Report of the

3rd High-Level Meeting on Aquaculture Transformation in Asia and the Pacific Region

1-2 July 2025, Shanghai Ocean University, P.R. China

Prepared by:

Network of Aquaculture Centres in Asia-Pacific
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亚洲及太平洋区域水产养殖转型第三届高级别会议
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1-2 July 2025 Shanghai Ocean University, China
HLM 3
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Shanghai Ocean University, China 上海海洋大学
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Executive Summary

Since the holding of the first (2022) and second (2023) High Level Meeting (HLM) on Aquaculture Transformation in Asia and the Pacific, the Network of Aquaculture Centres in Asia-Pacific (NACA) and the Food and Agriculture Organization of the United Nations (FAO) are actively collaborating with partners and NACA member countries, to facilitate implementation of the White Paper and stimulate aquaculture transformation in Asia and the Pacific Region. Momentum continues to build, but greater collective effort is required to achieve the targeted transformation by 2030. The HLM 3 was, therefore, organized to assess progress made in aquaculture transformation in Asia and the Pacific region and identify collaborative actions to catalyse further progress. Specifically, it aims to: share assessment results, innovation and investment showcases for aquaculture transformation in Asia and the Pacific region; discuss priority actions needed for investment and partnerships to upscale impacts; and, enhance and build new partnerships and intensify regional cooperation on aquaculture transformation. Organized by NACA, FAO and Shanghai Ocean University (SHOU), the meeting focused on the implementation of the White Paper, especially on innovative aquaculture technologies for sustainable intensification of aquaculture production, on the progress made in the development of National Innovation and Investment Plans (NIIPs) in some countries, and showcases of some innovative technologies in aquaculture around the region.

There were four panel discussions with invited experts from around the world: 1) Regional assessment of innovation and investment for aquaculture transformation in the Asia-Pacific; 2) Progress on aquaculture transformation following the White Paper's regional road map; 3) Innovation showcases for aquaculture transformation in Asia-Pacific; and, 4) Investing in innovation for transforming aquatic food system. Based on the different action priorities in the White Paper, country statements were delivered by representatives of NACA member governments and The Pacific Community (SPC; associate member of NACA), as well as from non-state representatives including WorldFish and SHOU.

Key takeways from the discussions and deliberations are the following:

- Future aquaculture needs to be knowledge based;
- Increase access to experts;
- Many farmers are still skeptical of unfamiliar technologies;
- Incentives must be aligned to ensure farms and other businesses operate not only profitably but also sustainably and responsibly;

- Positive aspects of aquaculture should be more widely highlighted; make use of storytelling to highlight positive social benefits;
- Bring investment down to the farm level (especially small-scale farmers);
- We should collaborate to leverage our collective strengths.

Looking ahead, NACA and FAO in collaboration with partners will continue to support the development of the NIIPs in four participating countries as pilot (India, the Philippines, Thailand and Vietnam). Assessment of the innovation space in support of the regional TCP to understand the innovation and investment ecosystem and identify key players, bottlenecks, gaps, and enabling policy support, especially in coordination to avoid duplication of effort will be undertaken. Assessment and monitoring of innovative technologies implementation will be conducted through the Aquaculture Transformation Monitoring and Assessment System (ATMS) which will be developed for implementation in due time. The establishment and operationalisation of the regional Aquaculture Innovation and Investment Hub (AIIH) will be pursued involving both public and private partners. This will pave way in the active expansion and collaboration with investors, and build investment strategies and partnership that meet the needs of aquaculture transformation. Lastly, preparation will be underway towards the holding of HLM 4 and continue to seek government support to raise awareness of the White Paper issues to the industry and on the ground.

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Background

Asia and the Pacific region has led the world's aquaculture production for decades. The region contributes more than 90 percent of global aquaculture production with a broad range of farming systems, all environments, species and engagement of millions of producers and value chain actors. However, aquaculture development in the region grows under various challenges, including scarcity in water and land, environmental pressures, climate change, generational changes and shifting globalization. Innovations and investment to transform aquaculture in the region are needed for a major shift towards more efficient, inclusive, resilient, and sustainable aquatic food systems. The approach is aligned with the **FAO's Blue Transformation Roadmap**[1] which outlines a vision for the FAO's work on aquatic food systems for the period 2022–2030, covering three core components on aquaculture, capture fisheries and value chain upgrading. The roadmap highlights a sustainable intensification and expansion of aquaculture as essential for increased future aquatic food supply.

To facilitate regional collaboration towards the Blue Transformation vision, the FAO Regional Office for Asia and the Pacific (FAO RAP) in collaboration with the Network of Aquaculture Centres in Asia-Pacific (NACA) convened a series of **High Level Meetings** (HLM) on aquaculture transformation, bringing together senior policy makers, business leaders, development banks, investors and development partners to discuss sector transformation through innovation and investment.

- High Level Meeting 1 (22-23 November 2022) discussed the White Paper on Aquaculture transformation – Innovation and Investment for Sustainable Intensification and Expansion of Aquaculture in Asia and the Pacific Region.
- High Level Meeting 2 (8-9 November 2023, Bangkok, Thailand) showcased progress being made in aquaculture transformation, identified priorities, actions and partnership opportunities to further accelerate innovation and investment for aquaculture transformation within the region.
- **High Level Meeting 3**, the present endeavor, was held from 1-2 July 2025 in Shanghai Ocean University, China, back-to-back with the 34th NACA Governing Council Meeting. The meeting included 65 participants from 19 states in the Asia-Pacific region and Middle East, intergovernmental organisations (Pacific Community, NACA, FAO), development partners (World Bank), and private sector (Guangdong Evergreen Group, FutureFish, Tathva, UniFAHS, Aquaculture Stewardship Council), and academia (Shanghai Ocean University, Chinese Academy of Fisheries Sciences, Standford University). The list of participants is attached as **Annex 1**.

[1] FAO. 2022. *Blue Transformation - Roadmap 2022–2030: A vision for FAO's work on aquatic food systems*. Rome, Italy. https://doi.org/10.4060/cc0459en

Objectives of HLM-3

The main objective of HLM-3 was to assess progress made in aquaculture transformation in Asia and the Pacific region and identify collaborative actions to catalyse further progress. The specific objectives of HLM-3 were as follows:

- Share assessment results, innovation and investment showcases for aquaculture transformation in Asia and the Pacific region.
- Discuss priority actions needed for investment and partnerships to upscale impacts.
- Enhance and build new partnerships and intensify regional cooperation on aquaculture transformation by 2030.

The programme is attached as **Annex 2**.

Opening session

Dr. Rong Wan, President of Shanghai Ocean University, delivered the welcome remarks. Opening remarks was made by Haiwen Sun, Deputy Director of Bureau of Fisheries, Ministry of Agriculture and Rural Affairs. Dr Eduardo Leano, NACA Director General, gave a presentation on the background and objectives of HLM-3. A video of the background presentation is available online at: https://enaca.org/?id=1424

Introduction and Panel Discussion

Mike Phillips, FutureFish, presented a regional assessment of innovation and investment for aquaculture transformation in the Asia-Pacific region. A video of the presentation is available online at: https://enaca.org/?id=1423. This work, conducted in 2024 and early 2025, aligns with the goals outlined in the White Paper on Aquaculture Transformation[2], aiming to increase production, improve environmental resilience, enhance aquaculture value chains, and strengthen governance by 2030.

The assessment highlighted several key innovation areas contributing to these goals, including:

1. **New or Novel Production Systems**: Innovations such as urban aquaculture, nature-based solutions, and low-cost systems developed in Thailand, including the urban mud crab condominium and biofloc systems.
2. **Genetics, Breeding and Seed Quality**: Advancing genetic improvements and domestication, with a focus on carps and tilapia, which are critical for food security but have received less attention in genetic research.

