

# **CIRCULAR BLUE BUSINESS MODEL IN BIOFLOC FISH CULTIVATION BASED ON CIRCULAR ECONOMY AND BLUE ECONOMY: A LITERATURE REVIEW**

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## **Abstract**

The aquaculture sector faces a dual challenge: rising global food demand and the degradation of aquatic ecosystems caused by exploitative conventional practices. To address this, a systemic transformation is required that integrates sustainability principles into business logic. This study aims to develop the Circular Blue Business Model (CBBM), a strategic business model that combines circular economy principles (closing material loops and regenerating resources) with blue economy principles (sustainable utilization of fisheries resources) within the context of biofloc fish farming enterprises. By employing a Systematic Literature Review (SLR) approach following the PRISMA 2020 protocol, this research analyzes 60 Scopus-indexed scientific articles (2015–2025) and maps conceptual relationships using VOSviewer. Findings reveal a fragmented literature between circular and blue economies, a dominance of technical perspectives in biofloc studies, limited integration of strategic and business dimensions, and insufficient attention to the roles of micro-enterprises and local institutions. Sustainability emerges as a conceptual bridge, but is rarely operationalized as a core business model design principle. Based on these insights, this study proposes the CBBM as a holistic framework comprising four key elements: (1) an ecosystem-regeneration-based value proposition, (2) value creation through biofloc circular economy practices, (3) value delivery via cross-sectoral partnerships, and (4) fair and inclusive value capture. The CBBM not only addresses theoretical gaps among technology, policy, and business strategy, but also offers practical guidance for entrepreneurs, policymakers, and academics in advancing a resilient, inclusive, and SDG-aligned aquatic food system.

**Keyword:** Circular Blue Business Model (CBBM); circular economy; blue economy; biofloc; systematic literature review; sustainability; sustainable business model.

## 1. Introduction

The aquaculture sector faces dual challenges, namely increasing global food demand on the one hand, and degradation of aquatic ecosystems on the other (Mugwanya et al., 2021). Exploitative conventional practices have led to waste accumulation, water eutrophication, and over-reliance on external inputs such as feed and clean water. In this context, the sustainable development paradigm demands a systemic transformation that not only improves operational efficiency but also reconfigures the entire business logic to align with ecological boundaries and principles of social justice (Narwal et al., 2024). This transformation demands the integration of a multidimensional approach that is capable of bridging economic, environmental and social objectives simultaneously and this is a challenge for contemporary strategic management research.

Two key conceptual frameworks offering transformative solutions are the circular economy (CE) and the blue economy (BE). The circular economy emphasizes closing material loops through recycling, reuse, and regeneration of natural systems (Ellen MacArthur Foundation, 2015; Geissdoerfer et al., 2017), while the blue economy focuses on the sustainable use of marine and coastal resources for inclusive economic growth (Desmond, 2014; Kementerian Kelautan dan Perikanan, 2023). While both have different philosophical roots, they share a commitment to long-term sustainability and reducing their ecological footprint (Justin-Emanuel & Alexandru, 2014). The integration of these two approaches can be called “circular blue” logic which offers great potential for the aquaculture sector, which operates within the scope of terrestrial and marine ecosystems, and ensures food production and ecosystem conservation.

At the operational level, the biofloc farming system has emerged as a concrete manifestation of circular economy principles in aquaculture. This technology utilizes microorganisms to convert ammonia waste into microbial protein that can be reused by fish, while also enabling up to 90% water reuse (Crab et al., 2012). Thus, biofloc not only increases resource efficiency, but also reduces dependence on external inputs and environmental impacts (Matishov et al., 2025). However, the majority of existing research to date is technical in nature, focusing on biological aspects, water chemistry, fish growth, or optimization of technical parameters, and does not consider strategic, economic, or business model dimensions that enable long-term scalability and sustainability at the business level.

A preliminary review of the literature shows that although many studies discuss the circular economy or blue economy separately (Ministry of National Planning and Development, 2024; Murray et al., 2017), very few explicitly integrate it within the context of aquaculture, let alone within a business model framework. Furthermore, most research on biofloc remains within the domain of fisheries science and engineering (Halim et al., 2019), with minimal involvement of a strategic management perspective. As a result, there is a significant gap between technical innovation in the field and the business strategy required to achieve a systemic transition.

