

## Introduction

### Nutritional and Environmental Significance of Bivalves

Malaysia faces challenges in ensuring long-term food security due to rising populations, depleting fish stocks, and increasing protein demand. Bivalve aquaculture offers a promising solution, as these filter feeders can contribute to sustainable protein production (Boyd et al, 2022). One potential solution is to invest in sustainable aquaculture practices to increase seafood production. This can help alleviate pressure on wild fish populations while also providing a reliable source of protein for the growing population. Bivalve culture can support food security by providing nutritious food rich in essential nutrients like protein and omega-3 fatty acids necessary for human health and well-being (Yaghubi, 2021). Increasing bivalve production through aquaculture can contribute to meeting the growing demand for food and improving food security worldwide. Bivalve aquaculture has a significantly lower environmental footprint than other protein sources (Box 1). They don't require land, freshwater, or feed inputs and can even filter and improve water quality (Suplicy, 2020). Bivalves efficiently convert organic matter into high-quality protein, requiring minimal resources and contributing minimal greenhouse gas emissions compared to other protein sources (Willer & Aldridge, 2020). The bivalve industry in Malaysia includes green mussels, oysters, cockles and clams.

### KEY POINTS

This policy brief aims to highlight the potential of the bivalve industry contribution to Malaysia's food security goals. Bivalves offer a sustainable and nutritious seafood source. To fully exploit their benefits, the report recommends focusing on four key areas:

#### 1. Empowering Local Communities:

- Increase access to affordable bivalves for low-income populations through subsidised pricing and community-based distribution.
- Encourage and support community-driven bivalve cultivation projects to improve food security, nutrition, and local economies.

#### 2. Developing Smart Bivalve Aquaculture:

- Establish a framework for integrating innovative farming technologies within the National Agrofood Policy.
- Implement demonstration projects showcasing the benefits of technology adoption in Aquaculture Industrial Zones.

#### 3. Strengthening Evidence-Based Fisheries Management:

- Implement science-based management strategies for bivalve populations, ensuring sustainable long-term productivity.
- Enforce stricter regulations and prioritise habitat protection for healthy ecosystems.

#### 4. Advancing Bivalve Aquaculture through Advanced Research & Innovation:

- Invest in research initiatives to improve bivalve cultivation practices, including breeding techniques, disease management, and habitat enhancement.
- Develop superior broodstock with enhanced reproductive capabilities and disease resistance for different bivalve species.

**Box 1**

Utilising sustainable protein sources globally has become more urgent because of the environmental issues associated with conventional livestock farming. Bivalves have a much lower ecological impact than land-based protein sources (Table 1 and Figure 1). They also help with ecosystem services like water filtration. Bivalves are a great source of protein, have low-fat content, and are packed with essential nutrients like omega-3 fatty acids, making them a beneficial addition to a balanced diet.

