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Blue Foods for Indonesia: A Human & Planetary Health Action Lab

Blue Foods Technology: *Lessons Learned from Innovation in the Blue Foods Sector*

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Executive Summary

As global populations increase and strain traditional food systems, the sustainable production of nutritious blue foods emerges as a necessary consideration. Innovative technologies in the blue food sector are showing nascent potential in boosting productivity, eliminating points of inefficiency, and supporting national and international sustainable development goals. In Indonesia, blue food technologies could offer a powerful lever to propel the nation towards its vision of *Indonesia Emas 2045*, supporting increased global competitiveness, higher-value exports, and new economic opportunities for actors throughout the value chain. In this report, we showcase the tremendous potential of blue foods technologies while also highlighting the hurdles and trade-offs associated with adoption, particularly for the environment as well as the livelihoods of smallholders and coastal communities. Through this analysis, we offer BAPPENAS a perspective on how Indonesia could play a leading role in unlocking the potential of blue foods technology on both a domestic and international scale. By understanding recent technical and non-technical innovations, highlighting novel market developments, and examining policies in six countries (i.e., Chile, USA, Singapore, Japan, Norway, and Ecuador) that have successfully enabled blue food tech innovation, we illustrate a portfolio of strategies for Indonesia to achieve its blue foods development goals.

1. Introduction

Our research explores global examples of blue foods technology aimed at improving productivity, environmental safeguards, and the livelihoods of smallholders and coastal communities. The aim is to develop actionable insights for BAPPENAS based on key success factors, risks, and tradeoffs across a range of innovation models from other countries.

For our research, we found that the term *blue foods technology* encompasses a range of digital solutions and hardware technologies that enable more efficient data collection, cross-actor communication, predictive analytics, fisheries management, and more. While many of these technologies are point solutions, it is not uncommon for these to be bundled as part of a more comprehensive package, as many actors may also offer financial services, technical training, and other empowerment initiatives.

Within Indonesia, many players have emerged in the blue foods space, often straddling different parts of the value chain. Blue foods players are situated within a broader blue economy which extends well beyond fisheries and aquaculture to include tourism, energy (e.g. oil and gas, blue carbon), and offshore minerals mining. We are thus cognizant that any strategy on blue foods technology should be integrated with Indonesia's broader blue economy strategy. In addition, the baseline context for each case study warrants additional substantive research in advance of considering government policy interventions. This report will focus on key findings based on a study of the overall blue foods landscape, as well as country studies into successful policies that have promoted blue foods priorities.

2. Methodology

This report features a variety of findings built on an iterative approach that combines expert interviews with a review of journal articles and government / NGO reports. We first conducted a supply chain mapping exercise to understand the key actors at play in the blue foods sector in Indonesia. Then, we examined the trends in the development of blue foods technology itself. We analyzed the role of technology enablers such as governments, NGOs, venture capitalists, and philanthropists in the tech innovation ecosystem. Following our discussion on the novel trends and actors at play in the blue food technology space, we delve into an analysis of blue food tech

policies from six countries highlighted as key players by the experts we interviewed, focusing on success factors underlying their operating model and theories of change. Lastly, we synthesize actionable insights to propose policy recommendations to strengthen technological innovation in the Indonesian blue foods sector.

Throughout the report, we feature insights from 31 expert interviews, including impact-focused funds, philanthropists, tech operators, individuals with expertise in venture capital, and individuals with expertise in Indonesia's blue foods sector (such as social activists working with smallholder producers). These interviews elucidate key trends, challenges, and opportunities along the existing supply chain as well as point towards areas of opportunity surrounding economic productivity, environmental sustainability, and social inclusivity in production, processing, distribution, and market access that could support BAPPENAS in expanding its blue food tech sector. Additional resources and outputs, including a conceptual framework for evaluating competing blue foods futures, are located in Appendix 1 and in the supplementary information document.

3. Findings

3a) Dual Forms of Technological Advancement

Technology advances include both technical innovation and non-technical innovation.

In economic theory, technology is considered a key driver of long-term economic growth, allowing for a shift in the production frontier of firms and industries. Understood as the methods and processes used to produce goods and services, technology enhances productivity and leads to growth that is not solely dependent on additional inputs of labor and capital.¹ Our study finds that blue foods technologies have enabled fishers and aquaculture farmers to be more productive, reduce their costs, enjoy better access to markets, and receive rewards for more sustainable production practices.

¹ Solow, R. M. (1957). Technical Change and the Aggregate Production Function. *Review of Economics and Statistics*, 39(3), 312–320

While discussions around blue foods technology often focus on *technical innovations* – such as those involving biotech breakthroughs, precision hardware, AI-driven software, and cloud-based platforms, our study of innovative blue foods companies in Indonesia revealed that *non-technical innovations* play a significant role in achieving success. In fact, value is often created largely through new business models, improved management practices or better social engagement of coastal communities – with modest technical solutions playing a supplementary role.

This finding has significant implications for policymakers seeking to unlock economic value for Indonesia’s blue foods sector. Technical innovation is important, yet it is not sufficient for achieving far-reaching success. It is therefore important to not only encourage tech adoption but also to urge entrepreneurs and social innovators to build and scale ventures featuring new methods and processes within the industry.

Technical Innovations

We encountered a range of technical innovations—which may have promising outcomes for Indonesia—with a targeted set of implementation factors incorporated as outlined below.

Biotechnology for seaweed

Although Indonesia is the world’s second largest seaweed producer in the world, economic returns are low, and productivity has declined in recent years.² The decrease in yield over time may be attributed to the limited supply of quality seedlings suitable for the diverse and changing climatic conditions of the region.³

Beyond seedling innovation for improved resilience and productivity of *seaweed cultivation*, biotechnology research also has the potential to create value by uncovering new *use cases for harvested seaweed*, ranging from health foods and animal feed to biostimulants, biofuels and bioplastics. While the economic value of Indonesia’s seaweed produce is presently low, there is growing global optimism around seaweed. In a 2023 report, the World Bank projected seaweed markets to grow an additional USD11.8 billion by 2030,⁴ driven by a wide range of demands that are of important relevance to the Indonesian context.

² Napitupulu, L. S. et al., “Trends in Marine Resources and Fisheries Management in Indonesia”

³ Interview with Dodon Yamin, Banyu

⁴ World Bank Group “Global Seaweed: New and Emerging Markets Report”

Genetic engineering and innovations for better feed

Traditionally, aquaculture feed for both fish and shrimp has been heavily dependent on fish meal or fish oil obtained from wild fish, including “trash” fish, but this source is becoming more expensive and less healthy for farmed blue foods. As such, feed formulations have evolved over the past two decades, with fishmeal and fish oil increasingly replaced by plant and animal proteins and oils⁵ – a shift facilitated by advances in genetic engineering. Beyond alternative sources, science-based feed optimization techniques can preserve the nutritional value of blue foods farmed in intensive and super-intensive settings.

There are important gains that can be made by encouraging widespread advances in aquaculture feed practices. Beyond environmental sustainability and nutritional quality, there is significant room to improve aquaculture productivity and profitability, as feed accounts for up to 50% of production costs.⁶

Precision farming

The aquaculture space is currently experiencing a significant transformation, propelled by the integration of Internet of Things (IoT) technologies, cloud computing, and advancements in artificial intelligence (AI). The deployment of such solutions facilitates a more precise and efficient management of aquatic farming operations.⁷ Beyond reducing cost and improving revenues, Jennifer Bushman, a sustainable seafood expert, expressed her enthusiasm about the potential for technology to improve fish welfare.

However, alongside these advancements, the increasing effectiveness and use of precision farming solutions comes with the risk of replicating the mass monoculture practices seen in agriculture. One of our interviewees from the aquatech sector in Japan emphasized the importance for aquaculture to broaden its focus beyond salmon and shrimp to include a wider array of species in order to avoid the pitfalls of agricultural monocultures, where a limited number of species dominate global diets and production systems, making them more vulnerable to diseases and environmental changes. For Indonesia, this means that diversifying its

⁵ Naylor, “Blue Foods for Indonesia Lecture”

⁶ <https://jala.tech/blog/cultivation-tips/high-quality-feed-for-shrimp-growth#>

⁷ Priyadarshini et al., “Transition Pathways for Attaining Sustainability in Indian Agriculture by 2030”

aquaculture species and encouraging the adoption of species-agnostic technologies can contribute significantly to food security, nutrient availability, and environmental sustainability.

Traceability

Traceable and sustainable blue foods are typically premium products for a niche market, given the increased costs that are borne either by the suppliers or the buyers. However, there is growing consumer sentiment that the seafood industry needs to operate with greater environmental sustainability and without labor abuse, leading to policy momentum from governments and certification bodies for the same.⁸ If traceability solution providers in Indonesia adhere to global data standards (such as GS1 EPCIS) and those set by the Global Dialogue on Seafood Traceability, Indonesia's blue foods sector may gain a competitive advantage in reaching markets demanding high transparency.

Non-Technical Innovations

Whereas global blue foods tech players tend to favor technical innovation, Indonesia's home-grown champions and prospective disruptors have focused on non-technical innovation and comparatively modest technical solutions. We strongly emphasize the importance of such approaches, yet also note a potential for efficiency gains by addressing gaps in existing low-tech solutions.

Management practices

Indonesian blue foods startups often help producers improve production management. For example, eFishery and JALA offer customers digital dashboards to monitor key indicators of pond conditions and company finances as well as provide tips on best practices. Similarly, DelosAqua, a VC-backed saltwater shrimp operator, realized that enforcing basic hygiene protocols, such as washing hands and feet before entering the shrimp pond, could drastically reduce disease without the need for sophisticated technology.