[2] FAO & NACA. 2023. Aquaculture transformation – Innovation and investment for sustainable intensification and expansion of aquaculture in Asia and the Pacific region. Bangkok, FAO. https://doi.org/10.4060/cc4962en

3. **Smart Farming Systems, IoT, AI, and Machine Learning**: The use of AI and machine learning to enhance farm management, efficiency, and productivity through technologies like smart aerator systems and energy management tools.
4. **Health Management, Disease Control and Health Products**: Innovations in disease control, vaccines, and early warning systems to improve health management, particularly for shrimp farming, reducing reliance on antibiotics.
5. **Alternative and Novel Feed Ingredients and Feed Additives**: The exploration of sustainable feed alternatives, such as black soldier fly larvae and *Artemia* biomass, to reduce dependency on traditional fish meal and improve feed sustainability.
6. **Financial Services and Products**: Emerging tools like microfinance, insurance, and data-driven credit systems designed to support smallholder farmers and address financial challenges in the aquaculture sector.
7. **Water Quality, Waste Management, Circular Economy**: Development of circular economy systems and waste recycling technologies that improve water quality and reduce the environmental footprint of aquaculture.
8. **Social Innovation**: Empowering smallholders through community-based models, digital platforms, and more inclusive approaches that connect farmers to markets and resources.
9. **Climate Resilience and Energy**: Innovations aimed at reducing energy consumption and promoting renewable energy, including solar-powered shrimp farms, to enhance sustainability in aquaculture operations.
10. **Consumers and Aquaculture Products and Value Chain Improvement**: The use of digital tools to connect fragmented value chains, improving traceability and providing better market access, particularly for smallholder farmers.
11. **Seaweed and Innovative Products and Uses of Algae and Plants**: Innovations in seaweed farming, including offshore systems and the development of new products derived from seaweed, which have potential applications in agriculture and aquaculture.
12. **Institutions, Policy and Governance Innovation**: Strengthening institutions and fostering policies that support innovation, investment, and sustainable aquaculture practices, alongside efforts to improve governance and partnership frameworks.

Challenges & Opportunities:

- **Scaling Innovations**: Many innovations, particularly those for low-trophic species, are still in early stages and face significant challenges in scaling up.
- **Investment Gaps**: A major funding gap exists, especially for low-trophic species like carps and tilapia, which are vital for food security but have received less investment.
- **Private Sector Engagement**: The private sector is predominantly focused on high-value species like shrimp, leaving smaller-scale farming systems and low-value species underfunded.

- **Policy & Regulation**: Regulatory hurdles remain, particularly in health management, feed innovations, and the adoption of new technologies, which hinder broader implementation.

Panel Discussion

The panel discussion featured four experts:

- **Rishita Changede (TeOra):**
  Rishita Changede is the CEO of TeOra, a company that focuses on disease management solutions for tropical species aquaculture, particularly shrimp and fish. They use technologies such as microRNA, protein folding, AI, and computer vision to create vaccine-like solutions for these species. The products are designed for easy oral administration, making them scalable and feasible in regions where injections are impractical. TeOra's solutions have shown an efficacy of over 85%, with some products reaching 95%. The company has received repeat orders from farmers, indicating strong acceptance in the market. However, TeOra faced challenges in raising awareness on aquatic animal diseases, especially in the early stages of the company's development, and in securing investment.

- **Yuejuan Cai (Guangdong Evergreen Group):**
  Yuejuan Cai works at Guangdong Evergreen Group, which began as a grain trading company and later transitioned into the aquatic feed industry. The company has developed its own selective breeding program for shrimp, producing disease-resistant varieties like Zhongxin No. 1 and Zhongxin No. 2. These shrimp varieties have proven resistance to white spot syndrome and *Vibrio*. The company has also pioneered on artificial feeds for fish species such as yellow croaker, grouper, and sea bass. The company has expanded internationally, with feed mills in Vietnam, Indonesia, and Malaysia. While the company has achieved success with its breeding programs and feed solutions, they face challenges related to high investment costs in technologies like Recirculating Aquaculture Systems (RAS), which are essential for sustainability but prohibitively expensive for smaller farmers.

- **Kittiya Wongkamjan (UniFAHS):**
  Kittiya Wongkamjan is the CEO and co-founder of UniFAHS, a company that provides nature-based solutions using bacteriophages to control bacterial diseases in shrimp farming. UniFAHS works with farmers to understand the pathogen problems in their production systems and develops customized phage formulations to tackle these bacterial issues. The company's technology helps reduce bacterial contamination without disrupting the ecosystem or using harsh chemicals. However, one of the challenges they faced was how to communicate the benefits of using bacteriophages, especially since the term "phage" refers to a virus, which might scare some farmers. To overcome this, UniFAHS worked with distribution partners and communication experts who understand the farmers' needs and could

effectively explain the technology. This approach has been key in driving adoption among farmers.

- **J.K. Jena (Indian Council of Agricultural Research):**
  Dr. Jena is the Deputy Director General at the Indian Council of Agricultural Research (ICAR), overseeing various fisheries and aquaculture research institutes. ICAR has been involved in developing improved fish species through selective breeding programs, such as for rohu and catla, and is also exploring genome editing to accelerate genetic improvements. He emphasised that, while ICAR has made significant progress in breeding and health management, one of the biggest challenges in aquaculture remains the translation of research technologies into practical and actionable solutions for farmers, especially in developing countries. He noted that many farmers were unaware of the latest technologies available to them and that there were regulatory challenges, especially with the approval of vaccines and alternative feed ingredients.

On the biggest challenges faced when building the company and how they were able to overcome such, **Changede** (TeOra) shared that one of the most significant challenges was starting the company during the COVID-19 pandemic, which added uncertainty to an already challenging market. She also highlighted the initial difficulty in raising awareness on aquatic animal diseases. One of the biggest hurdles was securing investment, especially since aquaculture was often overshadowed by more well-known industries like livestock. And lastly, the lack of commercial-grade trial facilities for tropical species aquaculture, as most facilities were focused on salmon and other more commercially established species.

On communication barriers between researchers and farmers when introducing new technologies, **Kittiya** (UniFAHS) explained that communicating with farmers requires speaking their language and ensuring that the technology was framed in a way that makes sense to them. She emphasized that introducing new technologies is a gradual process and could not be rushed. By working with trusted intermediaries who had established relationships with farmers, UniFAHS was able to bridge the knowledge gap. Moreover, farmers needed time to adjust and often required consistent engagement before they fully adopt a new technology.

Cai (Guangdong Evergreen Group) discussed the high costs of sustainable farming systems like RAS and deep-sea farming, which remain investment-intensive making them inappropriate especially for small-scale farmers. She stressed the need for cooperation between the public and private sectors to make these systems more affordable and accessible. She also mentioned that infrastructure issues, such as inadequate electricity and poor transportation, need to be addressed to ensure the success of these aquaculture systems. Natural risks, such as typhoons and disease outbreaks, were additional challenges that need to be mitigated.

In the next five years, key challenges were identified by the panellists and suggested ways to solve them:

- **Changede** emphasized that disease management is a major challenge in aquaculture, particularly as intensification increases the risk of disease. She advocated for partnerships between universities, governments, and early adopters to ensure that new solutions were rapidly regulated and brought to market.
- **Cai** highlighted the high costs associated with sustainable aquaculture technologies as a key barrier. She suggested that partnerships between the public and private sectors were essential for overcoming these challenges and for making aquaculture practices more sustainable.
- **Kittiya** stressed the importance of both financial and technical support for farmers. She suggested that creating mechanisms to help farmers validate and verify new technologies would be key to fostering widespread adoption.
- **Jena** discussed the need for aquaculture to evolve into knowledge-based farming. He advocated for improving water efficiency, energy use, and genomics, and stressed the importance of partnerships to accelerate the adoption of these technologies.

Progress on aquaculture transformation following the White Paper regional roadmap

Tipparat Pongthanapanich, FAO, presented an overview and status on the development of the National Innovation and Investment Plans (NIIPs) and the Aquaculture Transformation, Monitoring, Evaluation and Learning System (ATMS). A video of the presentation is available online at: https://enaca.org/?id=1422. The presentation focuses on the ongoing efforts to accelerate aquaculture transformation in the region through National Innovation and Investment Plans (NIIPs) and a regional monitoring system. These efforts are aligned with the FAO's Blue Transformation Roadmap, which encompasses sustainable aquaculture, fisheries, and environmental management.

Key Points:

National Innovation and Investment Plans (NIIPs):

- The NIIPs are designed to help countries create tailored action plans that focus on innovation and investment in aquaculture. These plans are crucial for achieving the Blue Transformation's goals by targeting specific needs within each country's aquaculture sector.
- The FAO is working closely with countries such as India, Philippines, Thailand, and Vietnam to develop and implement these plans.
- Each country will develop a roadmap that outlines priority action areas and identifies specific innovations that will drive the transformation. This includes

addressing challenges such as energy efficiency, climate resilience, and sustainable feed alternatives.

Aquaculture Transformation Monitoring & Evaluation System (ATMS):

- The ATMS is a tool developed by FAO and NACA to monitor the progress of aquaculture transformation across the region. It will track the progress of the NIIPs and assess how well the region is achieving the 2030 aquaculture goals.
- The system will use indicators to measure the progress of aquaculture transformation and provide actionable data for decision-makers. This includes tracking investment flows, innovation adoption, and sectoral growth.
- Four countries (India, Philippines, Thailand, and Vietnam) are piloting the ATMS, providing baseline data and helping to refine the tool.

Linking Innovation and Investment:

- The importance of private sector involvement early in the process is crucial for scaling innovations and ensuring that these innovations can reach a broader market.
- Smallholder farmers and small and medium enterprises (SMEs) are seen as the primary beneficiaries of the transformation. However, these groups face challenges such as limited capital and knowledge. The role of innovation hubs, such as AquaHub[3], was highlighted as critical in facilitating connections between the government, private sector, and smallholders to foster innovation and investment in aquaculture.