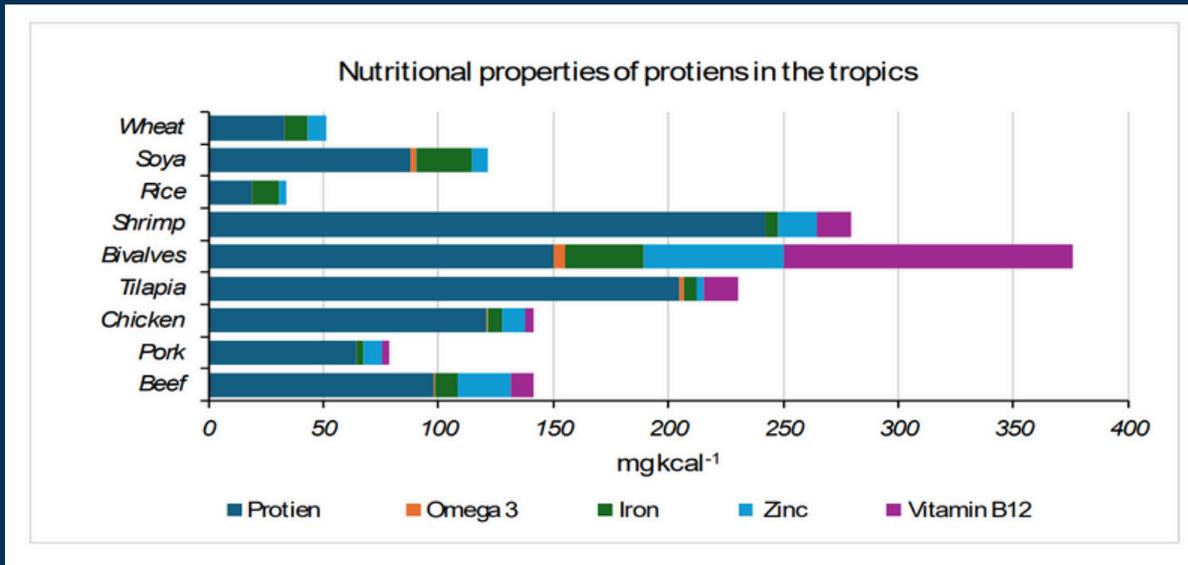


Figure 1: Nutritional properties of proteins in the tropics (Data: Willer & Aldridge, 2020)

Table 1: Environmental footprints of selected proteins by comparison to bivalve (Data: Willer & Aldridge, 2020).

	Land use (ha per t protein)	Greenhouse gas emissions (tCO <sub>2</sub> per t protein)	Freshwater use (m <sup>3</sup> per kg protein)	Eutrophication potential (kg P per t protein)
Beef	50	337.2	112.5	180
Pork	2	57.6	56.5	120
Chicken	3	42.3	34.3	40
Tilapia	7.5	40.7	15.9	82
<b>Bivalves</b>	<b>0</b>	<b>11.1</b>	<b>0</b>	<b>-148</b>
Shrimp	16.4	161.4	4.4	104
Rice	21.2	2.36	19.81	109
Soya	0.578	1.04	5.76	17.8
Wheat	4.62	3.54	11.84	30

## **Aquaculture and Bivalve Industry in Malaysia**

Malaysia is well-positioned to capitalise on aquaculture as a significant contributor to its agro-food sector in the ever-changing aquaculture industry (Box 2). Although no specific policy framework exists for bivalve aquaculture, the nation's strategic objectives within more extensive frameworks indicate a positive direction towards sustainable progress (Witus & Vun 2016). The National Agro-Food Policy 2021-2030 (NAP 2.0), a visionary plan stressing sustainable practices across various species, including bivalves, is the foundation for Malaysia's aquaculture goals. This policy encourages innovation and technology adoption and paves the way for improved bivalve farming techniques and disease management tactics. The Fisheries Act 1963 (Act 714) complements the NAP 2.0 by granting authority to state fishery departments to oversee and control aquaculture activities. This enables the development of customised regulations crucial for promoting appropriate bivalve aquaculture practices. The Ministry of Agriculture and Food Security oversees Malaysia's aquaculture sector. The government has designated specific regions as aquaculture industry zones to achieve its objectives. For instance, in 2022, the ministry dedicated 330 hectares of land to the cockle industry in Melaka, targeting an annual production of 1,600 tons of cockles. Projections suggest that by 2030, this industry will contribute approximately RM10.6 million to the economy, with fishermen potentially earning an income of RM3,000 per month.

Initiatives led by the Department of Fisheries Malaysia (DoFM) promote favourable aquaculture technologies to the environment and encourage the variety of species. These efforts are crucial in supporting the expansion of the bivalve sector. Furthermore, the Malaysian Fisheries Development Authority (LKIM) emerges as a critical partner, offering vital financial assistance and technical support to aquaculture activities, including bivalve farming. To ensure sustainability, LKIM has allocated RM 100,000 to Persatuan Nelayan Kawasan Sungai Tinggi for green mussel cultivation in the northern region intending to produce 1.5 tan mussel per week. With a commitment to research and development, LKIM's efforts promise to advance bivalve-specific innovations crucial for sectoral growth. LKIM's dedication to research and development ensures the advancement of bivalve-specific innovations essential for the sector's success.

Staying abreast of the latest developments in research and innovation is essential in bivalve production. Consequently, oyster entrepreneurs in Sungai Merbok, Kedah, have been in a decade-long partnership with the Center for Marine and Coastal Studies (CEMACS) at Universiti Sains Malaysia. This collaboration focuses on ensuring the adoption of cutting-edge aquaculture techniques. Efforts include the production of high-quality oyster seeds, maintaining suitable culture environments, and efficient harvesting practices. Thanks to this initiative, aquaculturists have successfully operated seven cages that house over 160,000 oysters. Beyond bolstering local fishermen, CEMACS has also transformed their aquaculture farms into local and international learning centres for students and communities, establishing them as knowledge hubs within the industry.