⁸ Interview with Mark Kaplan, Wholechain

New business models

Business model innovation is spurred by changes to an organization's value proposition to customers and its underlying operating model.⁹ In other words, this means finding new ways to operate in order to address problems which have not been solved. At its simplest, it requires neither new technology nor the creation of brand-new markets.¹⁰

The examples we came across illustrate not only new business models which have emerged in recent years, but also the types of basic industry gaps which remain in Indonesia's blue foods sector. Commenting as an outside observer, a US-based technologist who we interviewed notes that Indonesian fish aren't generally perceived as high-value enough for significant capital investment for aquaculture, with farmers not having enough money to pay for technology. Thus, the "only way to survive" is to create a tech-enabled financial or distribution business. eFishery created value by selling feed on credit to cash-strapped aquaculture farmers, and DelosAqua found an innovative way to achieve economies of scale in a saltwater shrimp market with many by small, inefficient farms. Many opportunities can be unlocked through new business models to address the high degree of fragmentation across the blue foods industry in Indonesia.

Carbon markets

The market for carbon credits is projected to grow to US\$50 billion¹¹ to US\$100 billion¹² by 2030. Specifically, blue carbon credits are a recent development that seek to quantify and "trade" carbon sequestration from ocean and coastal ecosystems so various entities—ranging from governments to corporations—can fulfill their net zero carbon emissions goals. Silvofishery and seaweed farms in Indonesia may have significant potential to sell blue carbon credits, but this will require government policy to develop a credible voluntary carbon market. Investigating connections between blue foods and blue carbon could be a potential avenue of strengthening the blue economy in Indonesia.

⁹ Bain Consulting Group, "Business Model Innovation"

¹⁰ Girotra and Netessine, "Four Paths to Business Model Innovation"

¹¹ Blaufelder et al., "A blueprint for scaling voluntary carbon markets to meet the climate challenge"

¹² Morgan Stanley, "Where the Carbon Offset Market Is Poised to Surge"

Social engagement

Any technology, however powerful, is only effective if its intended user has the willingness and ability to adopt it. Encouraging coastal communities to adopt new methods and processes is challenging at scale given the vastness of the Indonesian archipelago. Bryton Shang (CEO of Aquabyte) notes that in Norway and Iceland, a blue foods tech entrepreneur “can talk to all the key players over lunch.”, highlighting the consolidation of the system. By contrast, there are “30 million ponds in Indonesia,” and farmers need to be approached door-to-door to be convinced to adopt a new technology. It therefore comes as no surprise that innovative marketing, or social engagement, can go a long way in getting coastal communities to adopt new practices that in turn unlock value. Banyu, ABALOB, and mFish are examples of social initiatives that were able to deeply understand and work closely with the communities they were serving in order to make a technology product that fit into smallholder producers’ lives. We will be highlighting their work throughout this report.

3b) Innovation Ecosystems

Technology adoption is made possible by an innovation ecosystem in which connectors play a catalytic role.

Our study found that innovation does not exist in a vacuum but is the product of an ecosystem comprising a vibrant network of stakeholders bringing unique contributions that drive the maturation of ideas from inception to market. A common thread that emerged was the importance of collaboration and partnerships among these stakeholders in building innovation (Figure 1).



Figure 1: One overview of the many different types of players in the blue foods space is shown here. (Source: 2023 Blue Food Innovation Summit).¹³

Within this ecosystem, a number of ‘connectors’ serve as catalysts to assist entrepreneurs through the multifaceted process of developing and deploying innovative solutions. As can be seen in Figure 2, these include profit-driven venture capital (VC) firms, impact investors, venture studios, incubators, accelerators as well as market educators and evaluators. Among these, educators and evaluators like the [World Economic Forum](#) and [Fed by Blue](#) serve as important platforms to convene stakeholders across different networks.



Figure 2: An original graphic showing how technology thrives within an innovation ecosystem where connectors play a catalytic role.

¹³ Blue Food Innovation Summit, “An Event for Visionaries Shaping a Biodiverse and Resilient Blue Economy”

Interestingly, several cutting-edge international aquaculture tech firms highlighted that capital investment in the blue foods sector is lacking, particularly beyond early-stage investments. As a result of this, as well as reduced regulatory incentives in the US, many players are looking to find other operating locations, including in Southeast Asia. Indonesia may choose to make the most of this moment to leap ahead as a blue foods leader through policies that foster an active innovation ecosystem with greater support and capital for entrepreneurs compared to other countries.

At the same time, we also learned that many global blue foods catalysts with powerful networks are keen on operating in Indonesia but are unsure how to engage. Specifically, they cite the fragmented legal and regulatory framework, as well as the informal nature of smallholder blue foods economies, among their reasons for uncertainty. There is thus significant potential for Indonesia to leverage the extensive capital, expertise, and networks of global catalysts, if government, NGO and private sector players in Indonesia can find suitable models for developing partnerships.

Venture Capital (VC)

By definition, innovative ventures are risky because they involve testing new technical and non-technical methods. Because VC firms are set up precisely for making financial bets on early-stage ventures with high potential for growth, they act as the financial engines of the innovation ecosystem, including those in the blue foods space. Beyond the initial equity investment, they also provide strategic guidance to help startups navigate the complex journey from inception to “exit”, which is when the VC investors cash out on their investment (e.g. through an Initial Public Offerings (IPOs) on a stock exchange), typically 7-10 years later.

If Indonesia wishes to ensure the sustainable use of aquatic and marine resources, it is important that VCs active in the blue foods space are not focused on maximizing financial performance alone but are also supportive of efforts by their portfolio companies to safeguard the interests of the environment and coastal communities. This demands an innovative approach that integrates responsible investment practices, supports research and development for sustainable technologies, and cultivates partnerships with entities committed to ecological conservation. The concept of blue growth, emphasizing the sustainable development of marine resources,

highlights the necessity for innovation and the building of absorptive capacities to ensure the sector's sustainable progression.¹⁴ The remainder of this subsection provides information and context regarding venture capital companies active in the blue food sector.

This evolved approach is epitomized by **Aqua-Spark**,¹⁵ a venture fund out of the Netherlands, with a portfolio of over 50 sustainable aquaculture small and medium-sized enterprises (SMEs) supported by a network of 300 investors from more than 25 countries. Aqua-Spark's strategic investments span the entire value chain, including alternative feed solutions, sustainable farming practices, innovative technology, disease management, market access, and alternative proteins. A notable investment, **eFishery**, an Indonesian IoT startup, exemplifies Aqua-Spark's vision by enhancing fish farming efficiency and sustainability through smart-feeding technology.

Aqua-Spark distinguishes itself through two main features. First, it offers an innovative fund structure akin to a holding company, providing investors with flexibility through no mandatory lock-up periods and a semi-annual redemption mechanism. This approach, coupled with a strong focus on impactful investments, is supported by a broad network of experts, investors, and aligned partners, ensuring a robust foundation for fostering sustainable aquaculture practices. Second, Aqua-Spark's commitment to building a unique portfolio ecosystem is aimed at nurturing long-lasting partnerships with SMEs within the aquaculture sector.¹⁶ This collaborative effort is designed to drive the industry towards greater sustainability by advocating for transparency, efficiency, and resilience in operational practices. By doing so, Aqua-Spark not only aims to enhance the sustainability of aquaculture globally but also sets a new standard for the industry, envisioning a future where commercial aquaculture aligns with the ideals of true sustainability.

Another innovative VC firm is **Propeller Ventures**, which operates with a focus on combating climate change through ocean-based solutions. Partnering with institutions like the Woods Hole Oceanographic Institution (WHOI), Propeller Ventures invests in scientific advancements and innovations across various themes, such as carbon sequestration and novel biological ingredients for multiple industries.

¹⁴ Giannoumis, et al., "A Time and Place for the Sustainable Blue Economy: The Dilemma of Blue Growth Balancing Commercial Opportunities and Environmental Forces," in *OCEANS 2021: San Diego – Porto*

¹⁵ AquaSpark, "Aqua Spark - Investing in Solutions"

¹⁶ AquaSpark, "ImpactAssets 50: Aqua-Spark"

During our discussion with Steven Fox, a partner at Propeller Ventures, he shared insightful perspectives on how policy interventions could catalyze innovation within the fisheries and aquaculture sectors. Fox is particularly enthusiastic about government initiatives that could subsidize climate-resilient and yield-enhancing fishing tools and equipment, advocating for these tools to be readily available to fishers. He also calls for regulatory actions to ensure fishers have access to equipment aligned with climate goals, aiming to embed sustainable practices more deeply within the industry. Fox further pointed out several critical challenges confronting these sectors, such as the daunting risks for buyers, the significant environmental costs associated with emissions, and the rigid nature of current systems. These issues, he believes, create reluctance among insurers and investors due to perceived high barriers to entry and investment risks in aquaculture and fisheries.

Targeting Indonesia, Fox and other venture capitalists emphasized the crucial role of gender equity in unlocking the full potential of the fishing and aquaculture industries. Fox noted that gender inequity not only clashes with the investment criteria of many VC firms but also limits the breadth of investment opportunities, stifling innovation and progress. By advocating for gender equity, Fox believes that not only will it broaden the investment landscape, but it will also resonate with the ethical standards and investment ethos of progressive VC firms like Propeller Ventures.