Pilot Projects and Future Collaboration:

- Pilot projects are being developed in the target countries, which will focus on innovations that align with the White Paper and the national plans.
- A business matching process is being established to link startups and SMEs with investors and government programs to facilitate the commercialization of innovations.
- The FAO and NACA aim to involve stakeholders across the entire aquaculture value chain, from research and development to commercial scaling, ensuring that the innovation process is inclusive and collaborative.

Challenges and Recommendations:

- One of the key challenges highlighted was the difficulty of scaling innovations from pilot projects to full-scale commercial operations, particularly for small startups and SMEs.
- Investment in aquaculture innovation remains relatively low compared to other sectors such as agriculture or livestock. There is a need for more substantial public and private investments to boost the aquaculture sector.
- The development of a data-driven approach to project development and impact measurement was stressed, with the ATMS playing a key role in providing real-time feedback and performance metrics.

[3] From an initial concept (the Asia-Pacific Innovation and Investment Hub; AIIH) following the FAO/NACA White Paper on Aquaculture Transformation in Asia-Pacific.

Future Steps:

- FAO will continue to work closely with national governments and private sector partners to implement and expand the NIIPs and ATMS.
- For ATMS in particular, data collection, analysis, and reporting will become central to tracking progress and adjusting strategies to meet the 2030 aquaculture goals.

Wenbo Zhang, Shanghai Ocean University presented an assessment of aquaculture transformation initiatives in China. A video of the presentation is available online at: https://enaca.org/?id=1421. The presentation focussed on the challenges, policies, and initiatives the country is facing to promote sustainable growth in aquaculture.

Key Points:

Challenges in Aquaculture Development:

- Despite the success and continuous development of aquaculture in China, aquaculture growth rate has slowed significantly in recent years. Production growth, which was over 10% annually in the 1980s and 1990s, has now dropped to only about 2-3%, with some years seeing growth as low as 1%. As a result, China's global share in aquaculture production has decreased from a peak of 66% in 2000 to 56% in 2023. This slower growth is due to several factors, including socio-economic and environmental challenges and government's priority on agriculture over aquaculture. Additionally, there's increasing pressure to protect the environment, and aquaculture is seen as a potential contributor to environmental degradation.
- The industry also faces challenges such as the aging aquaculture workforce. Most farms remain small-scale, a legacy of the household responsibility system from China's economic reforms. Although the government has begun efforts to consolidate these farms into larger operations, majority remains small.

Government Policies and Initiatives:

- The central government has introduced various policies to address the challenges, focussing on green and healthy aquaculture. Key initiatives include the Five Actions for Green and Healthy Development of Aquaculture, which emphasizes eco-friendly practices like rice-fish farming, wastewater treatment, reducing chemical use, and improving fish breeding. The government is also promoting the replacement of trash fish with formulated feeds, with some species such as largemouth bass achieving 100% replacement.
- Additionally, aquaculture area planning has been implemented to regulate and manage farming zones. These areas are categorized as conventional, restricted, and prohibited aquaculture zones, helping to ensure that farming is done sustainably and without damaging the environment.

Innovation and Technological Advancements:

- Technological advancements have been a major focus in China's aquaculture transformation. The adoption of indoor RAS and offshore aquaculture systems are

being encouraged. Currently, 100 million cubic meters of RAS and 60 million cubic meters of offshore aquaculture systems are in operation. These systems allow highly intensified farming and are designed to improve efficiency and sustainability.

- China is also investing in pond standardization, upgrading existing farms with better infrastructure and more intensive farming practices. Examples are provision of aeration systems and automatic feeders to improve operational efficiency. The use of drones for feeding in low-intensity systems like mitten crab farming has also been explored, with one drone being able to replace up to 10 farm workers.

Economic and Environmental Sustainability:

- China's aquaculture sector is facing rising costs, especially for feed and shrimp farming, and is experiencing market fluctuations due to global disruptions like COVID-19 and regional conflicts. There are also concerns about the environmental impact of aquaculture, such as unsustainable intensification and the depletion of resources like water and land. However, eco-friendly policies and practices, including the reduction of chemical use and treatment of wastewater, are being implemented to mitigate these challenges.

Aquaculture Transformation Assessment:

- An assessment of 85 major aquaculture initiatives in China was conducted. These initiatives focus on growth, scaling up, and expansion particularly in terms of production. Most of the initiatives are aligned with nature-based solutions (NbS) and demonstration of sustainability. These efforts are in line with the White Paper's targets for increasing production while ensuring environmental protection.

Future Outlook:

- Given the limited space and water resources, China is focusing on intensifying production through innovative methods and expanding into new areas. These include inland water bodies for culture-based fisheries, saline-alkali lands, and offshore aquaculture. While there is still trial phase investment in some of these areas, China is working to develop the technologies and infrastructure to make these systems more commercially viable.
- In addition to technological innovation, there is a strong emphasis on value chain development and improving the efficiency of the entire sector, from breeding to processing to marketing. The government has also invested significantly in fish breeding and germplasm resources, with over 306 new varieties and 95 breeding farms already established.

Plenary discussion

1. ATMS Reporting Process: on how it might contribute to and avoid duplication of the already heavy reporting burdens of countries, e.g. Code of Conduct for Responsible Fisheries which already includes reporting on innovation. **Tipparat** acknowledged the concern, explaining that the ATMS would be simplified with no more than 20 key indicators. Some data would be drawn from existing FAO databases, while others would be collected directly from countries. The focus would be on keeping it

manageable and focused on impact at the farm level, minimizing the reporting burden.

2. Growth of China's Aquaculture: **Zhang** highlighted that while China's aquaculture growth is slowing due to limited land and water resources, there are still opportunities for investment in other countries with lower land and water costs, particularly in Southeast Asia. The global share in aquaculture production is declining, but production at the regional level would continue to grow. Sharing technology and investing in countries with lower costs is a potential solution.
3. Implementation of White Paper Actions: **Tipparat** explained that countries should focus on priority actions that align with their needs, rather than trying to implement all 76 sub-actions. NACA provides an excellent platform for governments to discuss and implement projects, and there is a strong emphasis on engaging in regional collaboration to share knowledge and implement innovations effectively.
4. Farm Visits and Real-World Practices: Jena and **Harrison Charo Karisa** (World Bank) proposed that NACA and FAO organize future meetings on-site, so that participants can gain firsthand experience and insights into actual aquaculture practices. This suggestion was aimed at enhancing practical knowledge and bridging the gap between theory and real-world practice. **Tipparat** agreed and suggested that farm visits be incorporated into future conferences. Vietnam is particularly eager to host such visits as part of the regional agenda.
5. Demolition of Aquaculture Farms for Environmental Restoration: **Zhang** confirmed that the government is focused on restoring natural environments, with many aquaculture farms being converted back to wetlands. However, this effort is challenging due to the prioritization of crop farming over aquaculture by the government. While some compensation is provided to farmers, expansion into new areas, such as inland or offshore, is becoming more viable.
6. Engaging Young People in Aquaculture: **Tipparat** mentioned that the focus of innovations is aimed at younger generations, who are more likely to be interested in modern, tech-driven farming. Innovation is for the next generation, highlighting the importance of making farming easier and more profitable for young people in order to attract them to the sector.
7. Inspiring the Next Generation: **NACA** emphasized the importance of focusing on future generations and engaging them in the aquaculture sector. It suggested that aquaculture is not just for the current generation but for the future, and the goal should be to inspire young people to have a passion for the industry. **Tipparat** added that, in many countries, farmers are aging, and the younger generation often doesn't want to continue farming in the same way as their parents. There is a need for innovation to make farming more attractive and accessible for the next generation. **DOF-Thailand** supported the idea that both young and old generations should collaborate to transform aquaculture. Young people well versed in information technology, while older farmers bring valuable experience to the sector. Both groups should work together to drive the sector forward.

Innovation showcases for aquaculture transformation in Asia-Pacific (lessons from IDRC/NACA AQUADAPT and Innovet-AMR, and FAO TCP projects)

Showcases of innovations for aquaculture transformation were presented by participants from Fiji, the Philippines, Thailand, and NACA:

Nature-Based Solutions in Fiji

Prashneel Chandra (The Pacific Community, SPC) presented NbS innovations being studied and implemented in Fiji. The presentation focused on various projects and case studies, highlighting sustainable solutions for aquaculture in the country.

Case Study 1: Regenerative Shellfish Farming.