In sync with these efforts, the National Blue Economy Blueprint (2021-2030) emphasises the important role of sustainable aquaculture in Malaysia's blue economy, emphasising environmentally-conscious practices that resonate with the ethos of bivalve farming. While these existing policies and frameworks provide a solid foundation, seizing the full potential of bivalve aquaculture demands concerted action. By developing specific guidelines, allocating dedicated funding, and fostering stakeholder collaboration, Malaysia can usher in a new era of bivalve aquaculture marked by sustainability, resilience, and economic prosperity.

The National Blue Economy Blueprint (2021-2030) highlights the crucial importance of sustainable aquaculture in Malaysia's blue economy. It emphasises the use of environmentally friendly practices that align with the principles of bivalve farming. Although the current policies and frameworks are a good starting point, fully realising the potential of bivalve aquaculture requires coordinated efforts. Malaysia may achieve sustainability, resilience, and economic prosperity in bivalve aquaculture by creating clear criteria, providing dedicated funding, and promoting stakeholder collaboration.

**Box 2**

The aquaculture sector has been highlighted as a critical component in promoting economic development under Malaysia's National Key Economic Areas (NKEA). Data show that the marine capture fisheries sector has continuously doubled the economic output of the aquaculture sector. Nonetheless, the upward trend of brackish water aquaculture signifies an optimistic future for Malaysia's protein diversification. Brackish water aquaculture is developing as a strategic avenue to meet rising seafood demand while reducing exploitation of marine capture fisheries and avoiding future climate change consequences. Such a paradigm change favouring aquaculture is consistent with Malaysia's goals of increasing food security and driving economic growth while protecting the integrity of its marine ecosystems.

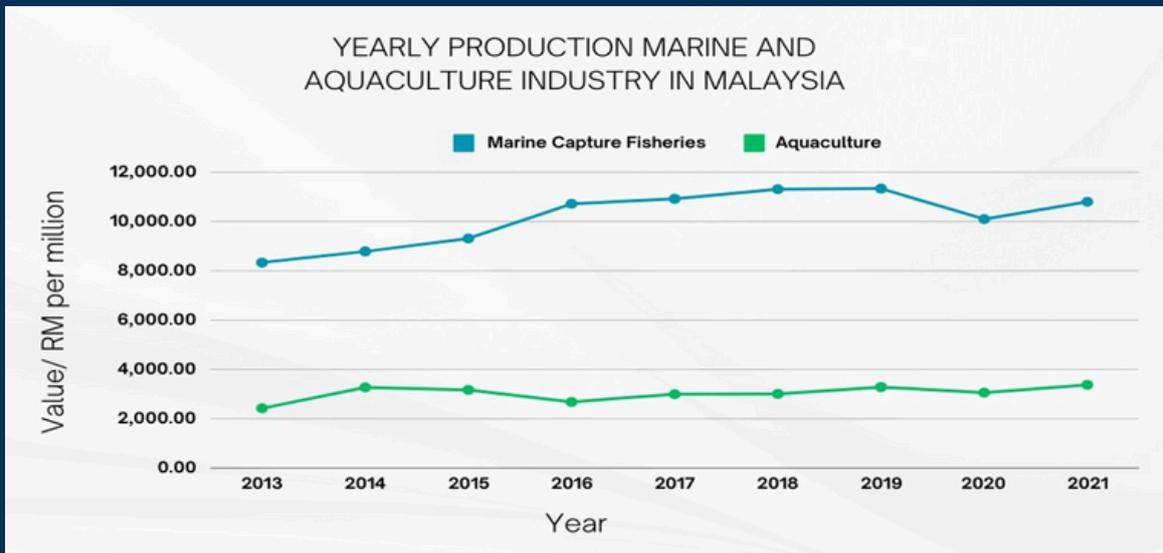


Figure 2: Production of Marine Fisheries and Aquaculture from 2013 to 2021 (Data: Department of Fisheries).

