Analysing the Growth of Biofloc Technology in the Regional Economy of Bangladesh

Аналіз зростання технології "Biofloc" у регіональній економіці Бангладеш

S.M. Naser Arafat
BBA Graduate, Department of Business Administration, MBA in Masters in Business Administration – Gopalganj Science and Technology University, e-mail: smbishal98@gmail.com
North Western University, Khulna, Bangladesh

С.М. Насер Арафат
Випускник програми Bachelor of Business Administration, кафедра ділового адміністрування, Магістр ділового адміністрування (MBA), e-mail: smbishal98@gmail.com
Північно-Західний університет, м. Кхулна, Бангладеш

Received: August 21, 2025 | Revised: September 09, 2025 | Accepted: October 31, 2025

DOI: https://doi.org/10.33445/sds.2025.15.5.22

Purpose. The purpose of the article is to analyse the growth, economic significance, and practical effectiveness of Biofloc Technology in the regional economy of Bangladesh, assessing its contribution to fish production, employment generation, and sustainable aquaculture development.

Method. The study applies a descriptive research design supported by secondary data analysis. Economic indicators, cost–benefit assessments, and production efficiency data were examined to compare traditional pond aquaculture with Biofloc-based systems. Comparative evaluation of protein retention, stocking density performance, feed utilisation, and microbial activity was used to assess technological effectiveness.

Findings. The results demonstrate that Biofloc Technology significantly increases production efficiency while reducing feed costs, space requirements, and dependence on traditional pond systems. Evidence shows higher survival rates, increased biomass output, improved nitrogen utilisation, and enhanced economic returns. The technology supports youth entrepreneurship, reduces unemployment, and promotes more resilient and sustainable aquaculture in Bangladesh.

Theoretical implications. The study strengthens theoretical perspectives on sustainable aquaculture and microbial-based nutrient recycling systems. It confirms that Biofloc Technology aligns with circular-economy principles through "upcycling" waste nitrogen into high-value microbial protein, contributing to ecological sustainability and resource-efficient production models.

Practical implications. The findings support the adoption of Biofloc Technology as a cost-effective and highly productive aquaculture method suitable for regions with limited land and water resources. Policy makers and stakeholders may utilise the results to promote entrepreneurship, youth employment, small-scale fish farming, and national strategies oriented toward food security and economic growth.

Paper type. Empirical research article.

Мета дослідження. Аналіз зростання, економічної значущості та практичної ефективності технології Biofloc у регіональній економіці Бангладеш, а також оцінювання її внеску у збільшення рибної продукції, створення робочих місць та розвиток сталого аквакультурного сектору.

Метод дослідження. У роботі застосовано описовий дослідницький підхід з використанням аналізу вторинних даних. Проведено оцінювання економічних показників, аналіз витрат і вигод, а також порівняння ефективності виробництва між традиційним ставковим рибництвом та системами на основі технології Biofloc. Додатково проаналізовано показники утримання білка, густоти посадки, використання кормів та мікробної активності.

Результати дослідження. Отримані результати свідчать, що технологія Biofloc істотно підвищує ефективність виробництва, знижує витрати на корми та скорочує потребу у великих площах для риборозведення. Підтверджено вищі рівні виживаності, збільшення біомаси, поліпшення використання азоту та зростання економічної віддачі. Технологія сприяє розвитку молодіжного підприємництва, зменшенню безробіття та формуванню більш стійкої та продуктивної аквакультури в Бангладеш.

Теоретична цінність дослідження. Дослідження підсилює теоретичні засади сталого розвитку аквакультури та мікробних систем повторного використання поживних речовин. Показано, що технологія Biofloc узгоджується з принципами циркулярної економіки, оскільки трансформує азотовмісткі відходи у високоцінний мікробний білок, сприяючи екологічній стійкості та ресурсоефективності.

Практична цінність дослідження. Практичні результати підтверджують доцільність упровадження технології Biofloc як маловитратного та високопродуктивного методу аквакультури, особливо у регіонах із дефіцитом земельних та водних ресурсів. Отримані дані можуть бути використані державними органами та зацікавленими сторонами для стимулювання підприємництва, розширення зайнятості молоді, підтримки малих рибних господарств і реалізації стратегій, спрямованих на зміцнення продовольчої безпеки та економічне зростання.

Тип статті. Емпірична дослідницька стаття.

Key words: Biofloc, unemployment, economy, growth, effectiveness.

Ключові слова: Біофлок, безробіття, економіка, зростання, ефективність.