- The Mangrove Oyster Project, pioneered by the Ministry of Fisheries in 2017, trained communities in spat collection from the wild. Initially, homemade baskets were used to culture oysters with a lifespan of only one year. With funding from FAO, the community now uses hexagonal baskets with a lifespan of 15 to 25 years, which greatly improves oyster culture. This initiative provides women in the community with an additional source of income, empowering them and helping them utilize coastal resources more effectively.

Case Study 2: Reviving Dormanrt Farm Using NbS.

- This farm, located near Nadi International Airport, has been dormant for 10 years due to its poor design, with ponds situated 10 meters above water level, leading to high pumping costs and constant loss of water due to leakages. To address this, the farm now uses nature-based equipment such as HDPE pond liners (to prevent water leakage), solar-powered water pumps (to save on pumping cost), solar paddle wheels and biofloc aquaculture systems (for better water management). These innovations have significantly reduced costs, improved turnaround times, and increased stocking density.

Case Study 3: Fiji's First Aquaculture Farm Relying on Renewable Energy.

- A 500-kilowatt solar power is being installed at a shrimp farm to generate about 220 kilowatts of electricity daily, making the farm renewable energy-dependent. The installation of pond liners and paddle wheels has also improved stocking density and reduced dry-out periods from 1-1.5 months to 1 week, improving operational efficiency.

Case Study 4: Off-Grid Tilapia and Freshwater Prawn Farm.

- This farm, located on the main island, operates off the grid, relying on hydro turbine systems and solar power (580-watt solar system) for energy. The introduction of solar pond liners and aeration systems has increased stocking density and reduced carbon footprints. The farm also uses drum ovens with wood chips to provide heating in the hatchery, reducing reliance on electrical heaters.

Challenges in Sourcing Nature-Based Equipment.

- 86% of the nature-based equipment being used in the country are imported where shipping costs (14% of the cost) and import duties (15%) have significantly increased the cost. This has greatly impacted how farmers manage the costs of importing the necessary equipment they need.

Comparative Analysis of Investment Returns:

- While the initial investment cost for these innovations is high, the return on investment is expected to decrease double or triple over the next 5 years, as the innovations increase efficiency and productivity in the farms.

Gender Analysis in Aquaculture:

- In the four case studies, 11 men are employed part-time and 10 men full-time. Women are mainly employed on part-time basis and spend 6 to 8 hours per day working on aquaculture farms, from farm husbandry to harvesting to post-harvesting and marketing. When asked about their career preferences, women expressed a desire to learn more about farm husbandry activities and take on administrative roles in the future.

RAS-P.I.N.A.S: recirculating aquaculture system with nature based solutions.

Elisa Claire Sy presented RAS-P.I.N.A.S., an innovative aquaculture practice developed by E-Primate, Inc. The system combines RAS technology with NbS to improve the sustainability, efficiency, and productivity of fish farming in the Philippines. A video of the presentation is available online at: https://enaca.org/?id=1419.

Key Points:

The Technology:

- RAS-PINAS is a Philippine-based solution that incorporates NbS into aquaculture to improve efficiency, productivity, and sustainability. It helps create a controlled aquatic environment that ensures optimal water quality and reduces environmental impact, making it a more sustainable approach than traditional fish farming methods. RAS-PINAS allows a high stocking density of fish and year-round production. The system produce uniform fish sizes for demand-based harvesting, which typically takes place every 3 to 4 months with fish sizes ranging from 250 to 300 grams. This allows farmers to better meet market demand and improve profitability.

NbS in the System:

- The system integrates live-cultured algae to absorb excess chemicals and improve water quality. The innovative use of Symbiotic Flora and Fauna (SFF), combining specific microorganisms and algal species, helps in filtration and waste management. These organisms also act as toxic chemical absorbers, buffer compounds, and organic catalytic converters in the system. This approach supports natural filtration and promotes the healthier growth of fish. Moreover, the system uses locally sourced materials like coconut husks, rocks, minerals, and mollusks shells for the filtration system and adapts commercially available aquaculture tools and equipment for local use.

Investing in Sustainable Aquaculture:

- RAS-P.I.N.A.S. has the potential to attract investment by demonstrating that sustainable aquaculture practices can be profitable. The system offers a controlled environment for fish farming that not only promotes food security but also supports community stability. By utilizing innovative technologies and NbS, the system enhances aquaculture sustainability while improving yields and reducing environmental risks.

Addressing the Gap for Youth and Future Farming:

- Acknowledging the gap between policy makers and farmers, the presenter emphasized that bridging this gap could help entice young people into aquaculture. Through platforms like AquaHub, E-Primate has received support to grow and adapt their operations, demonstrating that with the right support systems, young farmers will be more inclined to pursue fish farming as a viable and innovative career.

Nature-based solutions in Thailand

Montakan Tamtin, DOF Thailand, presented Thailand's innovation showcase focusing on NbS to enhance sustainability, efficiency, and resilience of aquaculture in the country. The presentation highlighted the current state, challenges, and practical implementations of NbS in both small- and large-scale aquaculture operations. This is to mitigate major challenges including climate change, pollution, environmental degradation, high production costs, and global competition A video of the presentation is available online at: https://enaca.org/?id=1418

Key Points:

NbS Applications:

- Thailand has adopted several NbS to improve aquaculture sustainability. Solar panels are used to reduce electricity costs and allow more frequent water changes, while nanobubble technology enhances water quality, controls disease, and reduces oxygen supply costs. Alternative protein sources, including seaweed, insects, duckweed, and azolla, help reduce reliance on fishmeal. Integrated rice-fish farming supports sustainable freshwater aquaculture, and non-fed aquaculture (seaweed, sea cucumber, and mollusks) further reduces inputs and environmental impacts. Some of these innovative technologies are summarized below:
    a) **Siriwan Farm (Snakehead Fish, Angthong Province)** uses solar panels to reduce energy consumption by 50%, which improves water quality and fish growth. Production cost was reduced by 11.7%, energy cost by 41.7%, and carbon dioxide emissions were also lowered.
    b) **Chokanan Farm (Red tilapia and Snakehead, Chiang Rai Province)** applies an automated water quality control (smart DO controllers) system and solar cells to regulate temperature and dissolved oxygen. This reduced production costs by 43% and made farm operations more user-friendly.

c) **Lumphu Farm (Super-intensive Shrimp, Chumphon Province)** uses a green innovative controller system to monitor and control dissolved oxygen, supporting high-density shrimp farming (10 tons per rai or 62.5 tons per hectare) with continuous partial harvesting. Production efficiency improved by 33%, energy costs were reduced by about 20%, and carbon emissions were lowered.
d) **The Freshwater RAS (Pathum Thani Province)** utilizes micro-nanobubble technology, which removes harmful substances, controls more than 90% of pathogens, increases growth by 30%, and allows high-density aquaculture with stocking rates increased from 10–20 kg/m^3 to 50–80 kg/m^3.

Policy and Community Recommendations:

- Green finance and innovation incentives are necessary to encourage NbS adoption.
- Support young smart entrepreneurs and next-generation farmers to overcome the challenge of an aging workforce.
- Regional collaboration is crucial for sharing best practices, harmonizing certification, and promoting private sector engagement in green and eco-friendly technologies.

Development of low-carbon aquaculture certification in Thailand

Montakan Tamtin presented the results of the project under the FAO Technical Cooperation Program (2023–2025). The initiative focuses on reducing greenhouse gas emissions from shrimp farming through innovation, certification, and stakeholder engagement. A video of the presentation is available online at: https://enaca.org/?id=1418

Key Points:

Carbon Footprint in Shrimp Farming

- Shrimp farming emits about 3.66 kg CO_2 equivalent per kilogram, with feed contributing 43% and energy 55% of total emissions.

Pilot Sites and Project Outputs

- Two pilot provinces, Chachoengsao and Chanthaburi, with 15 farms each (30 farms total), were selected.
- The project is structured around four outputs:
    - Intervention design for low-carbon certification, developed with expert consultations and stakeholder engagement.
    - Data collection and analysis from 30 shrimp farms to support certification development and reporting platforms.
    - Development of certification processes using one-year farm data, with applications prepared for submission to the Thailand Greenhouse Gas Management Organization.
    - Knowledge sharing through training of government officers, farmer training at pilot sites, and a national workshop in Bangkok.

Benefits of Low-carbon Aquaculture

- Economic and environmental benefits include lower production costs from solar energy, the use of automatic feeding systems to reduce feed loss and labor costs,

better water quality management, reduced mortality, improved yields, and reduced resource use.
- Market and policy benefits include higher-value products suitable for premium and export markets, potential for environmental certification, alignment with national emission targets and carbon credit programs, and opportunities for government and international financial support.