This research aims to fill this gap by developing the Circular Blue Business Model (CBBM) concept, a strategic framework that combines the principles of a circular economy as an operational mechanism, a blue economy as an ecosystem orientation, and strategic management theory as a foundation for value design. CBBM aims to bridge the gap between

technology, policy, and business practices, particularly for small- and medium-scale fish farming businesses. Globally, CBBM also plays a role in supporting the achievement of the Sustainable Development Goals (SDGs), particularly SDG 8 (decent work), SDG 12 (sustainable consumption and production), and SDG 14 (marine conservation) (Rojas-Serrano et al., 2024).

To systematically identify, map, and fill these literature gaps, this study employed a Systematic Literature Review (SLR) methodology following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) protocol (Shamseer et al., 2015). This approach allows for the identification of patterns, trends, and relationships among key constructs—such as the circular economy, blue economy, biofloc technology, and business models—through a transparent and detailed selection process. By analyzing 60 studies that met the inclusion criteria, this SLR not only synthesized existing knowledge but also revealed areas of weak conceptual integration, providing a strong empirical basis for the development of CBBM.

Initial findings from bibliometric mapping using VOSviewer reinforce the diagnosis of this literature gap. The visualization reveals three main clusters—circular economy, sustainability/aquaculture/biofloc, and blue economy—with “sustainability” acting as the central bridge. However, despite the correlation between “circular economy” and “blue economy,” the “business models” node is located on the periphery of the network, indicating minimal efforts to translate these principles into applicable strategic designs. The majority of the literature remains fragmented within each discipline, without cross-domain synthesis. Therefore, this study explicitly aims to integrate these three clusters through a strategic management lens, resulting in a CBBM framework that is not only theoretical but also practical and ready for implementation—thus addressing the urgent need for sustainable business models in the era of a circular blue economy.

## **2. Literature Review**

### **Circular Economy**

The circular economy (CE) is an alternative economic paradigm that aims to replace the linear "take-make-dispose" model with a regenerative system that mimics natural cycles. This concept emphasizes closing material loops through the key principles of: reduce, reuse, recycle, and regenerate (Pounds, 2021; Ellen MacArthur Foundation, 2013). In contrast to a linear economy that views waste as the end of the value chain, a circular economy views waste as a potential resource that can be returned to the production system (Brennan et al., 2015). This approach not only aims to minimize environmental impacts, but also to create new economic value through innovation in product design, services and supply chains (Webster, 2021).

The circular economy concept has evolved from its philosophical roots in industrial ecology to a strategic framework adopted by companies and public policy. In a business context, CE encourages a shift from product ownership to performance-based services (product-as-a-service), collaboration across the value chain, and the use of digital technologies for material flow tracking. Recent studies indicate that CE implementation in the food sector, including aquaculture, remains limited, with a primary focus on input efficiency and waste

management, but rarely linked to a holistic business model that encompasses social and institutional dimensions.

In the context of biofloc fish farming, the principles of a circular economy are particularly relevant because this system inherently closes the nutrient and water loop (Emerenciano et al., 2025). However, the majority of literature only emphasizes the technical aspects (Khanjani et al., 2024), without integrating it into a sustainable business strategy. This research argues that the full potential of the circular economy can only be realized if its principles are adopted not only as operational practices, but as the foundation of business model design, thereby creating economic, environmental, and social value simultaneously.

## **Blue Economy**

The blue economy is a development approach that focuses on the sustainable use of marine and coastal resources for inclusive economic growth, job creation, and improved community well-being, without compromising the health of marine ecosystems (MMAF 2023). This concept was first popularized by Gunter Pauli (2010) in response to the limitations of the green economy, which is considered too dependent on expensive technology. The blue economy emphasizes nature-based innovation, low-cost solutions, and the empowerment of local communities, especially in developing countries that depend on marine resources.

Over time, the blue economy has been widely adopted by international organizations such as the UN, the World Bank, and the European Union, and is part of the Sustainable Development Goal (SDG 14: Life Below Water) (United Nations, 2025). However, its implementation has often faced criticism for being too focused on economic growth without adequate consideration of social justice or ecological boundaries, thus risking “bluewashing” (OECD, 2017). To avoid this, recent literature calls for the integration of the blue economy with the principles of the circular economy and ecosystem justice, thus creating a more holistic and transformative approach.

In the aquaculture sector, the blue economy provides a framework for assessing how aquaculture activities can contribute to marine conservation, food security, and the well-being of fishers (MMAF 2024). However, empirical studies linking the blue economy to micro- or small-scale business models are still very limited. This research fills this gap by exploring how blue economy principles can be operationalized through CBBM in the context of biofloc fish farming.