Impact Investing to Amplify Reach

Besides equity funding from profit-driven VC firms, non-governmental organizations (NGOs) are increasingly embracing innovative approaches to “blend capital”, strategically combining both public and private financial instruments to maximize their impact.¹⁷ For example, Conservation International Ventures (CI Ventures) deploys “venture philanthropy” — the intersection of philanthropic and venture capital—to drive meaningful change in startups focused on sustainability. CI Ventures offers a diverse range of funding options tailored to the unique needs of startups including equity, debt, SAFEs (Simple Agreements for Future Equity), and convertible notes. The organization’s strategy focuses on de-risking companies, catalyzing

¹⁷ Jens Christiansen, “Fixing Fictions through Blended Finance: The Entrepreneurial Ensemble and Risk Interpretation in the Blue Economy”

follow-up funding, and facilitating their transition to become bankable entities attractive to the broader market.¹⁸

In an interview with the director of a leading impact venture fund, she highlighted challenges in securing “follow-up financing” for startups based in developing countries. The director emphasizes the hesitancy of blue economy investors to engage with social impact companies in developing regions unless they are registered in jurisdictions with more familiar legal frameworks like Singapore, the U.S., or Europe. This caution stems from perceived legal risks and the CI Venture’s requirement for investment returns within five-year periods, underscoring the delicate balance between impact and financial viability in venture philanthropy.¹⁹ Moreover, she raised concerns about the regulatory environment and policy decisions in countries such as Indonesia, where proposed bans on seaweed exports could hinder foreign investment and fail to support the local industry as intended.

Recognizing the unique hurdles faced by entrepreneurs in developing countries, she advocates for the creation of a supportive ecosystem that includes government grants, concessional terms of early-stage investment, and other safer financing avenues. Such measures could significantly enhance the entrepreneurial landscape in these regions, providing a more robust safety net that encourages innovation and iteration—a culture vividly embodied in Silicon Valley but scarce in the developing world.

Conservation International Ventures (CIV)'s strategic approach, particularly its open innovation and venture philanthropy model, is further illustrated through its collaboration with the **Global Fund for Coral Reefs (GFCR)**.²⁰ GFCR is a blended finance instrument aimed at mobilizing grant funding and private capital to protect and restore coral reef ecosystems. This public-private partnership encompasses a wide array of stakeholders including UN agencies, national governments, philanthropies, private investors, and organizations. Operating under a United Nations-managed grant system, the GCR employs a variety of financial tools such as pure grants, concessional loans, guarantees, and technical investments aimed at fostering substantial environmental impacts. For instance, aligned with its goals under GFCR, CIV has invested

¹⁸ Conservation International Ventures, “CI Ventures Impact Report”

¹⁹ Philippa Louey, “The Blue Economy’s Retreat from Equity: A Decade under Global Negotiation”

²⁰ Global Funds for Coral Reefs, Homepage

\$500,000 in SEADLING via a SAFE agreement in a \$1M round with AgFunder’s GROW Impact Fund and others, focusing on sustainable seaweed sourcing in Southeast Asia.²¹ Through a community-based distributed farming model, SEADLING aims to diminish plastic pollution, foster female financial empowerment, and safeguard biodiverse coral ecosystems from extractive industries. This venture philanthropy model provides a compelling blueprint for integrating venture capital’s financial strategies with NGOs’ philanthropic objectives, showcasing a path forward for sustainable development and environmental conservation.

The Transformative Role of Accelerators and Incubators

Financial backing is just one piece of the puzzle for emerging businesses tackling challenges like sustainable food and ocean health. Accelerators and incubators are redefining investment paradigms by providing the missing pieces—coaching, resources, and a like-minded network—that startups need to thrive. This fosters an environment where startups can not only secure capital but also develop operational expertise, refine growth strategies, and connect with key players in their industry.

Venture studios take this concept even further, immersing themselves in the operational aspects of startup development. They offer bespoke services tailored to the unique needs of each venture, ensuring a truly comprehensive level of support. For instance, Delta40 is a Venture Studio and VC fund with an innovative approach to empowering African entrepreneurs to bring their climate solutions to scale. Despite the commendable growth of venture capital in Africa, from \$250 million in 2015 to \$5.4 billion in 2022, a gap remains in reaching founders on the frontlines—particularly African and female founders, who possess immense potential for climate ventures yet receive a disproportionate slice of VC funds. Delta40 aims to reimagine this traditional VC model by mitigating disparities and creating a cycle of robust post-investment support and strategic guidance for navigating exits.

Their support spans four critical pillars: shared services, global networks, financial backing, and strategic guidance. Centralized shared services address key operational needs at negotiated prices. Access to global networks opens doors to expertise, follow-on funding, and partnerships

²¹ Global Fund for Coral Reefs, “2022 Annual Report”

critical for exits. Financial support from Delta40 allows founders to concentrate on building and scaling their ventures. Strategic support from the venture studio grants proprietary access to industry expertise and technology, fostering a path to commercialization.²²

Below, we present a detailed case study into HATCH Blue, a standout blue food tech accelerator and incubator that has embraced a multifaceted identity to launch and accelerate dozens of startups.

HATCH Blue: A Multifaceted Approach to Nurturing Blue Food Tech Innovation

Among the growing number of accelerators and incubators, HATCH Blue stands out for its laser focus on blue food technology and sustainable aquaculture, illustrating a holistic model for supporting the next wave of entrepreneurs across various business stages: funding, accelerating, and educating. Since its inception in 2017, HATCH Blue has solidified its position as the **world's first aquaculture accelerator**, with a global footprint extending from Norway to Singapore and Hawaii. This geographical diversity is crucial for tapping into various aquaculture markets and ecosystems, allowing HATCH to foster innovation across different cultural and environmental contexts. Strategic partnerships with major corporations like Cargill, the World Bank, and Mitsubishi enhance HATCH's ability to support sustainable practices and connect startups with significant players in the industry. Such collaborations are instrumental in promoting sustainable ocean food production methods, including offshore cage systems, which are vital for the future of aquaculture.

At the **Ocean Foundry**, HATCH Blue offers an open platform for entrepreneurs to ideate and develop their products. This stage is crucial for early-stage ideas, providing access to mentoring and R&D facilities without the immediate pressure of capital investment. It serves as a nurturing ground for innovation, where ideas can be refined and tested in a supportive environment.

HATCH's **Studios and Venture Builder** programs shape these promising ideas into viable companies through workshops and intentional community-building. Notably, HATCH

²² Delta40, Homepage

prioritizes diversity within the blue economy, with an impressive 70% of their ocean portfolio investments led by female founders.

To further empower women, HATCH co-hosts the **Women in Ocean Food program** with Conservation International Ventures and sponsored by the Aquaculture Stewardship Council (ASC). This program tackles the gender gap in blue food leadership by equipping female-led startups with the tools and resources they need to thrive.

The program's impact has been significant. For example, the second Women in Ocean Food Innovation Studio, held in Bali in 2022, nurtured 11 female-led startups (19 female entrepreneurs), shaping the future of Southeast Asia's blue food economy.²³ Liris Maduningtyas, CEO of Jala Tech, exemplifies this success. Originally an intern, Maduningtyas' potential shone through, leading Wayne Murphy (HATCH co-founder) and others to champion her for the CEO role, which reflects HATCH's commitment to fostering inclusive growth in blue food technology.

HATCH has also hosted a number of similar blue foods innovation programs with government agencies in Ireland and Singapore. In partnership with the Bord Iascaigh Mhara (BIM), the Irish Seafood Development Agency, HATCH developed the **BIM Aquatech Innovation Studio**—an equity-free program that aims to support the ambitious goals of the Ireland Department of Agriculture, Food and the Marine's 2030 strategy to position the nation as a knowledge base for aquaculture technology and attract external investment to the sector. The BIM Aquatech Innovation Studio has demonstrated its impact through impressive numbers: 5 programs completed, 39 companies accepted, over 100 mentors and experts engaged, €14 million in total funding raised, approximately €375,000 in average follow-on funding after program completion, and the creation of 165 jobs by alumni companies from 2018 to 2022.²⁴

Supported by the Startup SG Accelerator Grant program by Enterprise Singapore, the **Singapore Innovation Studio program** is the first-of-its-kind program focusing on developing early-stage aquatech founders specifically from the Asia region. The program boasts impressive results: half of participating companies secured over \$5 million in

²³ The Fish Site, “Bali Hosts Women in Ocean Food Innovation Studio”

²⁴ BIM Aquatech Innovation Studio, “Startup is an Ocean: Dive into the Opportunity”

investments after graduating. By focusing on the Asian region, the program fosters natural synergies among cohort members. Activities in Singapore, like a visit to the Marine Aquaculture Centre on St John's Island, further strengthen these connections and integrate founders into Singapore's robust aquaculture research and industry network.

For more developed firms, the HATCH accelerator program offers significant capital investment and access to a global network. This stage is critical for startups ready to scale, providing them with the resources and connections needed to achieve rapid growth and enter international markets. Access to this network and capital propels startups into new opportunities, driving innovation and sustainability in the aquaculture sector.

In fact, HATCH recently announced the launch of their **Blue Revolution Fund (BRF)**, extending the platform's scope from accelerator-stage support to pre-Series A and Series A investments. With €75 million raised for the BRF and backing from notable investors like the European Investment Fund (EIF), the Irish Strategic Investment Fund (ISIF), and Rentenbank, this initiative underscores HATCH's commitment to advancing sustainable aquaculture practices on a broader scale.²⁵

Wayne Murphy, Co-founder of HATCH, expressed strong interest in potentially collaborating with BAPPENAS to help scale Indonesia's blue foods economy. The organization's ability to forge strategic partnerships with governments, evident in its collaborations in Hawaii and Ireland, showcases a nuanced understanding of leveraging public and private sector synergies.

