2mm and 1.8mm dia is provided to growing *C. striatus*. In 2024, he also did farming of *C. striatus* using only 500nos seeds. He provides total 15kg pelleted feed everyday for his 5500nos *C. striatus*; dried turmeric dust, Terramycin powder and Becosul tablets are added with feed. I had a conversation with Sri Maity on 12/09/2025. Yearlings of *Catla catla* (200gm size, total 20kg) are stocked with *C. striatus*, which exhibited good growth.

New avenues, new farmer-friendly technologies are coming up in farming of non-conventional fish species. Dr Arunashri A. and Dr Siva N. have discussed in their article 'Fostering rural aquapreneurs through revitalization of derelict water bodies into aquaculture pools', in Book 'Farmer-friendly innovations in Fisheries: Rural poverty to prosperity', published by College of Fisheries, Kishanganj in July 2023, that "Under MGNREGS, water conservation and water harvesting structures are created by local individuals. These water bodies are often abandoned and left unused. It is believed that with proper utilization, minimal investment and effective management, these derelict water bodies can be transformed into profitable aquaculture pools". Certainly it can be done, and, in this context, I think farmers may go for *C. striatus* farming, fish and duck integration farming, or air-breathing fish culture.

Strategies to Delay Precocious Puberty in Farmed Fish for Enhanced Aquaculture Efficiency

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HIGHLIGHTS:

- Precocious puberty negatively impacts fish growth, quality, and farming productivity.
- Photoperiod manipulation can delay maturation in species like Atlantic salmon.
- Hormonal treatments like GnRH analogs regulate and suppress early gonadal development.
- Selective breeding programs target strains with genetically delayed puberty for long-term sustainability.
- Induced sterility techniques like triploidization divert energy from reproduction to somatic growth.
- Nutritional control, especially lipid and protein levels, influences puberty onset.
- Regular swimming exercises in some species delay testicular development through hormonal changes.
- Combining environmental, genetic, and management strategies provides optimal control of early maturity.
- Delaying puberty increases efficiency in hatcheries and improves overall aquaculture yield.

Introduction:

Precocious puberty in farmed fish, where fish reach sexual maturity earlier than desired, poses significant challenges in aquaculture. Early maturation often leads to reduced growth rates, lower feed conversion efficiency, compromised flesh quality, increased aggression, and higher susceptibility to diseases, all of which reduce the profitability and sustainability of fish farming. This article explores evidence-based strategies to delay precocious puberty in farmed fish, drawing from research papers and online resources, to enhance aquaculture efficiency while maintaining fish welfare and environmental sustainability. Precocious puberty in aquaculture species refers to the early onset of sexual maturation, which can negatively impact growth performance, flesh quality, and overall productivity. Managing and delaying this early maturation is crucial for optimizing aquaculture efficiency.

Understanding Precocious Puberty in Farmed Fish:

Puberty in fish marks the transition from an immature juvenile to a reproductively mature adult, driven by the activation of the brain-pituitary-gonad (BPG) axis. This endocrine system regulates the production of gonadotropins (follicle-stimulating hormone [FSH] and luteinizing hormone [LH]), which stimulate gametogenesis and sex steroid production. Precocious puberty is particularly problematic in species like Atlantic salmon (*Salmo salar*), Atlantic cod (*Gadus morhua*), and European sea bass (*Dicentrarchus labrax*), where early-maturing males (e.g., "jacks" in salmon) divert energy from somatic growth to reproduction, resulting in smaller, less marketable fish. For instance, in Atlantic salmon, precocious males can mature as parr (10–30 g) or jacks (0.5–5 kg), significantly impacting farm productivity.The onset of puberty is influenced by internal factors (e.g., growth rate, adiposity, genetics) and external factors (e.g., photoperiod, temperature, feed intake). Rapid growth, for example, is positively correlated with early puberty, making fast-growing strains more susceptible. Delaying puberty allows fish to allocate energy toward growth, improving yield, quality, and farm efficiency.

Strategies to Delay Precocious Puberty:

Several strategies have been developed to control puberty in farmed fish, focusing on environmental manipulation, genetic interventions, hormonal treatments, and nutritional management. These approaches aim to suppress or delay the activation of the BPG axis, ensuring fish reach market size before maturation.