## **Biofloc System Culture**

The biofloc farming system is an intensive aquaculture technology that utilizes microbial communities (biofloc) to convert nitrogenous waste, primarily ammonia, into microbial biomass that can be reused by fish. This technology allows for minimal water use (up to 90% less than conventional systems) and reduces dependence on commercial feed through the supplementation of natural proteins (Emerenciano et al., 2013). Biofloc also improves biosecurity due to its closed system, reducing the risk of disease from the external environment. Due to its efficiency, biofloc is considered one of the most promising solutions

for sustainable aquaculture in areas with limited water or land resources (Matishov et al., 2025).

Although the technical advantages of biofloc have been widely documented in the fisheries and aquaculture literature, its application in the field, particularly in developing countries, is often hampered by non-technical factors (Minaz et al., 2024). Small-scale farmers face challenges in water quality management, access to training, initial capital, and fair markets. Furthermore, most research still focuses on biological parameters (such as fish growth rate or microbial composition), while economic, social, and strategic aspects are rarely explored. Consequently, the transformational potential of biofloc as an enabler of systemic sustainability has not been fully realized.

Therefore, a more holistic approach is needed. On the one hand, biofloc is viewed as a technology and on the other, as part of a broader business ecosystem. Within the CBBM framework, biofloc is positioned as a core operational mechanism that embodies circular economy principles, while also serving as an entry point for implementing blue economy principles through empowering coastal communities and integrating them into sustainable food value chains.

## **Sustainability Concept**

Sustainability is generally defined as the ability to meet the needs of the present generation without compromising the ability of future generations to meet their own needs (Brundtland Report, 1987). This concept encompasses three main pillars: environmental, social, and economic—often referred to as the triple bottom line (Elkington, 1997). In a business context, sustainability is no longer seen as an add-on corporate social responsibility (CSR), but as the core of a long-term competitive strategy that creates shared value for all stakeholders (Kaligis 2025).

The evolution of sustainability concepts has led to the emergence of various operational frameworks, such as the circular economy, the blue economy, and sustainable business models (SBMs). SBMs emphasize the creation, delivery, and capture of value aligned with sustainability principles, through value chain redesign, ecosystem collaboration, and social innovation. However, the implementation of SBMs in primary sectors—such as agriculture and fisheries—remains challenging due to supply chain complexity, limited access to technology, and weak policy incentives (Bossier & Ekasari, 2017).

In this research, sustainability plays a role as an integrative principle that unites the circular economy and the blue economy (Justin-Emanuel & Alexandru, 2014). VOSviewer's analysis shows that "sustainability" is at the center of the conceptual network, connecting the two paradigms. This emphasizes that CBBM must be designed not only for ecological efficiency or economic growth, but also to achieve a dynamic balance between the three pillars of sustainability, particularly in the context of biofloc ventures involving smallholder farmers, local ecosystems, and global markets.

## **Circular Blue Business Model**

The Circular Blue Business Model (CBBM) is a new concept that integrates circular and blue economy principles into a company's strategic design. Unlike traditional business models oriented toward linear growth and resource exploitation, CBBM emphasizes value creation through ecosystem regeneration, material loop closure, coastal community empowerment, and nature-based innovation. This concept expands the framework of sustainable business models by adding spatial dimensions (ocean-coast-land) and a deeper ecological philosophy.

The literature on CBBM remains very limited. Most studies on sustainable business models focus on the manufacturing or energy sectors, while the aquaculture sector is often overlooked, despite its strategic importance for global food security. Some researchers have begun exploring the integration of CE and BE (Linder & Williander, 2017), but its application in the context of specific technologies such as biofloc has never been systematically studied. As a result, aquaculture businesses lack strategic guidance for designing business models that align with both paradigms.