Introduction

With almost seven billion people on earth, the demand for aquatic food continues to increase and hence, the expansion and intensification of aquaculture production are highly required. Ifremer was responsible for inventing this technology. The prime goal of aquaculture expansion must be to produce more aquaculture products without significantly increasing the usage of the basic natural resources of water and land (Avnimelech, 2009). The second goal is to develop sustainable aquaculture systems that will not damage the environment (Naylor et al., 2000). The third goal is to build systems that provide an equitable cost/benefit ratio to support economic and social sustainability (Avnimelech, 2009). All these three prerequisites for sustainable aquaculture development can be met by Biofloc technology.

Biofloc technology was first developed in the early 1970s at Ifremer-COP (French Research Institute for Exploitation of the Sea, Oceanic Center of the Pacific) with different penaeid species including P. monodon, *Fenneropenaeus merguiensis*, *L. vannamei* and *L. stylirostris*. During the 1980s and the beginning of the 1990s, research continued in Israel and the USA. In 1988, the Sopomer farm in Tahiti (French Polynesia) also implemented the technology. Nowadays, BFT has been successfully expanded in large-scale shrimp farming in Asia, Latin and Central America, as well as in small-scale greenhouses in the USA, South Korea, Brazil, Italy, China, and others. This Biofloc Technology is a very new concept in Bangladesh. Biofloc technology is a technique for enhancing water quality in aquaculture through balancing carbon and nitrogen in the system. Basically, it was developed to control overproduction. This technology is also called a waste treatment system. The technology has recently gained attention as a sustainable method to control water quality, with the added value of producing proteinaceous feed, and Biofloc systems were also developed to prevent the introduction of disease to a farm from incoming water. If carbon and nitrogen are well balanced in the solution, ammonium in addition to organic nitrogenous waste will be converted into bacterial biomass (Schneider et al., 2005). By adding carbohydrates to the pond, heterotrophic bacterial growth is stimulated and nitrogen uptake through the production of microbial proteins takes place (Avnimelech, 1999). This enhanced nitrogen uptake by bacterial growth decreases the ammonium concentration more rapidly than nitrification (Hargreaves, 2006).

So, biofloc technology is not only effective in treating wastewater but also provides nutrition to the aquatic animal. This technology has made fishery production more efficient and less time-consuming, and by applying this technology the fishery industry will boom in the future as producers will get more output at lower cost. Export will increase, as well as economic growth will accelerate in the country.

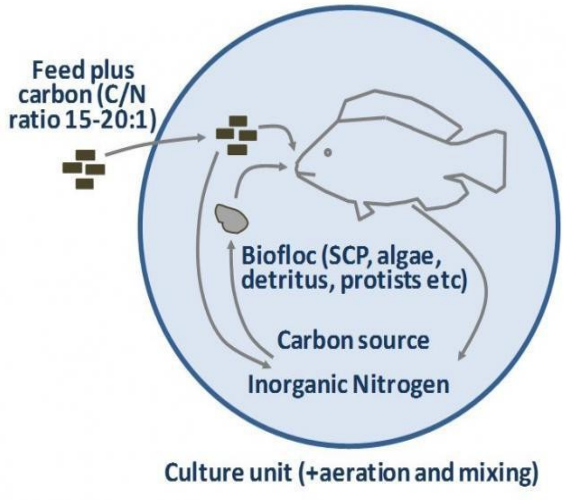

Figure 1 – Biofloc Technology Process in Bangaldesh

Literature Review

Biofloc technology makes it possible to minimize water exchange and water usage in aquaculture systems by maintaining adequate water quality within the culture unit, while producing low-cost bioflocs rich in protein, which in turn can serve as feed for aquatic organisms (Crab, 2010; Crab et al., 2007, 2009, 2010a). Compared to conventional water treatment technologies used in aquaculture, Biofloc technology provides a more economical alternative (a decrease of water treatment expenses by approximately 30%), and additionally, a potential gain on feed expenses (the efficiency of protein utilization is twice as high in Biofloc technology systems when compared to conventional ponds), making it a low-cost sustainable component for future aquaculture development (Avnimelech, 2009; De Schryver et al., 2008). Conventional technologies to manage and remove nitrogen compounds are based on either earthen treatment systems or a combination of solids-removal and nitrification reactors (Crab et al., 2007).

The strength of Biofloc technology lies in its 'cradle-to-cradle' concept as described by McDonough and Braungart (2002), in which the term "waste" in fact does not exist. Translated into Biofloc terms, waste nitrogen generated by uneaten feed and excreta from the cultured organisms is converted into proteinaceous feed available for those same organisms. Instead of "downcycling," a phenomenon often found in conventional recycling attempts, the technique actually "upcycles" by closing the nutrient loop. Hence, water exchange can be decreased without deterioration of water quality and, consequently, the total amount of nutrients discharged into adjacent water bodies may be reduced (Lezama-Cervantes & Paniagua-Michel, 10). In this context, Biofloc technology can also be used in the specific case of maintaining appropriate water temperature, good water quality, and high fish survival in low- or no-water-exchange greenhouse ponds, helping to overcome periods of lower temperature during winter. Indeed, fish survival levels in overwintering tilapia cultured in greenhouse ponds with Biofloc technology were excellent, being 97 ± 6% for 100 g fish and 80 ± 4% for 50 g fish (Crab et al., 2009).