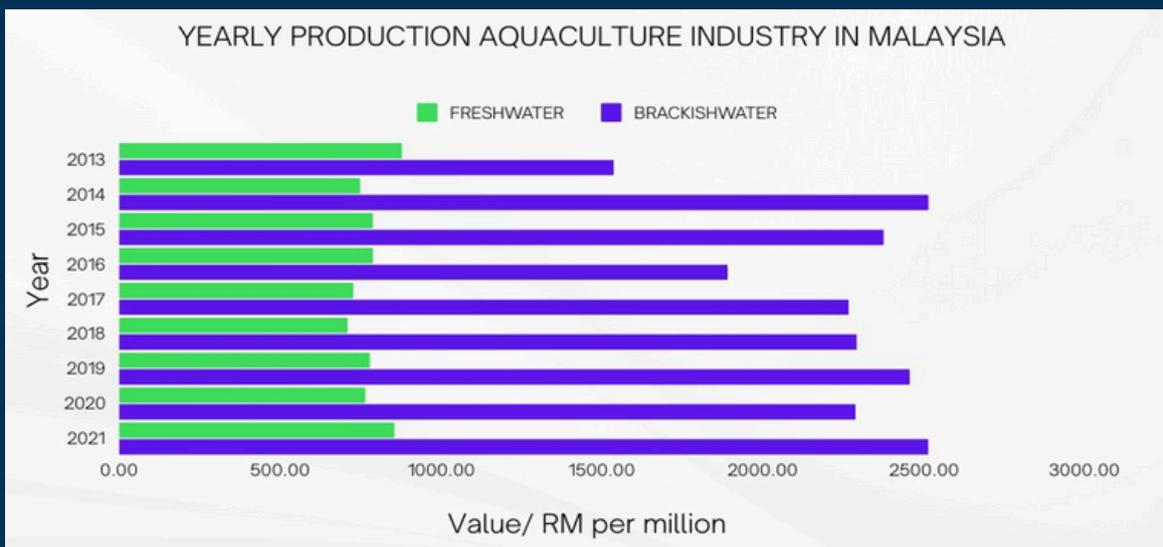


Figure 3: Production of Aquaculture (Freshwater and Brackishwater) from 2013 to 2021 (Data: Department of Fisheries).

## Challenges

Despite its potential, the industry faces numerous challenges and gaps that hinder its sustainability and growth. Recognising and addressing these issues is imperative for harnessing the full potential of bivalves as a resource for sustainable food production and economic development.

<b>Environmental Degradation</b>	Pollution and habitat destruction can significantly impact bivalve populations by affecting the water quality and ecosystems they depend on for survival.
<b>Overexploitation</b>	Unsustainable harvesting practices can deplete bivalve stocks, reducing their availability for future generations and disrupting ecological balance.
<b>Disease Outbreaks</b>	Bivalves are susceptible to various diseases, which can spread rapidly in aquaculture settings and lead to significant losses.
<b>Climate Change</b>	Changes in ocean temperature and acidity can affect bivalve growth and reproduction, posing a long-term threat to their populations.
<b>Lack of Technical Knowledge</b>	Limited access to advanced cultivation techniques and sustainable practices can hinder the industry's growth and sustainability.
<b>Financial and Technical Support</b>	Limited access to financial services and insurance for aquaculture operations, particularly for small-scale farmers, can hinder the ability to invest in sustainable practices or recover from losses.
<b>Access to Market</b>	Small-scale producers often face difficulties accessing broader markets due to logistical challenges, lack of market information, and competition with larger producers.

## **Policy Recommendations**

The bivalve industry in Malaysia holds significant potential to contribute to food security, given its capacity for sustainable harvesting and production. Unlocking the potential benefits of bivalve consumption for both the environment and human health demands exploring practical approaches to replace conventional meat and fish with bivalve meats. To fully employ the benefits of the bivalve industry for food security, further support is needed in the following areas:

### **Empower Local Communities :**

Enhancing access for low-income individuals to bivalves, a nutritious seafood source, within Malaysia. Access to nutrient-rich seafood, including bivalves, is vital for ensuring food security, particularly among vulnerable populations. In Malaysia, efforts should be made to improve access to bivalves for low-income communities, enabling them to benefit from the nutritional value of these shellfish. Initiatives such as subsidised pricing schemes and community-based distribution programs can help increase access to bivalves among those most in need. Furthermore, pushing for community-driven bivalve cultivation initiatives has the potential to empower local people while reducing food insecurity. Encourage and support community-driven bivalve cultivation projects to empower local communities, improve food security, and enhance nutritional intake. Successful models, such as collaborations with institutions like the Center for Marine and Coastal Studies (CEMACS) (Box 3), should be replicated and scaled to benefit more communities. These projects contribute to nutritional well-being and foster community empowerment and sustainable practices in seafood production. Local economies can be strengthened by supporting community-driven bivalve cultivation, providing new income sources and enhancing the economic contribution of the fisheries and aquaculture subsector. This benefits individual food producers by diversifying income sources and positions Malaysian fishery produce more competitively in global markets (NAP 2.0, Fisheries and Aquaculture Subsector).