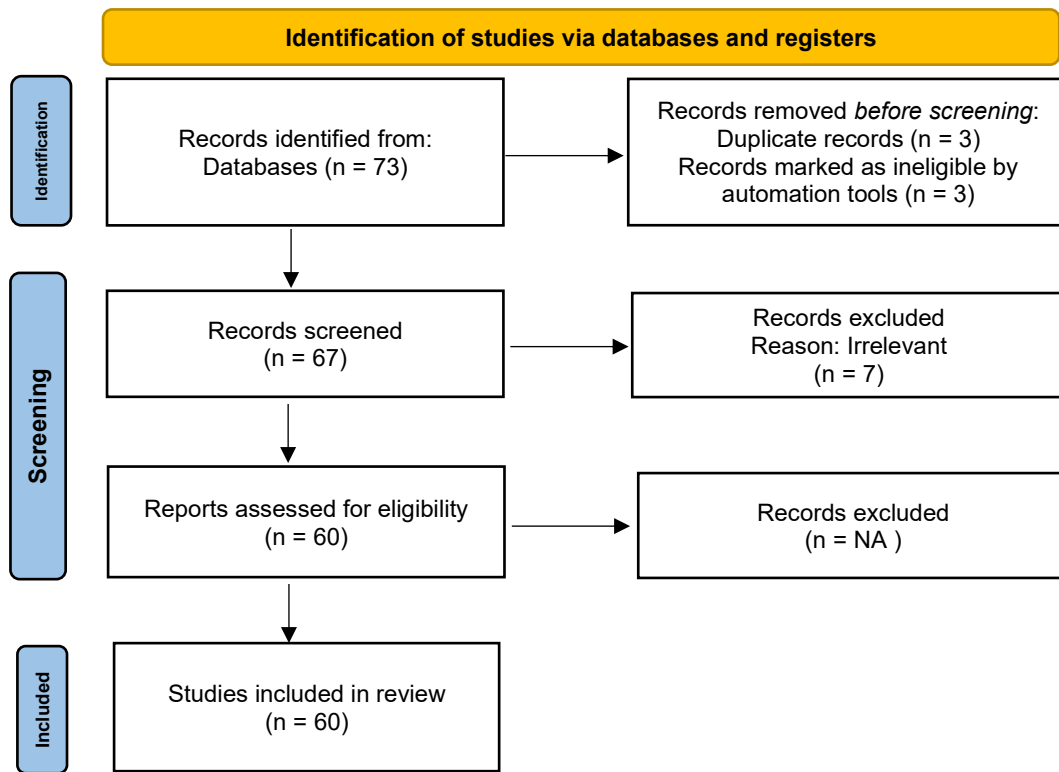
This research contributes by proposing and operationalizing a CBBM framework specific to biofloc fish farming. Through SLR and bibliometric analysis, this research identifies key elements of CBBM: (1) ecosystem regeneration-based value proposition, (2) value creation through the biofloc circular loop, (3) value delivery through cross-sector partnerships, and (4) equitable and inclusive value capture. Thus, CBBM is not merely a theoretical concept, but a strategic tool that can be used by entrepreneurs, policymakers, and investors to drive the transition towards a resilient and sustainable aquatic food system.

### **3. Methodology**

#### **Article Selection Process**

The research analysis method was conducted using a systematic literature review (SLR). SLR analysis was used as a tool for PRISMA 2020 (Haddaway et al., 2022), so that the SLR used is transparent and scientifically consistent. The process of searching for articles in journals used search data from Science Direct, Google Scholar, and Web of Science. The journals used were only journals indexed by Scopus Q1-Q4 with publication years 2015-2025. The keywords used in the journal search were "Circular Blue Business Model (CBBM)", "biofloc", "circular economy", "blue economy", "systematic literature review", "sustainable business model". From the obtained journals, a review analysis was then conducted to facilitate understanding and analysis of each journal obtained.

The following is a flowchart of the article selection process carried out using the PRISMA 2020 search method.



**Picture 1. Search Method Flowchart of PRISMA 2020**

The literature selection process began with the identification stage, where 73 articles were identified through a systematic search of various scientific databases. Of these, 6 were eliminated before the screening process: 3 were duplicates, while 3 were automatically flagged as ineligible by the search engine. After this stage, 67 articles were left, which then proceeded to the screening stage. At this stage, an assessment was conducted based on the title and abstract to assess relevance to the research topic. Seven articles were excluded for being irrelevant, leaving 60 articles for further eligibility assessment. This stage demonstrates the rigorous and gradual selection process to ensure that only literature truly relevant to the research focus was considered.

### Data Analysis

Furthermore, based on the results of a literature review study of Scopus journal articles Q1-Q4 with a research span of 2015-2025 from the results of a review of 60 journal articles used, a model was found from the results of the base bibliographic data processed with VOSviewer as follows:



**Gambar 2. Mapping Results and Research Article Clusters with VOS Viewer**

This VOSviewer mapping reveals a network structure of literature organized into three main clusters, visually represented by different colors: (i) green (circular economy); (ii) red (sustainability and aquaculture); and (iii) blue (blue economy and sustainable development). The green cluster, centered on the "circular economy," demonstrates that the circular economy concept is a strong theoretical foundation in the reviewed literature. The red cluster, encompassing "sustainability," "aquaculture," and "biofloc technology," highlights the practical focus on the aquaculture sector and its specific technologies. The blue cluster, comprising "blue economy" and "sustainable development," emphasizes the sustainable development dimension of marine and coastal areas. The interconnectedness of these clusters demonstrates that research in this field does not operate in isolation, but rather is interconnected in the pursuit of sustainability goals.

