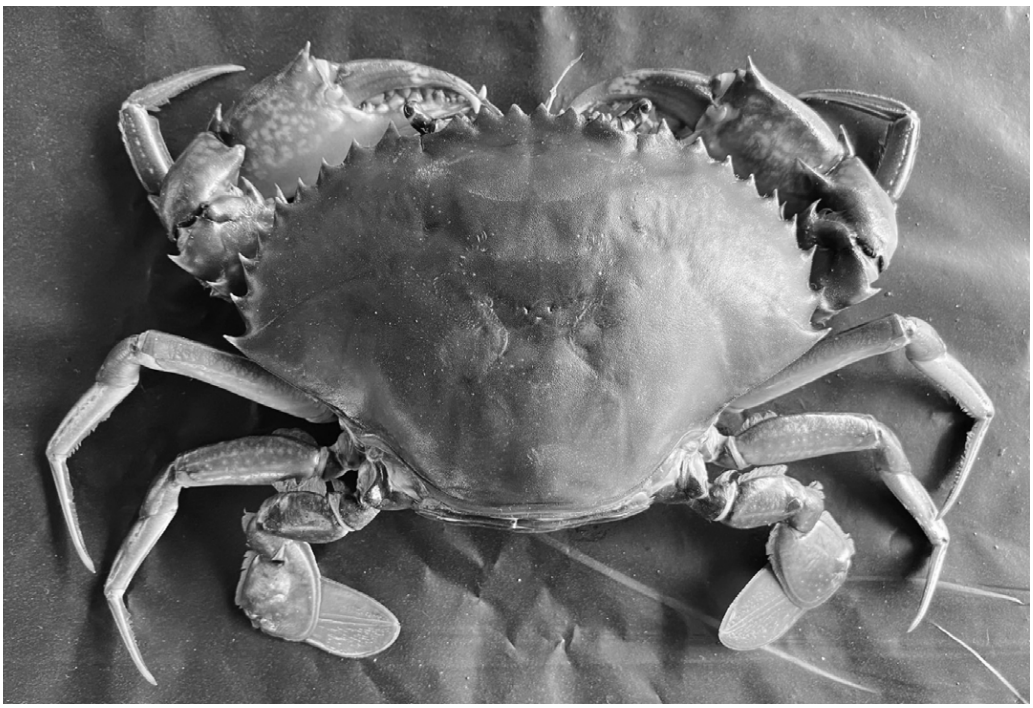
Status, technological innovations, and industry development needs of mud crab *(Scylla spp.)* aquaculture[1]



Background

An expert workshop on mud crab aquaculture, organized by the Food and Agriculture Organization of the United Nations (FAO) in collaboration with the Aquaculture Innovation Centre (AIC), was held in Singapore from 27 to 30 November 2023. The main objective of this technical event was to assess the current progress and development, as well as to identify persisting bottlenecks, future challenges and priority needs of the sector and identify key pathways for sustainable mud crab aquaculture production at a global level. The workshop was divided into four main sessions: a glimpse of the current global status of mud crab aquaculture; the advancement of mud crab hatchery, larviculture and nursery production; the development of current value chains, marketing and farming systems; and a final session on topics related to management, conservation, transportation and future industry needs.

The experts agreed that there is a strong and increasing global market demand for mud crabs, both in hard-shell and soft-shell forms. Soft-shell crabs are seeing a rise in demand, in particular, as a result of the value-adding opportunities they provide. Key advances include a shift towards the use of formulated feeds to reduce a dependence on unsustainable wild fishery feed resources and the improvement of hatchery production methods, including the adoption of probiotics and the integration of advanced water quality management technologies.

The industry's future will also be strengthened by the development of selective breeding and genetic improvement programmes. At present, most mud crab farming employs extensive production systems. However, research and trials on intensive farming systems, including strategies to minimize cannibalism, are gaining attention, incorporating cellular systems (individualised compartment) to reduce cannibalism. Many processes across the entire mud crab aquaculture system, ranging from broodstock culture to juvenile production, still require optimisation. Close collaboration and knowledge exchange among stakeholders are required to propel these advancements forward.