1. Photoperiod Manipulation:

Photoperiod, or the duration of light exposure, is a powerful tool for controlling puberty in fish, as it influences the BPG axis through

melatonin signaling. Research shows that constant or altered light regimes can suppress gonadogenesis in several species. Adjusting light exposure is a non-invasive method to control sexual maturation. Studies have shown that modifying the photoperiod can significantly reduce the incidence of early puberty in farmed fish. For instance, implementing a daily light cycle of 21 hours of light followed by 3 hours of darkness reduced early maturation rates in Atlantic salmon from 33% to 10%. For example:

- **Atlantic Cod**: Continuous light exposure starting in July significantly reduced testis growth and spermatogenesis compared to natural light conditions, with high apoptotic germ cell loss observed in constant light groups.
- **European Sea Bass**: Constant long photoperiods (e.g., 24 hours of light) suppressed early puberty in juvenile males, with a narrow photosensitive period identified for optimal suppression of gonadogenesis.
- **Atlantic Salmon**: Abrupt changes in photoperiod, such as switching from long to short days, disrupted puberty progression in precocious males, preventing completion of maturation in some cases.

Implementation: Farmers can use artificial lighting systems to maintain constant or extended photoperiods during critical developmental stages. For instance, continuous light before and during gametogenesis reduced sexual maturation in male European sea bass. This method is environmentally friendly, as it avoids chemical interventions, and can improve fish welfare by reducing stress associated with early maturation. However, prolonged light exposure may affect fish behavior and energy expenditure, requiring species-specific optimization.

2. Temperature Control:
Water temperature modulates the timing and progression of puberty by affecting metabolic rates and hormone production. Lower temperatures can delay gonadal maturation, while higher temperatures often accelerate it. For example:

Pikeperch (*Sander lucioperca*): Temperature-induced puberty at 12°C for 12 weeks, followed by maintenance at 14°C, resulted in slower gonadal maturation compared to higher temperatures (16–18°C), with 80% of females reaching mid-vitellogenesis at 14°C after 16 weeks.

Atlantic Salmon: Cold water conditions (e.g., 4–8°C) delayed the final stages of sexual maturation compared to warmer conditions (12–16°C).

Implementation: Recirculating aquaculture systems (RAS) allow precise temperature control, enabling farmers to maintain suboptimal temperatures for puberty during key developmental windows. However, temperature manipulation must balance growth rates and welfare, as excessively low temperatures may slow somatic growth.

3. Genetic and Hormonal Interventions:
Genetic and hormonal approaches target the molecular mechanisms of puberty, offering precise control but raising ethical and regulatory concerns. Hormonal therapies, such as the administration of gonadotropin-releasing hormone analogs (GnRH-a), are employed to regulate the timing of puberty. These treatments can delay or suppress gonadal development, thereby extending the growth phase. However, the application of hormones must be carefully managed to avoid potential side effects and ensure fish welfare. Creating sterile fish populations through methods like triploidization or gene editing can prevent sexual maturation altogether. Sterile fish allocate more energy towards somatic growth rather than reproduction, leading to improved growth rates and flesh quality. For example, sterile coho salmon have demonstrated continued growth beyond the typical maturation period of fertile counterparts.

Genetic Silencing of FSH Receptor: A study on Atlantic salmon used CRISPR-Cas9 to alter the FSH receptor (*fshr*) gene, preventing puberty in some males while preserving fertility. This approach delayed maturation, allowing for larger, healthier fish with better market value. Unlike other fish species (e.g., medaka, zebrafish) where both FSH and LH are required, salmon rely solely on FSH for puberty, making this a promising species-specific strategy.

Triploidization: Inducing sterility through triploidization (creating fish with three chromosome sets) prevents puberty by disrupting gametogenesis. Triploid sea bass exhibited reduced gonadal development compared to diploids, improving growth performance. However, triploid fish may face welfare issues, such as increased disease susceptibility, limiting commercial adoption.

Hormonal Manipulation: Exogenous hormones, such as gonadotropin-releasing hormone agonists (GnRHa) or luteinizing hormone (LH) preparations, are typically used to induce maturation but can be adapted to suppress puberty by disrupting natural hormonal rhythms. For example, steroid implants in juvenile sea bass reduced precocity under continuous light. Hormonal treatments, however, are controversial due to potential residues in fish and environmental impacts.

Implementation: Genetic interventions like CRISPR require advanced facilities and regulatory approval, making them less accessible for small-scale farms. Triploidization is more established but requires careful monitoring of fish health. Hormonal treatments are practical but should be minimized to address consumer and environmental concerns.

4. Nutritional Management and Feed Restriction:
Nutrition plays a critical role in puberty onset, as high energy reserves (adiposity) signal the BPG axis to initiate maturation. Feed restriction or dietary modifications can delay puberty by limiting energy availability. Diet composition influences the onset

of puberty. Feeding strategies that control energy intake, particularly lipid content, can modulate growth rates and delay sexual maturation. However, prolonged feed restriction may negatively affect fish health and welfare, so balanced nutritional plans are essential.