The term "sustainability" occupies a central and strategic position in this network, serving as a conceptual bridge connecting two major paradigms: the "circular economy" and the "blue economy." This demonstrates that sustainability is not only an end in itself, but also a connecting principle that enables the integration of the logic of the circular economy, which focuses on waste reduction and resource reuse, with the blue economy, which focuses on the sustainable use of marine resources. In the context of CBBM, this position emphasizes that a successful business model must be able to align both approaches. The presence of "sustainability" at the center indicates that all initiatives, whether derived from the circular economy or the blue economy, must ultimately be measured based on their impact on environmental, social, and economic sustainability.

The direct link between the "circular economy" and the "blue economy" through "sustainability" is a key finding of this mapping. It demonstrates a trend in the literature moving towards integrating both paradigms, rather than simply applying one or the other. In the context of aquaculture, this is particularly relevant because this sector has great potential to become a concrete example of the circular economy, for example, by recycling water, utilizing waste as fertilizer, or using by-products as feed. This mapping provides empirical evidence that the scientific literature is beginning to recognize the importance of this synergy.

The red cluster, which includes "aquaculture" and "biofloc technology," indicates that the literature extends beyond theory or policy to technology and field practice. The proximity of "biofloc technology" to "aquaculture" indicates that these technologies are considered concrete applications of sustainability principles in the aquaculture sector. In the context of CBBM, this is crucial because it demonstrates that the designed business model must be able to be implemented with existing technologies, such as biofloc, which is known to be environmentally friendly and efficient in resource use. The close relationship between the two demonstrates that technological innovation is a key driver in realizing sustainable business models in this sector.

The "business models" node, located outside the main cluster but still directly connected to the "circular economy," demonstrates its position as an applicative or strategic element. This means that while "business models" are not central to theoretical discussions about the circular economy or sustainability, they are a means of translating these principles into concrete business practices. Within the CBBM framework, this is crucial. This analysis suggests that research should address not only "what" to do (circular and blue economy principles) but also "how" to implement them through the design of innovative and economically viable business models. "Business models" are the bridge between theory and practice, between the idea of sustainability and corporate profitability.

#### **4. Results and Discussion**

There are five main findings in this study. First, there is a conceptual fragmentation between the circular economy and the blue economy in the aquaculture literature. The SLR analysis revealed that most of the literature discusses the circular economy and the blue economy separately, rather than within the aquaculture domain. Studies on the circular economy tend to focus on input efficiency, water recycling, and waste management on land/sea, for example, studies from Yarnold et al. (2019) and Verreth et al. (2023). While studies on the blue economy place more emphasis on marine conservation, coastal governance, and macro policies, for example studies from Ujjanti et al. (2024) and KKP (2024). Sangat sedikit penelitian yang secara eksplisit mengintegrasikan keduanya dalam satu kerangka analitis, misalnya hanya studi dari Iustin-Emanuel dan Alexandru (2014). This analysis reveals a conceptual fragmentation that hinders the emergence of systemic solutions. In the context of CBBM, these findings provide justification for developing an integrative framework that bridges the two paradigms, particularly since biofloc cultivation requires a holistic approach that is not trapped in spatial or philosophical dichotomies.

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Second, the dominance of technical perspectives in biofloc research, with minimal strategic and business dimensions. Of the 60 studies analyzed, more than 75% focused on technical aspects of biofloc: water quality parameters, microbial composition, fish growth rate, or feed efficiency, for example, studies from Dheeran et al. (2025) and Abdul-Qadir et al. (2024). Only less than 10% touch on microeconomic aspects, revenue models, or marketing strategies, for example a study from Ogello et al. (2021). No studies have explicitly designed or tested sustainable biofloc-based business models. This indicates that technological innovation has not been matched by business innovation. CBBM aims to fill this gap by positioning biofloc not merely as a technology, but as the core operational engine in a business ecosystem that simultaneously creates economic, social, and ecological value.