### **Develop a Comprehensive Smart Farming Framework:**

Establish clear guidelines supporting the implementation of smart farming within the aquaculture sector as part of the National Agrofood Policy 2021-2030 and the National Agricommodity Policy 2021-2030. Accelerate the Adoption of Modern Technologies: Encourage using big data analytics, IoT, AI, drones, robotics, and sensors in aquaculture practices. Implement demonstration projects in Aquaculture Industrial Zones to showcase the benefits of technology adoption. As advocated in the Twelfth Malaysia Plan (2021-2025), adopting smart farming practices in the aquaculture sector can significantly enhance Malaysia's agricultural productivity and sustainability. Policymakers must consider these recommendations to ensure the long-term growth and competitiveness of the aquaculture industry.

### **Evidence-Based Fisheries Management:**

Through efficient management protocols, sustain and enhance the productivity of marine capture fisheries, including the bivalve industry. Adopt and implement science-based management strategies to sustainably manage bivalve populations and other marine resources. These strategies should be informed by current research and data on marine ecosystems and fisheries dynamics to make informed decisions that balance productivity with conservation. By adopting efficient management protocols that include science-based strategies, strict regulatory enforcement, and habitat protection, Malaysia can ensure the sustainability and enhanced productivity of its marine capture fisheries, including the bivalve industry. This approach not only secures the long-term viability of these fisheries but also contributes to national food security and the economic prosperity of coastal communities. This strategy aligns with key priority area B, Theme 3 of the Twelfth Malaysia Plan (RMK-12), emphasising the efficient management of natural resources to protect and leverage Malaysia's natural capital. Adhering to evidence-based fisheries management will uphold the sustainability of Malaysia's marine capture fisheries, including the bivalve industry, and play a critical role in enhancing national food security. Furthermore, this approach supports the economic well-being of coastal communities. It aligns with Malaysia's broader environmental and economic objectives, marking a significant step towards responsible and informed stewardship of marine resources.

### **Advancing Bivalve Aquaculture through Research and Innovation:**

Conducting research aimed at bolstering the production of cultured bivalves, emphasising refining and disseminating effective cultivation practices across Malaysia. Research and innovation play a vital role in increasing the production and sustainability of bivalve aquaculture. Malaysia should invest in research initiatives to enhance the production of cultured bivalves by developing and disseminating effective aquaculture practices. This includes research into breeding techniques, disease management strategies, and habitat enhancement measures. By leveraging scientific advancements, Malaysia can unlock the full potential of bivalve aquaculture to contribute to food security and economic development. Research and breeding initiatives, similar to those undertaken in the oyster industry in Malaysia, are essential for developing broodstock with superior reproductive capabilities and producing high-quality seed for other bivalve species. By focusing on triploid genetics, which exhibits accelerated growth rates, heightened disease resistance, and other desirable traits, this research can facilitate the cultivation of robust and resilient bivalve populations. Moreover, such efforts contribute to the sustainable expansion of the bivalve industry by ensuring the availability of premium-quality seed stock for aquaculture operations, thereby enhancing productivity and promoting long-term viability.

#### **Box 3**

Universiti Sains Malaysia's Centre for Marine and Coastal Studies (CEMACS) is renowned for its expertise in shellfish cultivation and has played a key role in advancing the aquaculture industry with oyster farming. They have set up the initial artificial shellfish center in Malaysia and are actively sharing their expertise on green aquaculture practices with local farmers. There is a significant opportunity for local production to meet domestic demand, considering the high percentage of imported oysters in the market. CEMACS is dedicated to assisting in the establishment of oyster farms through the provision of training, oyster seeds, and advice on hatchery development. The focus is on promoting environmental sustainability and highlighting the economic benefits of oyster farming for local fishermen.



## Conclusion

The bivalve industry illustrates excellent potential for improving food security and strengthening livelihoods in Malaysia. By focusing on providing nutrient-rich bivalves to vulnerable populations, improving bivalve fisheries productivity through effective management, and encouraging research and innovation in bivalve aquaculture, Malaysia can maximise the bivalve industry's potential for a more resilient and food-secure future for coastal communities. By implementing the proposed policy recommendations, Malaysia can strengthen food security, enhance marine resource conservation, and build the resilience of coastal communities in the face of climate change and environmental degradation.

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