Restricted Feeding: Short-term or repeated feed restriction delayed puberty in Atlantic salmon and European sea bass by reducing energy allocation to gonadal development. Unlike prolonged starvation, which is unsuitable for aquaculture due to growth losses, periodic feed restriction maintains acceptable growth rates.

Dietary Composition: Diets low in marine fish oils and high in plant-based oils delayed sexual maturation in male European sea bass, altering testis histology and reproductive hormone levels.

Implementation: Farmers can implement controlled feeding regimes, such as reduced rations during critical puberty windows, or switch to plant-based feeds. These strategies are cost-effective and sustainable, reducing reliance on marine ingredients. However, nutritional management must ensure adequate growth and welfare, as underfeeding can stress fish.

5. Selective Breeding and Monosex Stocks:

Selective breeding exploits genetic variation in age at puberty to produce strains with delayed maturation. Monosex stocks, particularly all-female populations, reduce the incidence of precocious males, which mature earlier than females in many species. Selective breeding programs aim to develop strains that naturally exhibit delayed sexual maturation. By choosing broodstock with desirable traits, such as slower maturation rates, producers can gradually shift the population genetics towards delayed puberty. This approach offers a sustainable, long-term solution without the need for chemical interventions.

- **Selective Breeding**: In Atlantic salmon, breeding programs targeting late maturation achieved 8–10% gains per generation in growth traits, delaying puberty and improving yield. The Genetic Improvement of Farmed Tilapia (GIFT) program similarly prioritized growth over early maturation.
- **Monosex Stocks**: All-female stocks in species like salmon and sea bass exploit sex-dimorphic growth patterns, as females mature later and grow larger. This is achieved through hormonal sex reversal or genetic selection.

Implementation: Selective breeding requires long-term investment in genetic programs, but it offers sustainable, chemical-free solutions. Monosex stocks are widely used in tilapia and salmon farming but require expertise in sex determination and breeding. Both approaches enhance efficiency by reducing the proportion of early-maturing fish.

Impacts on Aquaculture Efficiency and Sustainability:

- **Increasing Growth and Yield**: Fish allocate energy to somatic growth rather than reproduction, resulting in larger, more valuable individuals. For example, delayed puberty in Atlantic salmon reduces the incidence of jacks and grilse, which are less profitable.
- **Improving Feed Conversion**: Early maturation reduces feed conversion efficiency due to energy diversion to gonadal development. Photoperiod and nutritional strategies minimize this loss.
- **Enhancing Flesh Quality**: Puberty alters muscle composition, reducing market quality. Delayed maturation ensures consistent texture and flavor, as seen in sea bass studies.
- **Reducing Aggression and Stress**: Precocious males, particularly in salmonids, exhibit increased aggression, compromising welfare. Delaying puberty mitigates these behaviors, improving group dynamics.
- **Supporting Sustainability**: Strategies like photoperiod manipulation and plant-based feeds reduce environmental impacts compared to hormonal treatments or marine-based feeds. Polyculture systems, where species with complementary traits are co-farmed, further enhance resource efficiency and reduce interspecific competition.

Challenges and Considerations:

- **Species-Specific Responses**: Puberty control varies by species due to diverse reproductive patterns. For instance, Atlantic salmon rely solely on FSH, unlike other fish, requiring tailored approaches.
- **Welfare Concerns**: Triploidization and prolonged feed restriction may compromise fish health, while constant light exposure can disrupt natural behaviors. Welfare assessments, using indicators like swimming activity and stress hormones, are critical.
- **Cost and Scalability**: Genetic interventions and RAS-based temperature control are expensive, limiting adoption by small-scale farmers. Photoperiod and nutritional strategies are more accessible but require optimization.
- **Regulatory and Consumer Acceptance**: Hormonal treatments and genetic modifications face scrutiny due to environmental and food safety concerns, necessitating transparent practices.

Future Directions:

- **Precision Aquaculture**: Sensors and telemetry can monitor fish behavior and physiology in real-time, optimizing photoperiod and temperature regimes.
- **Genomics and Proteomics**: High-throughput tools like proteomics can identify biomarkers for puberty onset, enabling targeted interventions.
- **Sustainable Feeds**: Developing alternative protein sources (e.g., insect meal, algae) can reduce reliance on marine ingredients while delaying puberty.
- **Polyculture and Ecosystem Services**: Co-farming species

with delayed puberty traits (e.g., molluscs, seaweed) can enhance nutrient recycling and farm efficiency.