Third, "sustainability" serves as a conceptual bridge, but its translation to the operational level is minimal. Most studies refer to sustainability as an outcome, not a design principle. This analysis reveals a gap between sustainability rhetoric and its implementation. In CBBM, sustainability is reconceptualized as the foundation of strategic design: every component of a business model, from the value proposition to the supply chain architecture, must be explicitly designed to strengthen ecological resilience and social equity. This finding strengthens the argument that sustainability must be operationalized, not simply declared.

Fourth, existing literature tends to focus on national policies, large corporations, or international projects, while the role of micro, small, and medium enterprises (MSMEs) and local institutions (cooperatives, farmer groups, village governments) is rarely explored. Yet, in developing countries like Indonesia, fisheries MSMEs are the backbone of the aquaculture sector (Rizos et al., 2016). Critical analysis shows that the transition to a blue-circular economy will not be successful if it is not inclusive. Therefore, CBBM is designed with a bottom-up principle: integrating local capacity, traditional knowledge, and institutional collaboration mechanisms as integral parts of the business model. (Suryantini et al., 2021).

Finally, opportunities for digital integration and ecosystem collaboration as CBBM enhancers. Although still limited, several recent studies have begun to explore the role of digital technologies, such as IoT for water quality monitoring, e-commerce platforms for direct marketing, or fintech for access to financing in supporting aquaculture sustainability (Hu et al., 2024). These findings open up opportunities to enrich CBBM with a digital dimension. The analysis shows that digitalization is not simply an efficiency tool, but an enabler of ecosystem collaboration: connecting biofloc farmers with consumers, financial institutions, input providers, and regulatory authorities within a single shared value platform. Thus, CBBM is not only ecologically regenerative but also digitally connected and socially collaborative—making it a resilient business model in the era of a circular blue economy.

## **6. Summary, Implications, and Recommendations**

This study uses a Systematic Literature Review (SLR) approach and VOSviewer bibliometric analysis which reveals five main findings: (1) there is a conceptual fragmentation between the circular economy and the blue economy in the aquaculture literature; (2) the dominance of technical perspectives in biofloc studies, with minimal integration of strategic and business dimensions; (3) sustainability is often treated as a normative goal, rather than an operational design principle; (4) there is a lack of attention to the role of micro actors and local

institutions in systemic transitions; and (5) the enormous potential of digitalization and ecosystem collaboration that has not been optimally utilized. These findings confirm the existence of a significant gap between technical innovation, policy frameworks, and applicable business models, where this gap is the basis for the development of CBBM.

Theoretically, this research contributes to the strategic management and sustainability literature by expanding the concept of sustainable business models into the Circular Blue Business Model (CBBM), an integrative framework that explicitly combines the logic of the circular economy (closing material loops), the blue economy (sustainable use of marine-coastal resources), and the three-pillar sustainability principle. CBBM not only addresses criticisms of paradigmatic fragmentation but also enriches business model theory with spatial, ecological, and social dimensions. Furthermore, this research strengthens the argument that systemic transformation requires cross-disciplinary integration that connects fisheries science, ecology, economics, and strategic management in one comprehensive narrative.

Practically for fish farming businesses, particularly MSMEs, CBBM offers strategic guidance for designing businesses that are not only technically efficient but also ecologically resilient and economically viable. This model encourages them to position biofloc as the core of the regenerative value chain, forge partnerships with vegetable farmers, inclusive financial institutions, and digital platforms; and develop a sustainability narrative as a competitive differentiator. With CBBM, biofloc businesses can transform from mere production activities to become part of a blue-circular economy ecosystem that creates shared value for all stakeholders.

For governments and policymakers, this study recommends: (1) developing policy incentives that support CBBM adoption, for example, green subsidies for biofloc systems, “blue-circular” product certification, or priority access to sustainable financing; (2) strengthening the capacity of local institutions (such as Freshwater Aquaculture Centers and farmer groups) as training and incubation centers for sustainable business models; and (3) encouraging cross-sector collaboration through multi-stakeholder forums connecting fishermen, academics, the private sector, and local governments. Policies that are responsive to CBBM will accelerate the transition towards a fisheries sector that is aligned with SDGs 8, 12, and 14.

A future research agenda that needs to be undertaken is qualitative and quantitative empirical studies to test the validity and feasibility of CBBM across various geographic and social contexts. Research could explore the role of digital technologies (IoT, blockchain, AI) in strengthening the transparency, efficiency, and inclusiveness of CBBM. Furthermore, comparative studies across countries could reveal how institutional and cultural factors influence the adoption of this model. Ultimately, CBBM is not an endpoint, but rather a starting point for systemic transformation in the fisheries sector, making relevant contributions not only to academia but also to the future of food security.

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