Innovations on alternatives to antimicrobials in aquaculture

Chokanan Prompichai, NACA, presented two IDRC-supported technologies under the Innovet AMR-2 project (Nanovac, a nanobubble-assisted vaccine for tilapia; and, ShrimpGuard, a bacteriophage-based solution for *Vibrio* spp.), and explored related phage-based solutions and farmer perspectives. A video of the presentation is available online at: https://enaca.org/?id=1417

Key Points:

Comparison of Technologies

- Nanovac faces regulatory hurdles (on vaccine), high equipment costs, and long timelines to show farm-level results. ShrimpGuard, though still in laboratory testing, was prioritized for its novelty, potential near-term AMR impact, and synergies with other phage innovations.

Phage-Based Innovations in Thailand

- Three notable phage solutions are in development:
    1) *ShrimpGuard*: Nano-encapsulated vibriophage cocktails with immune enhancers (lab stage).
    2) *Lyse V (UniFAHS)*: A vibriophage cocktail already commercialized in Thailand and overseas.
    3) *Chula Jumbo Phage*: A nucleus-forming jumbo vibriophage targeting *Vibrio parahaemolyticus* (Vp-AHPND). Piloted and field-tested in multiple shrimp farms.
- These phage products can be applied either as feed additives or directly in water.

Farmer Perspectives

- Farmers in eastern and southern Thailand learned about phage technology mainly through researcher outreach and events. They welcome phages as a natural "bacteria killer," but concerns remain over higher costs, limited technical knowledge, uncertain long-term performance, and the need for clearer guidance.
- Farmers who adopted phages reported rapid reduction in mortality from vibriosis, biofilm control in hatcheries, and residue-free products that meet environmental and market standards. However, results varied under different farm conditions, and cost remains the key barrier.

Panel Discussion

Panelists for this session include:

- Chinthaka Hewavitharane (The Pacific Community, SPC)

- Elisa Claire Sy (E-Primate, Philippines)
- Montakan Tamtin (Department of Fisheries, Thailand)
- Ubolratana Suntornratana (NACA)
- Chokanan Prompichai (NACA)

Commercialisation and Target Users of NbS:

- **Sy** explained that small-scale farmers, particularly older generations, are often resistant to change due to fear of new practices. Her company is working hand in hand with farmers to build trust and demonstrate results, with the goal of gradually leading them towards NbS adoption. Moving from "zero to one" had already been achieved after years of research, trials, and implementation, placing them several steps ahead of traditional farming.
- **Regional Perspective: Hewavitharane** emphasised that from the Pacific Community perspective, climate change and rising energy costs are pressing challenges for aquaculture. Scaling NbS is already happening through private enterprises co-investing alongside grants from the Pacific Community. Traditional aquaculture is becoming increasingly unsustainable, while NbS are seen as inevitable solutions that enhance both sustainability and production.
- **Thailand's National Approach: Montakan** described how it is implementing its national Bio-Circular-Green (BCG) plan through flagship projects aimed at reducing carbon emissions. For example, DO controllers will be distributed to pilot farms of varying scales to reduce production costs and energy use. Following the late King Rama IX's model, projects begin at small scale and are expanded sustainably, driven by farmer willingness to adapt.
- **Generational Transfer of Knowledge: Ubolratana** highlighted that many shrimp and fish farms in Southeast Asia are family-run enterprises intended to be passed down from one generation to the next. However, a gap exists: younger farmers often struggle to absorb knowledge, while older farmers can be hesitant or slow to pass it on. Bridging this gap and supporting younger farmers who are more adept with technology, is critical for sustainable aquaculture.

Farm-Level Impact and Commercialisation Potential: NACA emphasised that NbS technologies are already proving effective at farm level. The next step is to accelerate wider adoption and commercialisation to advance aquaculture transformation across the region.

Market Certification and Carbon Footprint: FAO informed that Thailand has a strong national system through the Thailand Greenhouse Gas Management Organization (TGO), which oversees multiple certification schemes. The current project targets the Carbon Footprint certification, reporting emissions per kilogram of shrimp. Certification requires life-cycle assessments aligned with ISO standards, validated by consultants and reviewed by TGO. Future steps will include certification for reduced emissions through adoption of innovations and good practices. While the FAO TCP project initiates this process,

responsibility for follow-up lies with Thailand. FAO added that although NbS may not always appear profitable, the project defines NbS broadly, covering both commercialised innovations and those that are still emerging.

Panel discussion on investing in innovation for transforming aquatic food systems

Tipparat Pongthanapanich, briefly presented on a key step toward HLM4, linking to sessions 8 and 9, to clarify the way forward and how to shape HLM4 and related activities through the FAO-TCP mechanism until the end of 2026. This is intended to encourage resource mobilisation in the four pilot countries. A video of the presentation is available online at: https://enaca.org/?id=1422.

Key Points:

- A World Bank report, "Harnessing the Water," outlines investment direction in aquaculture. The cited message is that business as usual with 0.5 trillion US dollars gives 159 million metric tons of fish, while if investment is tripled there would be 100 tons more of fish by 2050, and job creation would be almost doubled.
- Aquaculture covers the whole value chain, from inputs (seed, feed, chemicals, vaccines) to processing, consumers, and waste management. Transformation requires capital and must be faster and more efficient. Examples from China shows how scaling can reduce unit costs and improve access.
- Venture capital for innovation in Asia remains too limited relative to production dominance. Investment lags across the innovation space including early-stage ideas, incubators, start-ups, SMEs, and even large firms. Coordination among key players is needed so each can focus on their strengths, with fair sharing of costs and benefits to fill existing gaps.
- Major donors, including the World Bank and Global Environmental Facility (GEF), are shifting attention toward food systems and aquaculture. GEF projects, which previously focused on conservation with aquaculture as a small component, now emphasize carbon footprint reduction. Thailand, as a pilot country, has made progress that can be bundled into larger portfolios. TCP encourages cross-country learning to avoid repeating mistakes.
- Key questions include how to mobilise investment for aquaculture transformation in a way that benefits all stakeholders, which mechanisms can support innovators from start to scale, and how to manage perception and investment risks. Participants are invited to raise further questions to the panel to shape the way forward.

The panel discussion was moderated by **Michael Phillips** (FutureFish) and **Tipparat** (FAO), with the following panelists: **Harrison Charo Karisa** (World Bank); **Fred Puckle Hobbs** (Tathva); **Ali Mohammad Alshaikhi** (Kingdom of Saudi Arabia); and, **Chris Ninnes** (Aquaculture Stewardship Council)

- **Karisa** informed that the World Bank recently released a report presenting a positive outlook for aquaculture growth over the next five years. He also described the launch of the AquaInvest Platform for Africa in February, designed to mobilise aquaculture investment programmes and create stronger collaboration globally. One challenge identified is changing the way people within the Bank and its partners to think about aquaculture, so that it is recognised as an investable sector. He outlined how the Bank works through its different arms – International Bank for Reconstruction and Development (IBRD), International Development Association (IDA) and International Finance Corporation (IFC) – together with partners such as the GEF and USAID, to support aquaculture development. He stressed that collaboration and partnerships are critical to unlocking investment at scale.
- **Hobbs** described Tathva's work as a financial structuring firm focused on food systems, seeking ways to direct capital more effectively to producers. Drawing on his background in banking and his work with seaweed farmers in Indonesia, he noted that many value chains remain fragmented and poorly served by financial institutions, leaving smallholders reliant on microfinance. Large banks often avoid aquaculture altogether because they see it as too risky. He pointed out aggregation as the most practical way to deliver finance, services and data to small producers at scale, and underlined the need for revolving credit, stronger SME financial management, and better storytelling to help investors see both the business case and the social impact of investing in aquaculture.
- **Alshaikhi** described the particular challenges of developing aquaculture in Saudi Arabia, a desert country with no rivers and extreme summer heat. Despite this, a clear strategy and strong partnerships between government and the private sector have enabled the industry to grow. A robust biosecurity system, in place for more than eight years, has underpinned this progress. Since 2016 production has expanded rapidly, supported by government measures such as land allocation, subsidies for inputs, and concessional arrangements to encourage private investment. Saudi Arabia is now shifting toward closed and recirculating systems, investing in trout farming with large hatcheries, and has created a regional centre for fish disease management and training. He noted that supply chains remain a weakness, but also represent a major opportunity for future investment and sector development.
- **Ninnes** stressed that aquaculture must be treated first and foremost as a business, including at the level of family-operated farms. Many smallholders are trapped in cycles of debt, and without insurance or access to credit, they cannot expand or adopt new technologies. Certification currently covers only about a quarter of global production, so ASC has developed an improvement program to encourage the adoption of better management practices adapted to local conditions. Improving farm profitability is essential, which depends on lowering input costs, reducing risk, improving survival rates and providing access to insurance. Blended finance combining concessional, impact and commercial capital was identified as a key mechanism to achieve this.