Conclusion:

Delaying precocious puberty in farmed fish is a critical strategy for enhancing aquaculture efficiency, improving fish growth, quality, and welfare, and ensuring sustainability. Photoperiod manipulation, temperature control, genetic and hormonal interventions, nutritional management, and selective breeding offer complementary approaches, each with unique benefits and challenges. By tailoring these strategies to species-specific needs and integrating them with modern technologies, the aquaculture industry can overcome the challenges of early maturation, meeting the growing global demand for seafood while minimizing environmental impacts. Continued research and collaboration among scientists, farmers, and policymakers will be essential to refine these methods and promote a sustainable blue revolution. Delaying precocious puberty in farmed fish is vital for enhancing aquaculture efficiency. Employing a combination of strategies—such as photoperiod manipulation, hormonal treatments, selective breeding, induced sterility, nutritional management, and physical exercise—can effectively manage sexual maturation. Tailoring these approaches to specific species and farming conditions will optimize growth performance and product quality.

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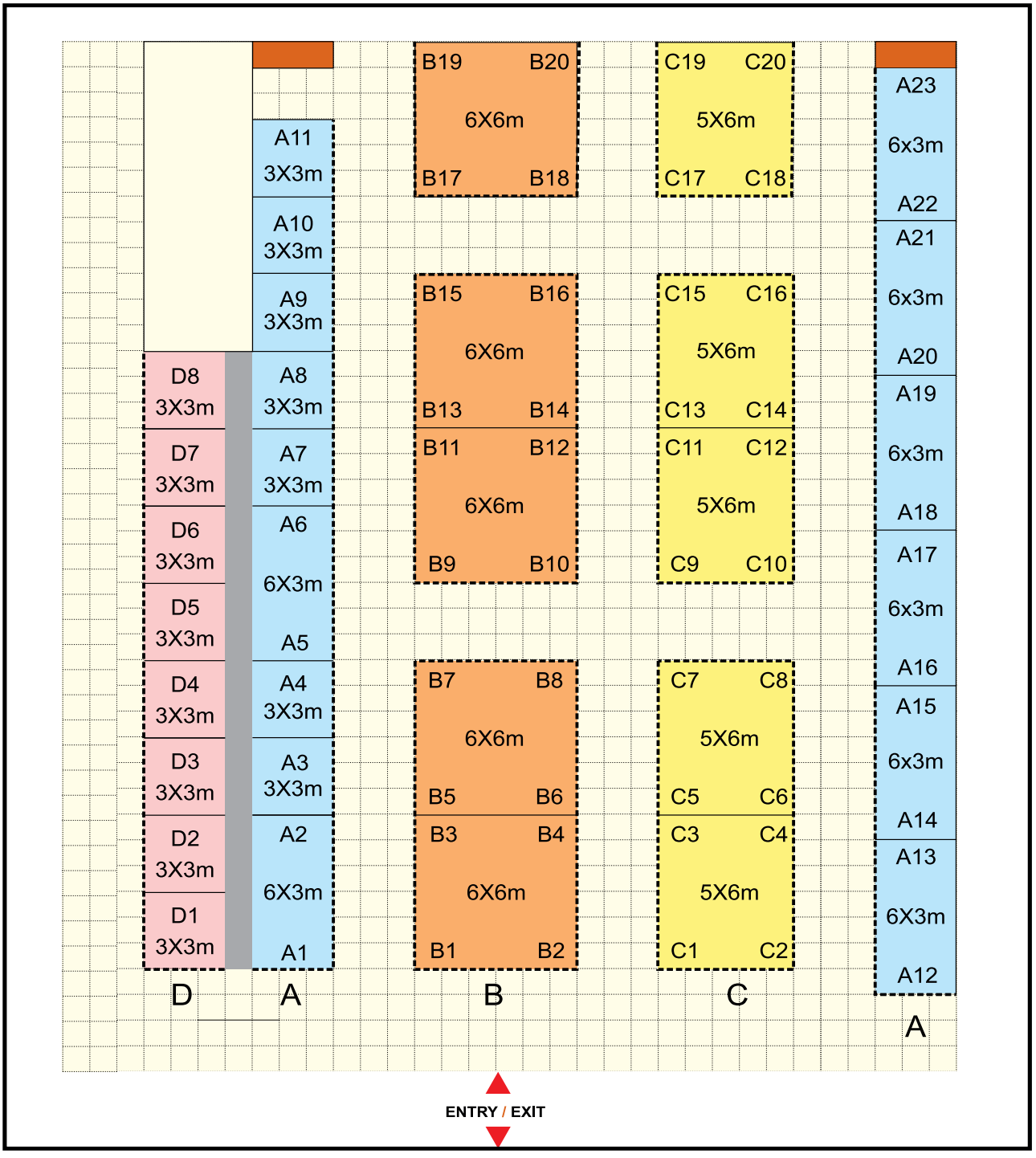

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