Open Innovation: Building Public-Private Partnerships

As the sustainable Blue Economy expands rapidly, its contribution to local, regional, and global economies cannot be overstated, with estimates placing its value in the trillions and predicting continued exponential growth. This growth is fundamentally predicated on a healthy marine ecosystem that ensures increased access for women and other underrepresented groups, embodying an economy scaling at such a pace that inclusivity becomes imperative. Challenges identified by industry stakeholders, such as Kristin Veriga from eFishery, underscore the critical

²⁵ The Fish Site, "Hatch Celebrates Raising €75 Million for Blue Revolution Fund"

need for collaborative efforts to tackle issues of sustainability, productivity, and equity within the aquaculture sector. The sector's fragmented nature and the complexities presented by legal, regulatory, and geographical hurdles, particularly in Indonesia's archipelagic context, necessitate a "coalition of the willing" composed of public-private partnerships (PPPs). These partnerships, embodying the essence of open innovation, are crucial for balancing economic growth with environmental sustainability and societal needs. Through innovative partnerships and state-sponsored innovation programs, the Blue Economy can navigate its complexities, ensuring a sustainable and inclusive future for this vibrant and crucial industry. One example that Indonesia could seek to emulate is the Hawaii Ocean and Science Technology Park, which we explore as another detailed case study.

Hawaii Ocean and Science Technology Park: Innovation Clusters Unlocking Sustainable

Economic Impact

One of the most significant advancements in fostering a sustainable blue economy has been the formation of innovation clusters. These clusters bring together a diverse mix of academic institutions, industry leaders, government agencies, and startups, ensuring a comprehensive approach to innovation. By creating, maintaining, and deepening collaborative partnerships, innovation clusters drive regional opportunities and address specific needs, playing a pivotal role in supporting a balanced, sustainable blue economy.

The Hawaii Ocean Science and Technology (HOST) Park, administered by the Natural Energy Laboratory of Hawaii Authority (NELHA), is one such innovation cluster that is driving impact through its diverse assembly of more than 40 ventures. This unique conglomerate, occupying 870 acres of prime coastal property in Kailua-Kona, Hawai'i, is distinguished not only for its contribution to marine science, renewable energy, and other demonstration projects but also for its role in fostering sustainable economic development through public-private partnerships (PPPs).

HOST Park's model of de-risking investment in early-stage companies and accelerating their path to market readiness has proven effective, as evidenced by the University of Hawaii Economic Research Organization's (UHERO) analysis which revealed that the park generated a total economic impact of \$145.4 million in 2022. This underscores the park's significant

contribution to Hawaii's economy, especially during the resilience it demonstrated amidst the COVID-19 pandemic.²⁶ HOST Park's unique capability to bring ashore high-quality, pristine supplies of both warm surface and cold deep seawater 24 hours a day underpins its economic potential, leveraging the dual temperature seawater delivery system and high solar insolation for a variety of pre-commercial, commercial, research, and educational endeavors (University of Hawaii Economic Research Organization, 2022; Natural Energy Laboratory of Hawaii Authority, n.d.).

One model of HOST Park's success in nurturing innovation through PPPs is the HATCH Blue's "Ocean Foundry" incubator, which has supported startups like Symbrosia. Symbrosia, a macroalgae production and research startup, exemplifies the symbiosis between traditional Hawaiian wisdom and modern innovation. By developing a seaweed supplement from *Asparagopsis taxiformis* for livestock feed, which reduces methane emissions in ruminants by over 80%, Symbrosia highlights the transformative power of HOST Park's environment in fostering sustainable solutions to global challenges. This approach not only addresses critical environmental issues but also underscores the importance of culturally respectful innovation, illustrating the potential of innovation clusters like HOST Park in unlocking sustainable economic impact (Natural Energy Laboratory of Hawaii Authority, n.d.; HOST Park, n.d.).

It is worth noting that HOST Park has brought up hesitation from local coastal communities. Local fishers are concerned about the quality of genetically modified organisms, fish escapes from controlled aquaculture pens, and the impacts of overfertilization with hormones. A Ph.D. candidate we spoke to who previously worked in this setting shared that the sentiment on the ground was much more mixed than the overwhelmingly positive sentiment of venture and tech players. Hence, if implemented in Indonesia, such a facility would need to ensure sufficient consultation, engagement and buy-in from communities concerned.

²⁶ Hawaii State Government, "Total Economic Impact Generated by HOST Park Jumps Significantly to More than \$145M Annually"

Social Enterprises as a Focal Point for Public-Private Partnerships

mFish was a global private-public partnership that sought to address both sustainability and improving coastal livelihoods through a mobile app for fishers. It was led by Tone Mobile, a social enterprise, and the success of mFish's pilot project on Lombok was a direct result of a partnership and involvement with the US State Department's Office of Global Partnerships, GSM Association, EcoHub, KKP, and XL Axiata. Due to a change of presidential administration in the United States, the mFish initiative was discontinued in 2016. However, the program is still seen as a successful example of a public-private partnership.

While the key players seem vastly different, each had a key role to play in the success of the mFish pilot project in Lombok. The satellite information used for the satellite maps that directed fishers towards schools of fish was provided by the US State Department and was a key factor that led to significant reduction in fishing time and transportation costs for small-scale fishers. The cell service was provided through XL Axiata, one of the largest telecom companies in Southeast Asia. KKP provided the data feed for average prices at over 40 ports across the country to help fishers access the best prices possible for their fish. And lastly, through a thorough understanding of fisher livelihoods, mFish built in a messenger component where the coop manager could send fishers messages throughout the day. This partnership between vastly different yet critically important players was a large factor in the success of mFish's first pilot project in Lombok.

ABALOB, a South African-based non-profit organization dedicated to elevating small-scale fisheries and fishing communities with technology, is another example of a social enterprise who collaborates extensively with governments. They have worked with the South African Department of Agriculture, Forestry (DAFF), and Fisheries and have been endorsed by the Minister of the DAFF to become "the official catch management system." ABALOB's work on integrating "Safety-at-Sea functionalities" for its platform is also done in partnership with the DAFF, University of Cape Town, fisher communities, and other NGOs and have received a seed grant from South Africa's Technology Innovation Agency to do so.²⁷

²⁷ Republic of South Africa, "The Abalobi initiative receives a prestigious seed grant from the Technology Innovation Agency"

An effective innovation ecosystem, therefore, does not merely support the technical development of ideas but also provides a synergistic platform for entrepreneurs to engage with these complexities, ensuring that innovative solutions not only take off but also reach their market potential. Regulation can play a key role in empowering ancillary players, such as accelerators, venture capitalists, and researchers to drive innovation in the blue foods sector. In the following section, we will discuss ways in which government regulations have been able to support the aforementioned actors in the space.

3c) The Role of Government Policy

Government policy can help grow the innovation ecosystem, with different levers leading to different results.

Below, we offer country examples into how regulation has promoted blue foods innovation in seven countries around the world. Key learnings, highlights, and trade-offs are synthesized in the following sections of the report. Figure 3 below shows a high-level overview of the six countries selected for further exploration; these countries were selected for their diversity of approaches to addressing blue foods priorities.

While we selected examples that we believed would be most relevant and insightful for Indonesia's present context, we acknowledge that the same policies may need to be contextualized in order to have similar effect in Indonesia. A useful way to do this is through industry consultation, which would be welcomed by the blue foods sector in Indonesia. One of the Indonesian entrepreneurs we interviewed expressed a desire for the Indonesian government to first engage industry actors for early feedback when designing a policy intervention, to help avoid misaligned policies.

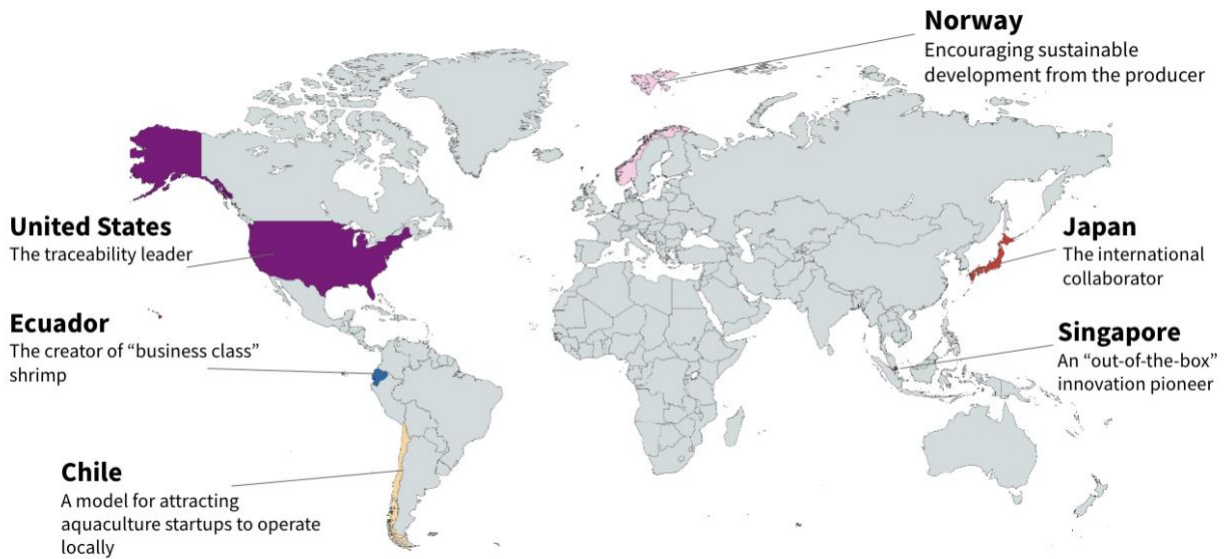


Figure 3: An original graphic displaying the diverse range of countries from which our policy synthesis is based on.