Although mud crab aquaculture is a relatively small sector in the global aquaculture industry, it has promising growth potential based on several decades of industry development, a solid technological foundation and strong global demand. The decline of shrimp aquaculture industry in many countries has opened opportunities for alternative aquaculture options, with mud crab farming gaining increasing attention. This sector merits consideration of private sector investment to meet market demand.

In addition, mud crab aquaculture and its associated product value chains support the livelihoods of local communities in mud crab producing countries. Thus, future development of the mud crab aquaculture sector can contribute to livelihood improvement and economic growth in many developing countries. To build on the momentum generated by the

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workshop, the experts agreed on the importance of further dissemination of information through digital channels, targeted events and meetings to engage the broader aquaculture community.

International mud crab industry status

The most recent FAO production figures showed that whilst China dominates global production of mud crabs with over half the total annual production of 296 000 tonnes, Viet Nam has demonstrated the strongest growth over the past decade, increasing its production by over 650 percent, to about 81 000 tonnes/year.

The main species produced in China and Viet Nam is the green mud crab, *Scylla paramamosain,* which also contributes to Indonesian farming. In the Philippines and India, the giant mud crab, *Scylla serrata,* is the most common species farmed, whilst the orange mud crab, *Scylla olivacea,* is cultured by countries including Thailand, Myanmar, Bangladesh and Indonesia. However, globally, all mud crabs of the genus *Scylla* are generally regarded as one type of crab, with no specific preference for individual species in most markets.

Mud crab farming now incorporates intensive (individual compartments), semi-intensive and extensive systems, polyculture and crab fattening of both hard-shell and soft-shell crabs. The choice of system selection depends on several factors, including space, resource availability, technical feasibility, and availability of financial resource. In some countries with more advanced mud crab culture technologies, such as China and Viet Nam, the growth of the sector has led to significant segmentation of the industry, with individuals or companies specializing in the sale of live feeds, broodstock, larvae and/or crablets, juveniles and farming.

Identified global key issues include:

- Continued dependence on wild seedstock for farming.
- Use of unsustainable feed sources such as trash fish.
- Insufficient hatchery production of quality seedstock.
- Inadequate aquatic health management of mud crabs.
- Domestication and genetic improvement of mud crab broodstock.

The reliance on capture-based stock for farming, coupled with overfishing, has resulted in significant reduction in catch per unit effort, decrease in the size of wild broodstock, and increase in the costs of wild stock for farming in many countries. This highlights the urgent need for more investment and transfer of technology to establish more mud crab hatcheries. Having the capability to produce sufficient high quality seedstock would not only reduce wild stock reliance but could also contribute toward sustainable fishery management through targeted restocking of wild populations. Transition from a capture-based to hatchery-based industry is critical to underpin the long-term sustainability of the industry and wild mud crab populations.

Fishery management

In most mud crab producing countries, overfishing of mud crabs, at varying degrees, is apparent. However, Australia has demonstrated that it is possible to sustainably manage wild mud crab populations. Its management regime reflects the country's unique industry structure, involving few fishers and strong regulatory and enforcement capabilities. It is considered possible to adapt Australia's management approach to help improve fishery management in other countries, if there are adequate resources and the necessary political will.

Many other countries, e.g. Indonesia and Philippines, have fisheries regulations limiting mud crab catches based on size and sex which contribute to better fisheries management, but generally and globally more needs to be done in this area to effectively manage and conserve wild *Scylla* populations. The decline of wild mud crab populations, particularly *S. olivacea* has also been exacerbated by the destruction of mangrove habitats in a number of countries. Mangroves serve as critical breeding, nursery, and feeding grounds for mud crabs. The loss of these vital ecosystems has far-reaching socio-economic consequences.