General discussion

- Farmer-first investment design is essential: financial instruments must reflect farm cash-flows and seasonal risks, combined with extension, data capture, and market access.
- Aggregation is a key delivery mechanism, with farmer groups and SMEs acting as integrators that meet lender requirements, manage risk, and demonstrate repeatable returns.
- Risk reduction tools are needed, including stronger biosecurity, affordable insurance, credit guarantees, and credible traceability and performance data for lenders.
- Blended finance can absorb early losses and recycle capital through impact and commercial tranches, complemented by blue/green bonds and ecosystem-service finance.
- Regional platforms should be built upon to connect investment, regulation, and knowledge sharing, avoiding duplication and accelerating scale.
- Supply chain modernisation—especially cold chain, logistics, and market infrastructure—was recognised as a critical enabler to convert productivity gains into farmer incomes and bankability.
- **Kwang Suk Oh** (FAO) highlighted that technical guidelines are being prepared to clarify the roles of governments, financial institutions, and investors. He stressed the importance of public private partnership (PPP) to enhance investment in prospective aquaculture sectors and ensure that farmers are supported in these initiatives.
- **Tipparat** summarized the key messages and noted that collaboration and coordination are essential to avoid competition and to leverage each other's strengths. It was highlighted that certification, financing support, insurance, and good coordination mechanisms are critical to make aquaculture more attractive for investors. Governments must prepare platforms and regulations to enable investment and innovation in aquaculture, ensuring that the sector is professionalized and sustainable

Statements from NACA Member governments

Statements were invited from NACA member governments to identify their top five priority actions for aquaculture transformation; to present current and potential aquaculture transformation projects and initiatives; and to identify specific innovations where knowledge and capacity could be shared to accelerate aquaculture transformation.

Bangladesh

Bangladesh identified four priority actions for aquaculture transformation: sustainable intensification of farming systems; diversification of species, products and markets; acceleration of innovation and investment; and coping with climate change. Several

initiatives are underway to implement these priorities. Under the World Bank–financed Sustainable Marine and Coastal Fisheries Development Project, 300 shrimp farmer clusters have been formed, covering 7,500 farmers. Each cluster operates as a single culture area and has been supported with PCR-disease detection and water quality testing kits, SPF seed, high-quality feed, and training. Productivity gains have been notable, with shrimp yields increasing from 448 to 721 kg/ha. Grants have also supported conversion of hatcheries to SPF production, while polyculture, seaweed and seabass mariculture, and post-harvest service centres are being developed.

A second initiative, the Community-Based Climate Resilient Fisheries and Aquaculture Development Project, is constructing climate-resilient infrastructure such as post-larval markets and service centres, and has developed early warning advisories for floods, heatwaves, cold waves and lightning, with a digital system in preparation. A programme on fish production and capacity building aims to establish cryopreservation centres for pure-bred seed supply, introduce IoT-based pond systems, smart feeders and aerators in hatcheries, and installation of solar power. Infrastructure upgrades and training for hatchery personnel in IoT-based aquaculture are also included.

Together, these projects highlight Bangladesh's focus on clustering small farmers, upgrading hatchery capacity, building resilience to climate risks, and introducing new technologies such as IoT, renewable energy and mariculture diversification to drive aquaculture transformation.

Cambodia

Cambodia identified its top priorities for aquaculture transformation as sustainable intensification, accelerated innovation, sustainable feeds and feeding, and improved aquaculture governance. The key initiative is the EU-supported CAPFISH Program for sustainable and inclusive growth, which promotes climate-resilient and inclusive aquaculture through research, knowledge sharing, and governance for export standards. Complementary efforts include the recently concluded USAID-funded Commercialisation of Aquaculture for Sustainable Trade Project, which modernised production practices, strengthened hatcheries, and promoted national quality standards, and the forthcoming National Strategic Plan for Aquaculture Development 2026–2035, which will guide sector development for the next decade.

Innovations highlighted include a shift away from reliance on small wild fish for feed towards commercial feeds and climate-resilient practices, improvements in data and information management, and preparations for international food safety audits. At the community level, hybrid models, conservation-linked aquaculture, and integrated aquaculture systems are being trialled to support adaptation and sustainability.

Hong Kong SAR, China

Hong Kong SAR, China identified its top priorities as improving aquaculture productivity, supporting farming in suitable concentrated areas, expanding production based on

feasibility studies, ensuring development within environmental carrying capacity, and promoting aquaculture research and innovation. Key initiatives include development of modern offshore cage farms, with new fish culture zones expected to add 8,000–9,000 tonnes of capacity over the next 10–15 years. This is guided by hydraulic and biological modelling to assess carrying capacity. Inland aquaculture is framed as conservation effort, with 350 hectares of ponds planned as nature reserve, while continuing aquaculture using container-based systems that also provide tertiary water treatment and bird habitat. Financing is led by the government through Sustainable Fisheries Development Fund amounting to USD 128 million, supporting innovation and business expansion, alongside with low-interest loans for small farms. Areas for knowledge sharing, including environmental impact assessment methodologies for marine fish culture and an AI-based harmful algal bloom monitoring system under development are also highlighted.

India

India highlighted five priority areas: reliable supply of high-quality seed, feed, and knowledge; investment in highly productive aquaculture systems; strengthening research and innovation; increasing industry participation; and expanding knowledge and skills development. Major efforts are focused on selective breeding programmes for six key species, with expansion to additional brackishwater and marine species planned. Cryopreservation of fish milt has been taken to commercial scale in about 40 hatcheries, supported by the establishment of brood banks, nucleus centres, and farmer clusters. Feed efficiency, genetics, nutrition, and health management, including disease surveillance and seed quality, are also national priorities.

India is scaling up advanced production systems such as ponds, cages, RAS, biofloc, and inland saline aquaculture. Energy-efficient systems using solar technology and high-yield tank-based shrimp farming are being promoted. Diversification includes more than 75 species to meet regional consumer demand, including high-value species. Government investment has been substantial, with USD 2.5 billion allocated in the past five years, resulting in 25,000 hectares additional production areas, 4,000 biofloc units, 12,000 RAS units, 3,200 hectares of inland saline aquaculture, 900 hatcheries, and 25 brood banks.

Infrastructure for marketing and logistics has also been expanded with thousands of vehicles, cold storage, and live-holding facilities. A dedicated Ministry of Fisheries, Animal Husbandry and Dairying has placed fisheries higher on the national agenda, with USD 0.7 billion earmarked for traceability, insurance, and digitisation. India emphasised its readiness to share expertise in selective breeding for growth and disease resistance, diversification of species and systems, and next-generation field diagnostics with other countries.

Indonesia

Indonesia's strategy for aquaculture transformation is aligned with the national Blue Economy policy, emphasising food and nutrition security, poverty reduction, economic growth, and environmental sustainability. Key elements include protecting ocean resources, reducing destructive fishing pressure, and conserving marine ecosystems.

Five priority commodities were identified: shrimp, seaweed, saline tilapia, crab, and lobster. For these, aquaculture models and action plans are being developed across marine, brackishwater, and freshwater systems. Implementation measures include modern aquaculture villages, pilot projects, and demonstration farms.

Notable initiatives include shrimp farming programmes in over 10 locations nationwide, such as a pilot project in Kebumen, Central Java, and an integrated farming project with Evergreen in Nunukan, East Nusa Tenggara. Saline tilapia production is being piloted in West Java, revitalising abandoned shrimp ponds, while seaweed modelling is underway in Maluku and Wakatobi. Crab culture models are being developed in East Java, and lobster modelling projects are being trialled nationwide, with early work focused in Sumatra. Indonesia reaffirmed its strong commitment to NACA's regional mission and to advancing sustainable aquaculture development through these priority actions and pilot programmes.

Maldives

Maldives outlined five priority actions for aquaculture transformation. First is creating an investment-friendly environment, opening the mariculture sector to foreign investors under a long-term legal and regulatory framework. Multi-species hatcheries for grouper, sea cucumber, milkfish, and shrimp are under construction, with four exclusive mariculture zones designated for foreign investment offering leases of up to 50 years. Second is enhancing sector visibility and market development through the Fisheries and Ocean Resources Promotion Corporation, which coordinates marketing, value addition, and feasibility studies to identify high-value aquaculture species suited to Maldivian conditions. Third is restocking programmes for high-value native species such as torafugu and sea cucumbers, combining ecological conservation with export potential. Fourth is capacity building, with international scholarships, university partnerships, and a national "More the Merrier" programme providing practical mariculture training for young professionals. Finally, aquatic animal health and biosecurity are being strengthened under a World Bank project, with updated legislation, improved diagnostics, stronger surveillance, and certification systems to support sustainability.