Case Study 1: Chile

A model for engaging aquaculture startups effectively.

Chile is the 2nd largest producer of salmon in the world²⁸ and has the largest aquaculture industry in Latin America.²⁹ As highlighted by one aquaculture startup founder we interviewed that operates in several countries globally, Chile is a leader in supporting aquaculture innovation. Chile’s success can be attributed to a myriad of factors, but the following section will focus on two sets of policies had an outsized impact on Chile's standing as a global aquaculture leader: Fondo de Desarrollo para la Pesca Artesanal Municipal (FONDEPA, *translated: Development Fund for Municipal Artisanal Fishing*) and the National Fisheries and Aquaculture Law.

In 2008, Chile passed a law known as FONDEPA, which established the national fund for fishing and aquaculture development. This fund is dedicated to financing initiatives, such as interest-free loans or grants, that promote sustainable development of the aquaculture sector, which has been appealing to fledgling startups that are resource-strapped. FONDEPA has three key parts that startups both inside and outside of Chile have noted as being conducive for growth. First, FONDEPA supports new research projects that address sustainability, operational

²⁸ AcuieStudios, “Chilean Aquaculture Market Report”

²⁹ FAO, “Aquaculture growth potential in Chile”

enhancements, or technological development related to aquaculture. This incentivizes innovation and competition by providing resources for new entrants to develop innovative solutions.

Second, the fund has created programs that train and upskill the aquaculture workforce. Third, finances from the fund have been used to finance modernization projects, enabling older fisheries to take advantage of new innovative tech solutions.

The outcomes of FONDEPA were tremendous. In our research, we interviewed a startup CEO who cited FONDEPA as a key enabler in helping his company to secure pilot programs and deals on the ground in Chile. In the ten years after the FONDEPA law was passed, aquaculture’s share in total fishery production in Chile almost doubled (Figure 4).

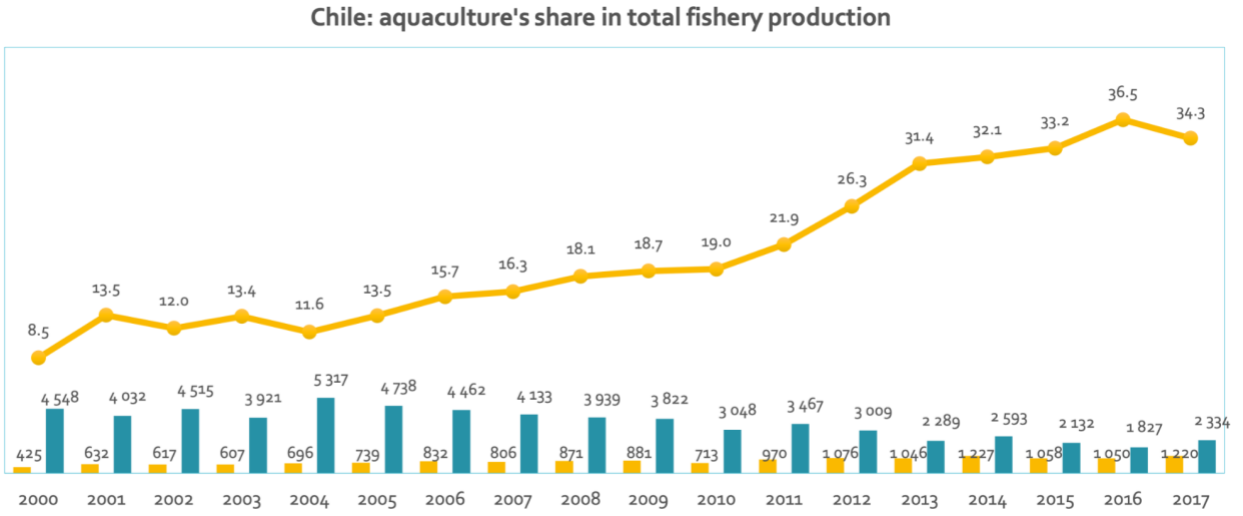


Figure 4: Aquaculture’s share in total fishery production nearly doubled, in part due to FONDEPA and associated policies. Sourced from FAO Global Fishery and Aquaculture production report (March 2019).

The second key component of success in Chile’s fisheries innovation was in 2018, when Chile passed the National Fisheries and Aquaculture Law. This law empowered Chile’s National Fisheries and Aquaculture Service (SERNAPESCA) with enhanced monitoring and enforcement capabilities. This law incentivised older and less advanced fisheries in Chile to invest in technologies that promoted fish well-being and sustainability due to stricter monitoring.

Anecdotally, we heard stories of this law leading older fisheries to seek out new innovations both within and outside Chile. It was after the advent of this law that GoogleX’s Project Tidal began collaborating with aquaculture experts in Chile and brought in their expertise in remote sensing,

computer vision, and data analytics. Second, this SERNAPESCA data has also provided insights for companies to identify areas for innovation. SERNAPESCA collaborated with local governments to develop workshops for fisheries managers on how to leverage this collected data to improve yield and fishery health. They also partnered with an international non-profit focused on supporting small-scale fisheries, Future Of Fish, to find interesting insights and develop predictive analytics to further optimize established processes.³⁰ Results from this collaboration were strong, with SERNAPESCA reporting their lowest and most efficient use of antibiotics in the aquaculture sector in 2022 due to the analytics provided.³¹

In tandem, the two laws had a synergistic effect and together spurred the rapid growth and development of a vibrant aquaculture industry in Chile. Several aquaculture innovators emphasized that Chile's favorable regulatory environment, established industry, and growing demand make it a top choice market to enter. However, we also heard that international companies find regulatory complexities difficult to navigate, leading them to often partner with an established player in Chile to get a foothold in the market. Importantly, Chile has also been navigating significant historic environmental impacts stemming from rapid expansion of the aquaculture industry—most notably from the salmon farming sector. The context regarding the implementation of innovative policies, technologies, and investment mechanisms and the lessons regarding the implications can provide many transferable lessons.

Case Study 2: USA

A global leader in traceability through cooperation and development of co-regulatory approaches.

In the past two decades, the United States has fostered innovation in the traceability space through a multi-pronged approach supported by regulation, grant programs, and education initiatives coordinated between different government agencies.

In 2019, the Congressional Research Service authored a report identifying regulatory uncertainty as a key barrier to offshore aquaculture development in the United States.³² This report was part

³⁰ Future of Fish, “Chilean Fisheries Government Data Modernization Workshop- versión en Español a abajo”

³¹ Global Seafood Alliance, “Is Chile’s salmon industry turning the corner on antimicrobials?”

³² Marshak, “U.S. Offshore Aquaculture Regulation and Development”

of a broader trend of reports issued by US based think tanks and public policy research institutes from 2012 to 2019 raising concerns about the regulatory environment around blue foods markets. One especially impactful report belonging to this trend was issued by the Government Accountability Office, the investigative arm of the US Congress that is frequently known as the “congressional watchdog”. This 2017 report emphasized consumer protection as being central to this new market creation and recommended that the US Food & Drug Administration (FDA) step in to ensure the safety of imported seafood from unsafe drug residues.³³

In large part due to these reports, the period between 2018 and 2023 saw an increase in regulation led by the FDA. In 2018, the FDA issued the final Technical Amendments to the Seafood Labeling Act, which mandated labeling seafood products with origin, fish name, and whether it was wild-caught or farm-raised.³⁴ This built on precedent set by the Fair Packaging and Labeling Act (FPLA) from decades prior, which ensured that consumer commodities have these accurate and clear informative labels. Other government agencies also participated in this increase of regulation in the blue foods space. The National Oceanic and Atmospheric Administration (NOAA) developed a traceability program for seafood in 2016 called the Seafood Import Monitoring Program (SIMP). This program requires permitting, recording of data, recordkeeping, and verifying the supply chain of seafood from extraction to point of entry into the US.³⁵ Experts suggested that this program is a great example of a co-regulatory approach, where private and government actors collaborate to participate in governance - often through information exchange. SIMP enables enforcement of traceability to be much less costly for the government by putting some of the data collection and processing requirements onto the private sector.

A second pillar of this approach to increase traceability has been through grant programs by the US Department of Agriculture and the Department of Commerce. These agencies offer funding opportunities for novel research & development projects, as well as for implementation projects. Seafood processors, aquaculture players, and research institutions have all been able to use these grants to build novel technologies for this space. In fact, the success of this program inspired

³³ Government Accountability Office, “Imported Seafood Safety: FDA and USDA Could Strengthen Efforts to Prevent Unsafe Drug Residues”

³⁴ US Food and Drug Administration, “Industry Resources on the Changes to the Nutrition Facts Label”

³⁵ Spiegel and Beyranevand, “Seafood Fraud: Analysis of Legal Approaches in the United States”

Australia to offer similar grant funding opportunities to improve traceability in the blue foods sector.³⁶ Over the COVID-19 pandemic, the USDA also announced \$50M USD in grants—distributed by various state agencies—to support seafood processors, processing facilities, and processing vessels through the Seafood Processors Pandemic Response and Safety Block Grant Program. Not only can inspiration be taken from the United States’ frameworks for ensuring sustainability, but also understanding these trends and regulatory frameworks can prepare Indonesian export industries to better market their products for an American market and better compete in a global market.

Case Study 3: Singapore

A pioneer in out-of-the-box innovation, driven by a focus on self-sufficiency and food sovereignty.