Future industry needs

The needs of the mud crab aquaculture sector identified during the workshop varied significantly between countries, between species and the hard- and soft-shell sectors. Additionally, their perceived importance will vary relative to stakeholders' roles in the mud crab value chain and their principal occupation (e.g. farmer, trader, processor, researcher or government). Overall, there was strong consensus to work towards a sustainable, hatchery-based mud crab farming sector, incorporating domestication, formulated feeds and reliable technology to produce high quality crab products to meet the increasing market demand. Global needs and recommendations generated by the workshop are listed below.

International

- Shift from a capture-based to a hatchery-based aquaculture sector.
- Replace low-value fish and other unsustainable fresh feeds with formulated diets.
- Increase hatchery and nursery production to meet the growing demand for seedstock.
- Domesticate and genetically improve mud crab broodstock.
- Implement sustainable management practices for mud crab fisheries.

Broodstock

- Ensure an adequate supply of broodstock to meet short- and medium-term hatchery demands before fully relying on domesticated stock.

- Domesticate and genetically improve mud crab broodstock.
- Improve husbandry and nutrition of broodstock to maximize reproductive performance.

Mud crab hatchery and nursery production

- Improve aquatic health management in hatchery and nursery operations.
- Develop improved hatchery and nursery systems to increase survival rates, reduce production costs and produce high quality seedstock.
- Incorporate enhanced monitoring and control of hatchery and nursery systems into management systems.
- Make use of advanced water management treatments and probiotics to reduce the dependence on prophylactic use of antibiotics.
- Utilize an improved understanding of the microbiome of mud crab larval and nursery systems to improve larval rearing protocols, feeds and feeding regimens.

Farming systems

- Improve extensive and semi-intensive pond-based systems through adoption of standard operational procedures and best aquaculture practices.
- Develop improved cellular systems for both soft-shell and hard-shell farming of mud crabs to reduce losses from cannibalism.
- Utilize best practices on biosecurity, improve health screening and increase aquatic health surveillance to reduce losses to common crustacean diseases.
- Formulate suitable mud crab diets to improve the physical nature of feeds to enhance growth and immunity, improve disease resistance and reduce wastes.
- Develop more efficient reduction of intra-specific aggression and cannibalism in communal farming systems.

Product handling and marketing

- Disseminate best practice on mud crab packaging and transportation techniques to support reduced waste, unnecessary stock loss and improved profits.
- Develop high quality standards for mud crab products to further improve value chain efficiency and international trade similar to other seafood commodities.
- Discourage forced moulting as this produces an inferior quality product.

Fishery management

- Regularly assess wild mud crab populations to address widespread overfishing concerns.
- Determine cost-effective mud crab fishery management plans. Such plans will only be effective with strong community, industry and other stakeholder consultation and government support.

Training

- Determine training needs as there are significant differences in mud crab aquaculture development between countries.
- Develop information, education and communication (IEC) materials to enable mud crab farming technology to be shared at scale via digital transmission.
- Support international collaboration in technology transfer and knowledge sharing.

General cross-sector recommendations

The establishment of aquatic health surveillance programmes and better management practices to mitigate significant diseases need to be developed. The development of disease screening platforms and molecular kits to monitor key viral and bacterial diseases are required, that include mud crab specific diseases, as well as generic crustacean ones.

In comparison to major aquaculture commodities, such as shrimp or salmon, there is still a paucity of research and information on mud crab aquaculture. To support the industrialization of mud crab farming, there is need for ongoing research and development in areas including, but not limited to:

- Genetics, genomics, immunogenetics and nutrigenomics.
- Nutrition and feed development, proteomics.
- Water quality treatment and management.
- Aquatic health management.
- Reduction of aggression and cannibalism.
- Immune system enhancement.
- Improved control of moulting.
- Microbiome analysis and microbial management.
- Moult death syndrome mitigation.
- RAS engineering.
- Automation of farm management systems including the incorporation of advanced sensors, internet of things, machine learning, deep learning, robotic systems and artificial intelligence.