Nepal

Nepal reported that aquaculture is among the fastest-growing agricultural sectors, contributing significantly to food security, employment, and rural livelihoods. The government has declared 2024–2034 the Agriculture Investment Decade, with aquaculture targeted for expanded public, private, and donor investment. Priorities include improving input quality, with standards for fish seed and feed under development following the 2022 National Fisheries Development Policy. Youth engagement is promoted through subsidies and insurance schemes, and aquaculture is increasingly linked with ecotourism, for example through rainbow trout farming integrated with homestay programmes in the hill regions.

To address intensification challenges, Nepal is strengthening technical capacity, upgrading laboratories, and investing in disease and water quality management. Value chain development is supported through collection centres, cold storage, insulated transport, and digital marketing platforms. Conservation is also a priority, with co-management approaches for aquatic ecosystems and active participation of women and disadvantaged groups.

Although Nepal does not yet have a large national aquaculture project, a new FAO TCP project has begun, and investment opportunities are being promoted internationally. Rainbow trout farming is a national strength, now established in 44 districts, with strong youth involvement. Nepal expressed readiness to share expertise in trout farming while seeking technical support for fish disease management.

The Philippines

The Philippines emphasised aquaculture's central role in national food security and economic growth, noting that the sector now accounts for 55% of total fisheries production. The country ranks 12th globally in aquaculture output and 4th in aquatic plant production.

Five priorities were highlighted. First, sustainable expansion of production, with commodity roadmaps for milkfish, tilapia, seaweeds, shrimp, and shellfish supported by multi-species hatcheries, feed mills, cages, and other infrastructure. Second, diversification into high-value species such as catfish, eel, pompano, groupers, siganids, and crayfish to build resilience and tap new markets. Third, climate adaptation, promoting RAS, integrated multi-trophic aquaculture (IMTA), and stress-tolerant strains, underpinned by a strategic plan for climate change adaptation and disaster risk reduction developed with FAO. Fourth, mainstreaming aquaculture in national development strategies, including the launch of the National Aquaculture Development and Management Plan (2024), which aligns with broader economic and fisheries frameworks and sets strategies for mobilising investment and institutional support. Fifth, improving quality, traceability, and certification, with national guidelines under development, producer training, stronger monitoring systems, and pilot testing of an Aquaculture Information System with geospatial mapping.

The Philippines reaffirmed its commitment to position aquaculture as a dynamic contributor to inclusive growth, and to collaborate regionally on innovation, best practices, and policy development.

Sri Lanka

Sri Lanka identified five priority actions: improving access to high-quality seed and feed, expanding aquaculture in suitable areas, strengthening research and innovation systems, reducing the environmental footprint of feeds, and enhancing biosecurity through the FAO's Progressive Management Pathway for improving Aquaculture Biosecurity (PMP/AB). Two sectors were highlighted as main drivers of transformation. Shrimp farming remains

the most profitable activity, with recent advances including farm intensification, infrastructure upgrades, and adoption of SPF species since 2020. Sea cucumber farming is an emerging focus, with around 5,000 acres identified for development in the Northern Province. A cluster-based production model links farmers to central hatcheries through producer societies, while a commercial-scale hatchery is being established. Integration of seaweed with sea cucumber farming is being promoted to diversify income and build resilience.

With FAO support, Sri Lanka has established breeding techniques for *Holothuria scabra* (sandfish) in government and private hatcheries. The country expressed readiness to share protocols and practical experience in sea cucumber hatchery development and juvenile production, as well as in *Macrobrachium rosenbergii* (giant freshwater prawn) breeding, supported by three government hatcheries and one private facility.

Thailand

Thailand identified two priority areas to accelerate aquaculture transformation. The first is a set of ongoing initiatives that reduce production costs and improve efficiency and quality. These include adoption of aeration, smart feeding systems, and renewable energy under the national nature-based solutions programme; promotion of genetically improved broodstock for species such as giant freshwater prawn, whiteleg shrimp, tilapia, seabass, and climbing perch; and wider distribution of improved strains through hatcheries. Higher yields have already been achieved as a result. Additional initiatives include the Smart Farmer Project, which promotes energy efficiency and smart farming practices, and national programmes aimed at reducing dependency on fishmeal through alternative feed ingredients. The second priority is to secure technical support from partners to advance biosecurity management, including implementation of the PMP/AB and livelihood-oriented biosecurity initiatives.

Thailand reaffirmed its commitment to sharing experience and good practices in five sub-action areas, while seeking collaboration on joint studies, investments, and projects that deliver innovations to increase farmer incomes and strengthen the resilience of small-scale aquaculture.

Vietnam

Vietnam outlined five priorities for aquaculture transformation: improving farm productivity through modern infrastructure and technology; ensuring reliable supplies of high-quality seed, feed, and knowledge; investing in efficient systems such as RAS and modern cage culture; diversifying species and developing markets for new products; and shifting towards technology- and innovation-driven business models, including digital transformation and traceability. National strategies issued in 2021 guide this work, including the National Strategy on Fisheries Development and the National Programme on Aquaculture Development, both focused on stimulating innovation and investment. Current initiatives include RAS pilot projects for shrimp, grouper, and tilapia; the

Mariculture Development Programme (2021–2030) to expand offshore cage farming in Khanh Hoa and Kien Giang; and IMTA such as shrimp–rice and shrimp–fish–rice models. Vietnam is also piloting high-tech aquaculture equipment, including intensive river-in-pond raceway systems, and expressed readiness to share experience in advanced technologies, diversification models, and integrated farming approaches with regional partners.

The Pacific Community (SPC)

The Pacific Community emphasised that while the region produces only a small volume of aquaculture products, the sector is critically important for food security, livelihoods, and economic development. The Pacific is home to highly diverse marine ecosystems, with largely untapped potential for aquaculture growth. Traditional methods continue to be used alongside new technologies, but frequent staff turnover in fisheries ministries creates persistent skill gaps, requiring continuous retraining.

Climate change is already affecting aquaculture, with declining spat settlement impacting pearl oyster and giant clam industries, while shifting pH and calcium carbonate concentrations threatens mariculture. Countries are increasingly turning to hatchery technologies, while also seeking improved genetics for inland aquaculture. Outdated genetic lines, mostly imported decades ago from Southeast Asia, limit productivity and climate resilience. Recent initiatives include new freshwater prawn lines in Fiji and efforts to secure improved tilapia strains.

Feed costs remain prohibitively high due to geographic isolation and lack of raw materials, but local innovations are emerging, such as deeper ponds to buffer against temperature extremes and greater use of renewable energy. Climate change is also creating new opportunities, including inland aquaculture in previously arid areas and mariculture at higher elevations. IMTA and unfed systems are being promoted, such as pearl farming combined with sea grape culture in Fiji. Hatchery development for sandfish is progressing, though evidence of reef reseeding impacts remains limited. Bivalve aquaculture is expanding in Micronesia, where land scarcity makes mariculture essential.

Regional frameworks provide important guidance, notably the Pacific Regional Aquaculture Strategy, which reflects national priorities, and the Pacific Regional Framework on Aquatic Biosecurity, developed during COVID-19 to reinforce domestic food security. Priority areas for collaboration with Asia include sharing traditional knowledge, building capacity through ongoing training, expanding access to technology, and strengthening research on tropical and endemic species. These species are expected to become increasingly important as global warming shifts production zones, making them critical for future food systems.

Statements from Non-state Representatives

Statements were invited from public and private companies, civil society, donors and development partners on matching areas of interest for innovation and investment opportunities, and potential collaboration and future activities.

WorldFish

WorldFish emphasised that aquaculture transformation requires not only vision but also practical levers of change, including appropriate incentive structures for producers, regulatory clarity and enforcement, targeted public investment, and strong political will to support inclusive innovation and fair market systems. Marking its 50th year as a CGIAR centre, WorldFish described its mission to co-develop solutions with partners across Asia, Africa, and the Pacific to ensure that aquatic foods contribute to equitable, resilient, and nutrition-sensitive food systems. Key areas of work include reducing post-harvest loss through improved processing and cold storage, advancing climate-smart and nutrition-sensitive aquaculture, developing digital tools such as PASCAS for data-driven management and market access, advancing selective breeding programmes including the GIFT strain of tilapia and improved carp varieties, supporting inclusive market systems for women and youth, and engaging in policy and capacity development across the value chain.

Current initiatives include the Climate-Adaptive, Inclusive, Nature-Based Aquaculture (CAINA) project, piloting regenerative aquaculture systems in Malaysia and the Solomon Islands. This work combines local knowledge with scientific tools to help small-scale producers adapt to climate and market challenges, while identifying technical, financial and policy enablers for scaling. Through the Asia–Africa BlueTech Superhighway Project, WorldFish is also promoting South–South learning, transferring Asia's experience in sustainable aquaculture and value chain innovation to partners in Kenya, Nigeria, and Zambia.