Singapore has emerged in the past decade as a world leader in the realms of vertical fish farming and alternative protein manufacturing. While many countries have leaned into using innovations in the blue foods sector to streamline operations, Singapore has doubled down on developing a portfolio ensuring food sovereignty in part due to the aftereffects of the COVID-19 pandemic.³⁷

Due to limited land resources, Singapore has pioneered innovative solutions for urban fish farming, powered by smart technologies such as Internet of Things sensors and autonomous underwater vehicles. In November 2022, the Singapore Food Agency introduced a new aquaculture research development program called Aquapolis, which aims to support Singapore in becoming a leading innovation hub for sustainable blue foods production. To do this, Aquapolis brings together researchers, think tanks, farmers, and companies to find synergies and fuel future research. Already, this new program is showing promising results, with a pilot research program enabling scientists to look into developing juvenile fish with faster growth rates and higher Omega-3 content.³⁸ The director of a leading impact venture fund notes that these joint efforts link well with the safety nets that Singapore has created for new entrepreneurs. A combination of government grants, concessional terms in early stage investments, and access to leading thinkers

³⁶ Australian Department of Agriculture, Fisheries, and Forestry, “Agricultural Traceability Grants”

³⁷ Thai, “Singapore: Food security despite the odds”

³⁸ Singapore Food Agency, “The Singapore Aquaculture Plan”

across academia and industry enables fresh talent to enter and innovate in the space while having a safety net; this is in contrast with much of the Global South where innovators have less structure and support, leading to innovators less likely to stay in the sector if their first venture is not successful.

Beyond this program, Singapore has prioritized working with accelerators and studios to attract companies to flesh out their innovation ecosystem. One of the experts we interviewed- Wayne Murphy, a partner at Hatch Blue (a global venture capital initiative focused on the aquaculture and alternative seafood sector), noted that Singapore has tremendous potential due to their soft promise of sourcing 30% of their food locally by the year 2030 and their interest in funding Hatch and other ventures that are working towards that goal. When funding of venture or portfolio approaches is combined with catalytic startup grants to promising young entrepreneurs, the impact is amplified. Natalie Longmire-Kulis, a program manager at Singapore's impact investing firm Potato Productions, emphasized that in most of Southeast Asia, scientific research is the catalyst for entrepreneurship. Successful entrepreneurs tend to be students who began scientific research in their communities at an early age and then partnered with their local communities and larger venture funds to accelerate growth of the solutions produced by their research.

Singapore is also a leader in the alternative protein space; alternative proteins typically refer to proteins that are derived from non-animal sources. There are four categories of alternative protein: plant-based proteins, algae and fungi-based protein (such as spirulina), cultured meat derived from tissue engineering, and insect proteins³⁹ One company we encountered in our research is INSEACT, a Singaporean startup developing a sustainable insect protein for shrimp aquaculture.⁴⁰ This startup is one of many transforming the alternative protein space for aquaculture and nurtured by the Singapore Aquaculture Plan, which aimed to invest in research and development, increase and optimize spaces for aquaculture, and drive the industry to adopt better technology and practices.

Tremendous interest exists from non-Singaporean venture capital firms. The director of a leading impact venture fund noted that their fund's excitement to invest in Singapore for a couple of

³⁹ Singapore Food Agency, "The Singapore Aquaculture Plan"

⁴⁰ The Fish Site, "INSEACT opens Singapore's largest insect protein facility"

reasons. First, she stressed the ease of business operations in Singapore which makes it easy for international investors to operate in the country. This is enabled by three factors: a strong regulatory framework where credit agreements and memorandums of understanding can be defended in court, close geographic proximity to the Philippines and Indonesia where demand is very strong for alternative proteins, and an ease of co-investing with Singaporean based angels and impact investors. The impact of these initiatives is expected to be significant, as they can help Singapore reduce its dependence on traditional food imports and contribute to the sustainability of its food system. By promoting the production and consumption of blue foods, Singapore can also potentially reduce its environmental footprint and contribute to global efforts to build a more sustainable food system.

Case Study 4: Japan

The national research enabler and international collaborator.

Japan's status as an island nation and long history of fishing and maintaining aquaculture farms has led them to develop significant expertise and research in these industries, supported by a variety of government initiatives. Japan's approach can be divided into two key elements: 1) the development of Japanese research expertise, and 2) the international collaborations that arise from other countries wanting to learn from Japan's fisheries and aquaculture researchers.

The development of their internal expertise, primarily through fundamental research, arises from a combination of university research programs as well as government research institutes.

Building upon their fundamental research initiatives and a mastery of fundamental aquaculture and fisheries sciences, Japan is able to expand into applied research initiatives and commercial technology development through domestic partnerships with Japanese technology companies.⁴¹

Government support for fisheries can be understood as three different components:

1. National research institutions

- a. Fisheries Research Agency, formerly titled the National Research Institute of Aquaculture (established in 1979), was created to conduct foundational research for the Japanese aquaculture industry.

⁴¹ Waycott, "Can artificial intelligence help solve sturgeon farming riddles in Japan?"

- b. National Research Institute of Fisheries Sciences, designed to support research and development in oceanography, food technology aquatic genomics, and more, in cooperation with the other Fisheries Research Institutes of the Fisheries Research Agency. They often cooperate with the Fisheries Research Agency to address regional fisheries resource issues.
2. **Fisheries experiment stations held at the prefecture level** were designed to conduct local research to account for the diversity of species and environments.⁴²
3. **The National Fisheries University and other University-Led Research Initiatives** specialize in fisheries technology, management, and development and train many of Japan's fisheries technology experts.

Japan's emphasis on building research institutions that are part of or adjacent to the government has supported Japanese startup innovation and collaboration between Japanese industries. For instance, Softbank Corporation has been using their image analysis and machine learning technologies to track sturgeon in collaboration with the Faculty of Fisheries Sciences at Hokkaido University and the town of Bifuka (also in Hokkaido) in developing AI and IoT technology for more efficient sturgeon farming as part of a broader effort to support Hokkaido's local sturgeon farming industry.⁴³ In turn, many of these university research initiatives in fisheries technologies have been transformed into high tech fisheries startups. In one instance, a startup began from a Kyoto University and Kindai University research project that was able to successfully increase the production of red sea bream while using 20% less feed by using AI and IoT technologies to monitor and adapt the environment to optimize fish growth, water temperature, and oxygen levels.⁴⁴

By developing a strong ecosystem of aquaculture and fisheries experts, Japan is able to share this expertise and foster international collaboration and stronger international relationships. Through the U.S.-Japan Natural Resources (UJNR) Aquaculture Panel, Japan has been in collaboration with the United States on sustainable seafood farming practices. The results of these efforts came into fruition when in 2016, the UJNR framework allowed Japanese and American researchers to pool resources and lower research costs in developing a SNP chip designed to screen fish

⁴² FAO, "National Aquaculture Sector Overview: Japan"

⁴³ Waycott, "Can artificial intelligence help solve sturgeon farming riddles in Japan?"

⁴⁴ Ministry of Foreign Affairs of Japan: "Japan's Smart Agriculture and Fisheries"

genomes as part of an effort to breed more climate resilient, fast growing, and disease resistant fish. Beyond sharing technological information and addressing common issues, fisheries scientists at NOAA highlight the friendly collaboration leading to further cultural understanding and friendship between scientists.⁴⁵ NOAA Fisheries from the United States and the Japan Fisheries Research and Education Agency (FRA) furthered their relationship by signing a Memorandum of Understanding (MOU) in 2017 to support research exchange between the US and Japan on issues such as aquaculture, marine resources and fisheries, climate change, and collaborates on development of sustainable aquaculture techniques through the U.S./Japan Cooperative Program in Natural Resources (UJNR).⁴⁶

Japan has also established the Science and Technology Research Partnership for Sustainable Development (SATREPS) which is a program designed to support the collaborative research and development between Japan and various developing countries on issues related to aquaculture, the environment, infectious diseases, natural resource management, and more. Within aquaculture, SATREPS is working with Thailand to establish high-value fish aquafarming, with eventual goals to apply successful initiatives to other countries in Southeast Asia. According to Dr. Kom Silapajarn, Director of Coastal Aquaculture R&D in the Thailand Department of Fisheries, this joint project has enabled the collaborative development of better breeding technology, genetic modifications of fish, and has supported Thai researchers receiving aquaculture training at Japanese universities.⁴⁷

SATREPS is supported by the Japanese Science and Technology Agency (JST), which has expertise in funding research projects at research institutions in Japan and will fund Japanese research institutions, and the Japan International Cooperation Agency (JICA), which has expertise in technical cooperation in developing countries and will fund the partnering nation in the development of research projects. Japan's international collaboration in developing aquaculture and fisheries technology is reflective of their vision for "science and technology diplomacy."⁴⁸

⁴⁵ NOAA Fisheries, "Bilateral Agreements"

⁴⁶ NOAA Fisheries, "Bilateral Agreements"

⁴⁷ SATREPS, "Improved aquaculture technology will save the world"

⁴⁸ Sunami, "Japan's Science and Technology Diplomacy"

Case Study 5: Norway

Encouraging sustainable development beginning from the producer through a range of licenses

Norway's aquaculture industry exports products to Europe and around the world, and Norwegian salmon is one of the primary export commodities.⁴⁹ Norway's priorities in their blue food sector focuses on sustainability through systems of licensing that encourage producer innovation in environmentally friendly aquaculture technologies. In addition to funding research and development through avenues such as Innovation Norway and the Research Council of Norway as well as tax exemption policies for companies developing sustainable technologies, Norway has created multiple licenses to support sustainable aquaculture-specific innovation: *green licenses* (2013), *development licenses* (2015), and *eco-technology licenses* (2021).⁵⁰ These mechanisms have been put in place as measures to reduce the numerous environmental pollution problems from increasing aquaculture production activities in the country.

The development of *green licenses* began following a period of salmon lice outbreaks. The mechanism of the licenses mandated that farmers adopt new technologies that reduced the spread of lice from their farms and into open waters if they wanted to expand production. While this scheme allowed farmers to continue expanding their production while maintaining sustainability, the uncertainty surrounding the delineation for green technologies and expansion area resulted in heavy administrative costs.⁵¹

Development licenses, implemented soon after green licenses, were similarly designed to encourage producers to develop sustainable technologies, but also incentivized production in coastal zones under fewer conflicts of interest.⁵² Projects under development licenses were also mandated to report results from the project annually and publicly⁵³ and were used to mitigate risk for large scale research and development investments that actors of all sizes in the industry can. The combination of *green licenses* and *development licenses* led to increased development of

⁴⁹ FAO, "National Aquaculture Sector Overview, Norway"

⁵⁰ Osmundsen et al., "Aquaculture policy: Designing licenses for environmental regulation"

⁵¹ Hersoug, "The greening of Norwegian salmon production"

⁵² Osmundsen et al., "Aquaculture policy: Designing licenses for environmental regulation"

⁵³ Hersoug, "The greening of Norwegian salmon production"

technologies to prevent the spread of lice in aquaculture farms to nearby ecosystems, such as laser technologies for combatting sea lice, vaccinations, and sea “skirts” to put around aquaculture farms.⁵⁴ For development licenses specifically, Norway has been able to strengthen relationships between the aquaculture industry and other sectors in technology and engineering through collaboration on large scale projects (supported by development licenses) in sonar technology, ocean related monitoring, and more.⁵⁵

Eco-technology licenses similarly are designed to encourage sustainable innovation, however the administrative burden of assessing applications for this license have been mitigated as the requirement to assess the feasibility and quality of the project is no longer a focal point of application assessment. Rather, applications will be assessed by an “innovation point” scheme that rates various categories of environmental impact—such as electrification, fish labeling for traceability purposes, sludge collection, etc.—to create a sum total score for evaluation and actors applying for an eco-technology license must create a program to record the project’s impacts.⁵⁶

Case Study 6: Ecuador

A small country that has created a national brand and successfully marketed the first ‘business class for shrimp’.

Ecuador has emerged as one of the major global producers of shrimp despite its relatively small size and has successfully marketed their product on a global level. Ecuador’s large-scale commercial shrimp culture began in the 1960’s and since then has built its current status as a major shrimp exporter,⁵⁷ exporting 99% of its total shrimp production, approximately 2.3 billion pounds of shrimp worth over \$6.6 billion USD in 2022.⁵⁸ The Ecuadorian shrimp industry landscape is dominated by four large and vertically-integrated companies that produce 42% of all Ecuadorian shrimp exports.⁵⁹ Ecuadorian shrimp is much more consolidated than Indonesian shrimp farms, all processed in a close geographic location, and more conducive to export for more formal markets. There were a variety of ways that Ecuadorian innovations in the shrimp industry were formed.

⁵⁴ Afewerki et al., “Innovation in the Norwegian aquaculture industry”

⁵⁵ Afewerki et al., “Innovation in the Norwegian aquaculture industry”

⁵⁶ Osmundsen et al., “Aquaculture policy: Designing licenses for environmental regulation”

⁵⁷ Marcillo, “Shrimp Farming and the Environment in Ecuador: Past and Present”

⁵⁸ Evans, “It’s a terrible blow’: Shrimp price collapse costs Ecuador shrimp industry \$1 billion in 2023”

⁵⁹ Seafood Watch, “Whiteleg Shrimp”

Ecuadorian Research Institutions

One way was through extensive public university-led efforts to train people to become researchers and technicians in aquaculture. For instance, the Littoral Polytechnic School (ESPOL), a public university, began an aquaculture degree in 1985, where many of today's aquaculture technicians and researchers were trained.⁶⁰

In 1990, Ecuador formed the National Center for Aquaculture and Marine Research (CENAIM)⁶¹ with financial backing from the government of Japan and a primary goal of supporting Ecuadorian aquaculture research, technological development, and personnel training.⁶² CENAIM provides a variety of research services and collaborates with the local community, supporting students from local universities to become professionals in aquaculture.⁶³ The combination of university-led efforts to improve aquaculture productivity, government research centers, and partnerships with the local community allowed for the proliferation of advanced technologies like automatic feeder, which is a critical part to Ecuador's capacity to export vast quantities of shrimp.⁶⁴ The extensive use of automatic feeders allows Ecuador to decrease prices of shrimp and become competitive in a global market.

Marketing and National Branding

According to Kristin Veriga from eFishery, Ecuador has done very well in branding their blue foods in international markets, as large actors in the Ecuadorian shrimp industry have an association that builds sustainability branding and communication programs to distinguish Ecuadorian shrimp. This industry collaboration is exemplified following the collapse of the Thailand shrimp in the early 2010's, when Ecuadorian shrimp producers began a significant marketing campaign for the entire industry, marketing themselves as sustainable, large, and quality shrimp producers.⁶⁵

⁶⁰ Minapoli, "Learn from the Ecuadorian Shrimp Industry"

⁶¹ Minapoli, "Learn from the Ecuadorian Shrimp Industry"

⁶² Gelis, "Trip along the Ecuadorian Coast"

⁶³ Gelis, "Trip along the Ecuadorian Coast"

⁶⁴ Fletcher, "Why Ecuador's aquaculture operators have created 'business class for shrimp'"

⁶⁵ Cherry, "Ecuadorian shrimp producers launch huge new marketing campaign"

Ecuador's branding strategy appears to come from a deliberate effort by not only the industry but also the government. Guntur Mallarangeng, CEO and founder of Delos, shares an anecdote of Ecuador's impressive presence at an international seafood expo, where the Ecuadorian delegation articulated a very compelling story of the nation's shrimp production processes and sustainability certifications. By contrast, Guntur observed that the Indonesian stand lacked a strong narrative about the SDG alignment of Indonesia's shrimp industry, noting disappointingly that there remains an incorrect perception that shrimp farming in Indonesia is driving mangrove deforestation.

Efforts in Improving Shrimp Genetics

Ecuador's response to the White Spot Syndrome Virus (WSSV) outbreak in 1999, which caused a 70% decline in shrimp production from previous levels,⁶⁶ illustrates the importance of prioritizing genetic improvement of shrimp broodstock. Prior to 1999, many farms had used wild shrimp for breeding purposes, which was ultimately vulnerable to such diseases.⁶⁷ As a result, prohibition of wild shrimp following the WSSV outbreak has led to improved productivity and disease resistance⁶⁸ through establishing hatcheries like the Semacua Hatchery and the ESPOL laboratory⁶⁹ that produced more disease resilient shrimp in the post larvae stages and trained personnel in aquaculture services. According to a survey from 2016, almost 80% of farmers interviewed stated that the main factor in increasing farm productivity was better shrimp seed and genetics.⁷⁰

⁶⁶ Responsible Aquaculture Foundation, "Case Study of the Outbreak of White Spot Syndrome Virus at Shrimp Farms in Mozambique and Madagascar"

⁶⁷ Lucien-Brun, "A Success Story: Ecuadorian Shrimp Farming"

⁶⁸ Marcillo, "Shrimp Farming and the Environment in Ecuador: Past and Present"

⁶⁹ Seafood Watch, "Whiteleg Shrimp"

⁷⁰ Marcillo, "Shrimp Farming and the Environment in Ecuador: Past and Present"

4. Synthesis

In this segment, we will integrate the diverse findings presented in the preceding sections to propose actionable recommendations for BAPPENAS to consolidate its blue foods technology sector.

First, it is important to acknowledge inherent trade-offs and nuances present within the blue foods tech ecosystem. The technologies that unlock value for small-scale farmers are different from those that directly create larger-scale systemic impacts. As a result, there are key factors to take into consideration about the degree of technological complexity and level of technological innovation that results in economic growth and empowerment of coastal communities.

From a governmental perspective, different policy levers can yield different results, as seen in the detailed country case studies in the previous section. For instance, Japan's focus on funding basic science research within the country can be contrasted to Chile's approach of attracting external startups to conduct business within the country. As a consequence, Japan's innovations will take longer to break into markets compared to the rapid tech deployment Chile is able to muster. Similarly, Singapore and Ecuador can also be compared in their approaches. While Singapore singularly approaches new and innovative market creation such as vertical fish farming and alternative proteins, Ecuador has created a brand by developing infrastructure to support shrimp farming that meets the United Nations Sustainable Development Goals and other traceability standards. While this branding has helped Ecuador access larger markets, the true environmental impacts include the loss of around 70% of Ecuador's mangrove ecosystem due to intensive shrimp farming.⁷¹ Understanding the tradeoffs and different angles for blue food technological intervention can enable policymakers to decide the segment of the value chain to innovate at for desired results, while ensuring environmental protection.

Acknowledging trade-offs of certain blue foods policies is also critical. Successful blue foods technologies have tended to enable higher food safety standards to be exceeded, new markets to be created, and higher global environmental standards to be pursued. This comes often at the cost of increased consolidation, increased government oversight, and a focus on global markets. Governments with higher environmental regulations (e.g. Norway) tend to sponsor increased

⁷¹ Client Earth Communications, "The hidden cost of farmed shrimp from Ecuador"

state-run research initiatives and investment funds (e.g. Innovation Norway) to catalyze startups that can play in these higher operating cost leagues.⁷²

Second, human-centered design and innovation is key to successfully deploying innovations. One key theme that emerged through this research is the importance of co-designing with relevant stakeholders. Co-design is a process of working jointly with end stakeholders to develop a product for them. Successful examples of co-design were seen with Singapore’s Aquapolis co-designing with farmers, researchers, and the private sector and with Japan’s co-design approach including government-backed research, investment management firms, and innovators.