Looking ahead, WorldFish committed to strengthening aquatic food value chains, building the evidence base for policy and investment, and aligning with the One Health agenda to ensure aquaculture both nourishes people and restores ecosystems. Transformation, they stressed, is not only about producing more but about producing more efficiently, with lower environmental impact, stronger equity, climate resilience, and nutritional benefits.

Shanghai Ocean University

Shanghai Ocean University (SHOU) underlined China's major role in global aquaculture, producing more than 60% of the world's farmed aquatic products. In 2024, national production reached 73.6 million tonnes, of which aquaculture accounted for 60.6 million tonnes (82%). Aquaculture is positioned as a key contributor to domestic and international food supply, reducing pressure on capture fisheries and promoting conservation.
The Chinese government has prioritised aquaculture development with pragmatic policies that emphasise green, healthy and sustainable growth. Five priority measures guide

transformation: 1) zoning of water bodies and tidal flats to regulate permitted, restricted and prohibited aquaculture areas; 2) strengthening the seed sector through a national census of genetic resources, the establishment of 105 breeding centres, and certification of over 300 aquatic varieties; 3) promotion of green production via ecological aquaculture demonstration zones covering more than half a million hectares; 4) expansion through pond renovation, rice–fish systems, saline-alkaline aquaculture, recirculating systems and offshore development; and, 5) tighter quality and biosecurity measures, including national disease surveillance and residue monitoring, with no major disease outbreaks reported.

SHOU will continue to support implementation of the White Paper on Aquaculture Transformation through the jointly established Ecological Aquaculture Center with FAO. Priorities include extending green technology packages, developing and promoting improved seed and standards, upgrading wastewater treatment, promoting standardised veterinary drug use, and increasing substitution of compound feeds. Public and social investment will be mobilised through government policy guidance to provide infrastructure, services and capital for transformation.

SHOU also expressed support for NACA's development of a regional Monitoring, Evaluation and Learning System, and offered to share China's experience in green aquaculture with other countries. It emphasised the importance of regional and international cooperation to accelerate aquaculture transformation and reaffirmed its commitment to working with NACA, FAO and other research institutions to promote sustainable aquaculture development.

Summary, conclusion and next steps

The 3rd High-Level Meeting on Aquaculture Transformation in Asia and the Pacific reviewed progress since the launch of the White Paper on Aquaculture Transformation and shared national and regional experiences to advance its 2030 vision: aquaculture transformed into more efficient, inclusive, resilient and sustainable aquatic food systems through innovation, investment and partnerships.

Key discussion points:

- **Food security and species focus:** Low-cost, low-trophic species such as carps, tilapia and catfish are vital to food security and offer scaling opportunities. However, their low margins limit adoption of cost-adding technologies such as vaccines.
- **Technology adoption:** Many farmers still struggle with production basics. Technologies must be intuitive, practical, and easy to use. Farmer scepticism highlights the need for improved communication and extension approaches.
- **Regulatory barriers:** Policy and regulatory processes delay commercialisation and deter investment. Harmonisation or mutual recognition of assessments across countries could reduce duplication while maintaining safety.

- **Genetic improvement**: Selective breeding represents the single largest opportunity for productivity gains, as demonstrated by examples such as the Jayanthi rohu in India.
- **Risk and insurance:** Intensification increases productivity but also disease risks. Aquaculture insurance remains difficult to access, particularly for smallholders.
- **Investment gaps:** The sector faces a significant shortfall in investment for innovation and company development. Despite Asia producing 90% of global aquaculture, it attracts only a small proportion of global investment.
- **Knowledge-based farming:** There is a need to shift from input-led farming to knowledge-based farming, optimising use of water, feed, energy, and land.
- **Private sector collaboration:** Greater access to academic, government and private sector expertise is needed. Downstream actors can support innovators in evaluating technologies.
- **Finance and value chains:** Aquaculture value chains are fragmented and often misunderstood by financial institutions, which see the sector as risky. Incentives must align profitability with sustainability.
- **Smallholder support:** Farmers face debt constraints but could improve profitability through better practices and inputs, supported by access to finance. Farmer groups and clusters offer practical mechanisms to aggregate smallholders for investment and services. Integration into financial systems is essential to provide sustainable credit access.
- **Sector promotion:** Aquaculture's positive contributions—employment, rural development, food security, and environmental benefits—require greater visibility. Storytelling can help highlight these social benefits.
- F**inance as part of the value chain:** Financial mechanisms must support capital recycling and sustainable sector growth.
- **Collaboration:** Participants emphasised the importance of collective action rather than competition, and the need for coordination across stakeholders.

Next steps

The following priority actions were identified:

- Advance implementation of the Aquaculture Transformation Roadmap.
- Continue supporting National Innovation and Investment Plans (NIIPs) in four pilot countries.
- Conduct a regional innovation space assessment to map ecosystems, key players, bottlenecks, gaps, and enabling policies, ensuring coordination to avoid duplication.
- Develop and implement the Aquaculture Transformation Monitoring System (ATMS).
- Further develop the AquaHub with private and public partners.
- Strengthen collaboration with investors to build strategies and partnerships tailored to the needs of aquaculture transformation, with emphasis on smallholders, SMEs and unbanked farmers.
- Track progress towards HLM-4.

- Engage governments to raise awareness of White Paper priorities with industry and producers.

Conclusion

The outcomes of HLM-3 will guide technical cooperation activities, investment strategies, policy development and collaboration across regional aquaculture networks. Implementation will require both national-level specificity and regional coordination, backed by timely data and effective partnerships.

Annex 1

PROVISIONAL AGENDA

Tuesday 1 July 2025	
0900–0910	**I. Welcome remarks by SHOU**
0910–0920	**II. Opening remarks by the Ministry of Agriculture and Rural Affairs**
0920–0945	**III. Background and objectives of HLM-3 by NACA**
0945–1015	**Group photo and coffee break**
1015–1200	**IV. Introduction and panel discussion** ● A regional assessment of innovation and investment for aquaculture transformation in the Asia-Pacific region presented by **Michael Phillips**, FutureFish ● Panel discussion ○ **Rishita Changede**, CEO, TeOra Company ○ **Kitiya Vongkamjan**, UniFAHS, Thailand ○ **Joykrushna Jena**, Deputy Director General of ICAR, India ○ Representative from **Guangdong Evergreen Conglomerate Co.,Ltd**, China Moderated by **Michael Phillips**, FutureFish
1200–1330	**Lunch break**
1330–1500	**V. Progress on aquaculture transformation following the White Paper's regional roadmap** ● Overview and status on the development of the National Innovation and Investment Plans (NIIPs) and the Aquaculture transformation monitoring, evaluation and learning system (ATMS) presented by **Tipparat Pongthanapanich**, FAO ● Assessing aquaculture transformation initiatives in China presented by **Wenbo Zhang**, SHOU ● Q&A by all participants Moderated by **Simon Wilkinson**, NACA
1500–1530	**Coffee break**
1530–1700	**VI. Innovation showcases for aquaculture transformation in Asia-Pacific (lessons from IDRC/NACA AQUADAPT and FAO TCP projects)** ● Introductory remarks ● Fiji, Philippines and Thailand presentations ● Panel discussion Moderated by **Eduardo Leano**, NACA
1700–2000	● **Excursion on SHOU Campus** ● **Dinner hosted by SHOU**

Wednesday 2 July 2025	
0900–1030	**VII. Panel discussion on investing in innovation for transforming aquatic-food systems** Panelists: ● **Harrison Charo Karisa**, World Bank ● **Fred Puckle Hobbs**, Co-Founder & Director, Tathva ● **Ali Mohammad Alshaikhi**, NACA GC Member, Kingdom of Saudi Arabia ● **Chris Ninnes,** CEO, Aquaculture Stewardship Council (ASC) Moderated by **Michael Phillips**, FutureFish and **Tipparat Pongthanapanich**, FAO
1030–1100	**Coffee Break**
1100–1230	**VIII. Open session to discuss specific key points and priorities** Statements are invited from NACA Government Members to: ● Identify top 5 priority actions (5 of 76 sub-actions proposed in the White Paper) for aquaculture transformation in the country. ● Present current and potential aquaculture transformation projects or initiatives that could further implement the top priority actions, with a focus on stimulating innovation and investment. ● Specify any specific innovations where the country has knowledge and capacity to share with other countries for accelerating the aquaculture transformation priority actions. Moderated by **Joykrushna Jena**, Chair of NACA Governing Council
1230–1330	**Lunch**
1330–1400	**IX. Statements from non-state representatives** Statements are invited from participants from public and private companies, civil society, donors and other partners on: ● Matching areas of interest for innovation and investment opportunities. ● Potential collaboration and future activities in response to Session VIII. Moderated by **Joykrushna Jena**, Chair of NACA Governing Council
1400–1430	**X. Summary of HLM-3 and next steps by NACA**
1430–1500	**XI. Close of HLM-3 by SHOU**

Annex 2

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