There are two reasons why co-design is critical. First, co-design ensures that a product is designed for the appropriate stakeholders and audiences. Initiatives such as ABALOB and the mFish pilot project in Lombok were able to achieve success through a close relationship with the community they serve. Co-design ensures that smallholder communities are able to benefit from blue economic development. Second, co-design supports informational transfer, which drives both technical and non-technical innovations. Previous codesign processes have unveiled pain points that weren’t well-characterized by other players in the ecosystem. Codesign spurs innovation by surfacing insights from the operators experiencing the pain points to the innovators and enablers that can design for these challenges.

Collaboration, both external and internal, has also emerged as an important and relevant factor to building a successful blue food technology innovation ecosystem. Countries like Japan, Norway, and Singapore have been able to spur internal collaboration between industries within their nation—Japan through partnerships with companies such as Softbank in aquaculture sensing technologies, Norway through development licenses, and Singapore through farmer, researcher, company partnerships in Aquapolis—which allow for innovation across sectors. External collaboration is evident in Chile’s welcoming of foreign initiatives and startups, Japan’s research-driven international partnerships, and indirectly through Singapore’s strong regulatory framework and ease of foreign investment into Singaporean initiatives.

When looking at the ecosystem of players needed to innovate (Figure 5), five categories emerge: ***coastal communities, tech innovators, investors, accelerators, and social mobilizers.*** Sections

⁷² Isaacs, “Multi-stakeholder process of co-designing small-scale fisheries policy in South Africa”

above have discussed tech innovators, investors, and accelerators in depth. We wanted to elaborate further about the interplay between coastal communities and social mobilizers.



Figure 5: An original graphic showing the range of social mobilizers uncovered in our research.

Social mobilizers are a previously understudied group of connectors that bridge coastal communities and tech innovators. Our research has uncovered a spectrum of social mobilizers, ranging from what we coined as the “Social enterprise” model to the “Silicon Valley capitalist” model. Groups towards the “social enterprise” end of the spectrum tend to focus on social impact and designing point of source solutions with coastal communities. ABALOBI, a South African-based non-profit organization dedicated to elevating small-scale fisheries and fishing communities with technology, is a prime example of such a focus on designing for individual communities. On the other end of the spectrum falls groups such as Aquabyte, a San Francisco-based aquaculture start-up that has raised venture funding to scale its machine learning and high-technology sensors globally. These “Silicon Valley capitalist” model groups are focused on scaling to deliver profitable returns to investors, most of whom are not affiliated with coastal communities. Positive effects can materialize downstream for coastal communities through job creation or corporate social responsibility, but a possibility of marginalization does exist.

A key lesson social mobilizers offer is that different versions of growth and innovation are possible and directly enabled by the kinds of players in an innovation ecosystem. Comparing

several enablers mentioned in this report, Hawaii's HOST park stands out as a mobilizer which helps create technologies that are aiming to be venture scale, while ABALOBI is focused on community empowerment and providing more contextualized solutions to local challenges in the small-scale fisheries sector.

5. Conclusion

This report presents key highlights from our research on blue food technologies around the world. While there are many lessons to be learned from studying how other governments have been able to support blue food technology innovation, this knowledge without proper contextualization in the Indonesian economy is limited in its utility. As such, we have conducted our global research with the Indonesian context in mind and have highlighted the findings we thought were of primary importance and relevance to Indonesia.

In this report, we find that the crux of enabling blue foods tech innovation lies in the nuanced execution of public-private partnerships and the alignment of various stakeholders' interests and capabilities. Indonesia has the potential to emerge as a leader in the blue foods sector by learning from global best practices and thoughtfully adapting these insights to its unique economic and cultural landscape. The memo underscores the critical role of policy in not only encouraging the adoption of advanced technologies but also in fostering an environment conducive to social innovation and entrepreneurship. As such, the path forward involves a deliberate focus on policies that catalyze innovation, facilitate an enabling ecosystem, and promote inclusive growth that benefits all players in the value chain.

The memo concludes by emphasizing the importance of opportunities presented by the global innovation landscape. The actionable insights provided throughout the report aim to support BAPPENAS in formulating strategies that leverage the country's comparative advantages while addressing the challenges posed by sustainability and equitable development. The findings presented in each case study stem from a preliminary investigation into the actors, actions, and implications playing out within each dynamic system. With thoughtful engagement and collaborative effort, Indonesia can chart a course towards a regenerative, sustainable, and prosperous blue economy that not only caters to its own needs but also contributes significantly to the global food system.

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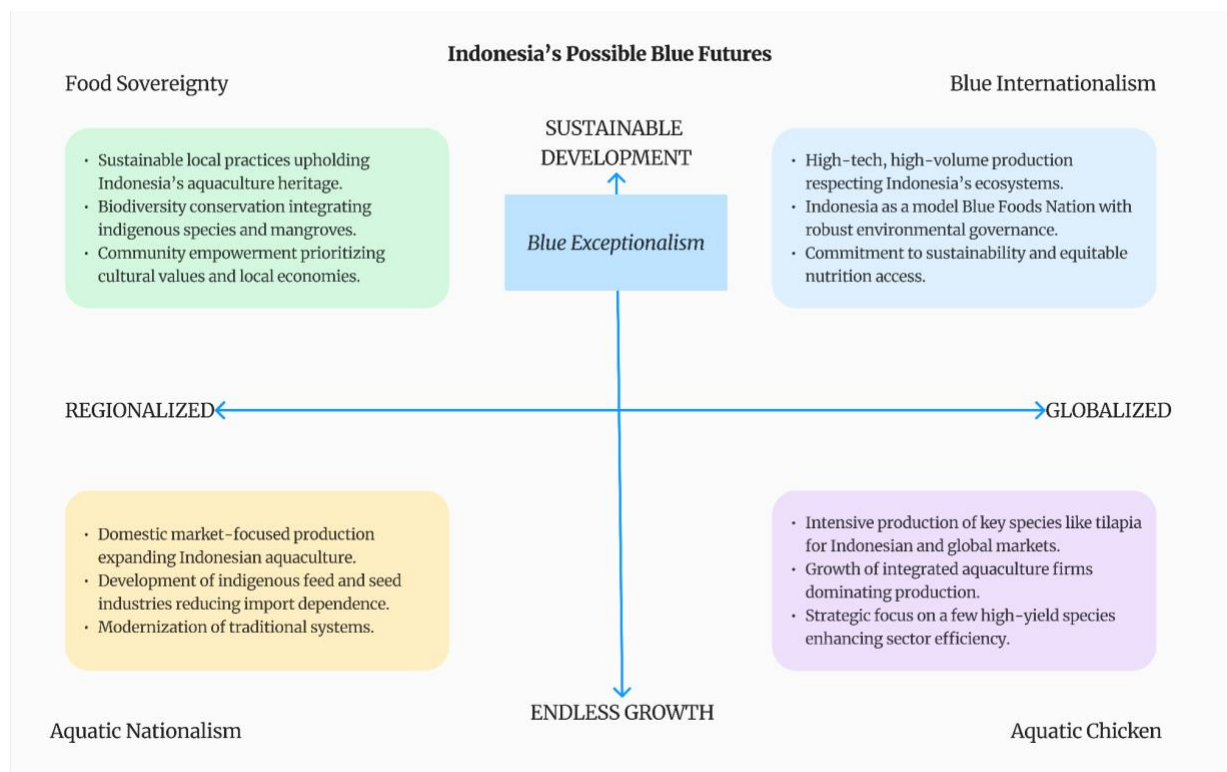
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7. Appendices

Appendix 1: A proposed conceptual framework for future blue foods scenarios in Indonesia

Taking into consideration that blue food technological innovation can lead to a variety of food production systems, we propose a conceptual framework to summarize our findings on blue food technology and its tradeoffs in Appendix Figure 1.



Appendix Figure 1: An original chart showcasing a range of four possible blue foods futures for Indonesia. “Blue exceptionalism” is presented as a possible goal, and trade-offs for each of the four futures are noted. (adapted from Gephart et al. 2020)⁷³

This chart outlines four potential scenarios of a future food system shaped by policy along the axes of sustainability vs growth and regionalization vs globalization, and which of the four food systems (Food Sovereignty, Blue Internationalism, Aquatic Nationalism, and Aquatic Chicken) Indonesia may be more likely to achieve depending on the type of technology and the type of innovators that Indonesia supports. Blue foods innovations that support the “Regionalized” end

⁷³ Gephart et al., “Scenarios for global aquaculture and its role in human nutrition.”

of the spectrum are developed with the aim to increase blue foods production for Indonesia itself, while innovations that support the “Globalized” end of the spectrum are aimed towards maximizing blue foods exports into the global market. Similarly, the vertical spectrum indicates the degree to which sustainability is encouraged in the innovations fostered. We display this chart to illustrate some of the inherent tradeoffs when working in this space: supporting food security domestically can affect national blue food exports, and supporting smallholder coastal livelihoods can affect larger internal and external innovators. We have labeled the section of the chart that we believe addresses both of BAPPENAS’ concerns to support smallholder coastal livelihoods and establish Indonesia as a country with high-tech and high-production blue food industries as “Blue Exceptionalism.” As a final note, this framework is helpful in illustrating the tradeoffs between policies that encourage the development of different forms of technology. It can be viewed as a spectrum and way to visualize the many different possibilities of the future.