The key to minimizing possible negative impacts of climate change on aquaculture and maximizing opportunities will be understanding and promoting a wide range of inventive adaptive technologies, such as Biofloc technology combined with greenhouse ponds.

Economic Viability — Cost reduction and profit calculation comparing traditional pond fish farming and Biofloc technology

First, it is necessary to identify which fish species are eligible for Biofloc technology: shrimp, tilapia, catfishes such as Pungas, Magur, Shing, Pabda, Koi, sea bass, salmon, cod, groupers, soles, small indigenous species (e.g., Bele), crabs, lobsters, mussels, clams, etc. To provide a clearer understanding, the following table presents an economic analysis of culturing tilapia, comparing pond fish farming and Biofloc technology in terms of costs and profits.

Table 1 – Economic Cost–Benefit Analysis of Biofloc Technology

Investment (BDT)	CF	WB	BFT	RWB
Pond Preparation	67,500	67,500	67,500	67,500
Cost of Fingerlings	750.00	750.00	750.00	750.00
Feed Cost	3,240.00	**1,261.00**	**1,625.00**	—
Operational Cost	304.30	155.88	500.00	183.18
Total Cost	4,361.80	2,234.40	**1,317.50**	2,625.70
Production (kg/treatment)	92.340	75.600	62.20	72.600
Gross Income from Sale	5,540.40	4,536.00	3,732.00	4,356.00
Net Profit while Starting/6 Months	1,178.60	2,301.60	**2,414.50**	1,730.30
Net Profit/Harvest/6 Months	48,510.0	94,749.2	99,453.3	71,230.7

Source: Economic analysis of over-wintered culture of mono-sex tilapia in ponds for 6 months' experimentation (Hossain, M.A., A.A. Hossain & N. Sultana, 2005).

Here, the sale price of tilapia = Taka 120.00/kg; operational cost was considered as 7.5% of total cost.

[Abbreviations: CF = Commercial Feed; WB = Wheat Bran; BFT = Biofloc Technology; RWB = Rice and Wheat Bran.]

From this table, it can be observed that production was the highest in the CF group receiving commercial tilapia feed, but the highest net profit was obtained in the BFT system due to the contribution of periphyton. Some profits were also recorded in the WB and RWB treatments; however, these values were lower than those of BFT, and economically farmers may not receive significant benefits from WB and RWB.

Therefore, the results of the present study suggest that it is possible to successfully culture monosex GIFT tilapia using BFT, and that the culture of monosex tilapia with periphyton is more economical and beneficial compared to wheat bran and even commercial tilapia feed under the farming conditions of Bangladesh (Hossain, M.A., A.A. Hossain & N. Sultana, 2005). According to the Department of Fisheries in Bangladesh, the average per-hectare fish production from ponds is 4,851 kilograms, which means around 20 kilograms per decimal. In contrast, in this experiment they obtained 600 kilograms from half a decimal, which clearly demonstrates the remarkable growth performance and harvest rate associated with Biofloc technology. Entrepreneurs report that this is 30 percent higher than the usual production from ponds using traditional fish-farming practices. Technology itself is a remarkable tool (Sykh Siraj, 2019).

Figure 2 – Fish Production in Biofloc Technology

Research Methodology

There are mainly three types of research: exploratory research, descriptive research, and causal research. To complete my research paper on "Impacts of Biofloc Technology on the Economy in Bangladesh — A precise discussion on how Biofloc technology has developed our fisheries sector, reduced unemployment, and increased our economic growth rate because of its cost-effective nature", I have conducted this study using the descriptive research method. By following the descriptive research method, I have attempted to examine the existing present scenario of Biofloc technology in Bangladesh, and I have also tried to evaluate its economic implications by identifying the unemployment rate, conducting cost–profit calculations, and analyzing the practical use of Biofloc technology in our fisheries sector.

There are two types of data sources: (1) primary sources and (2) secondary sources. In any kind of research paper, it is generally necessary to use both primary and secondary data sources. They differ from each other in several essential ways.

1 How Biofloc Technology Works

Heterotrophic bacteria feed on organic matter. Basically, the process follows this reaction: $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2$ + energy

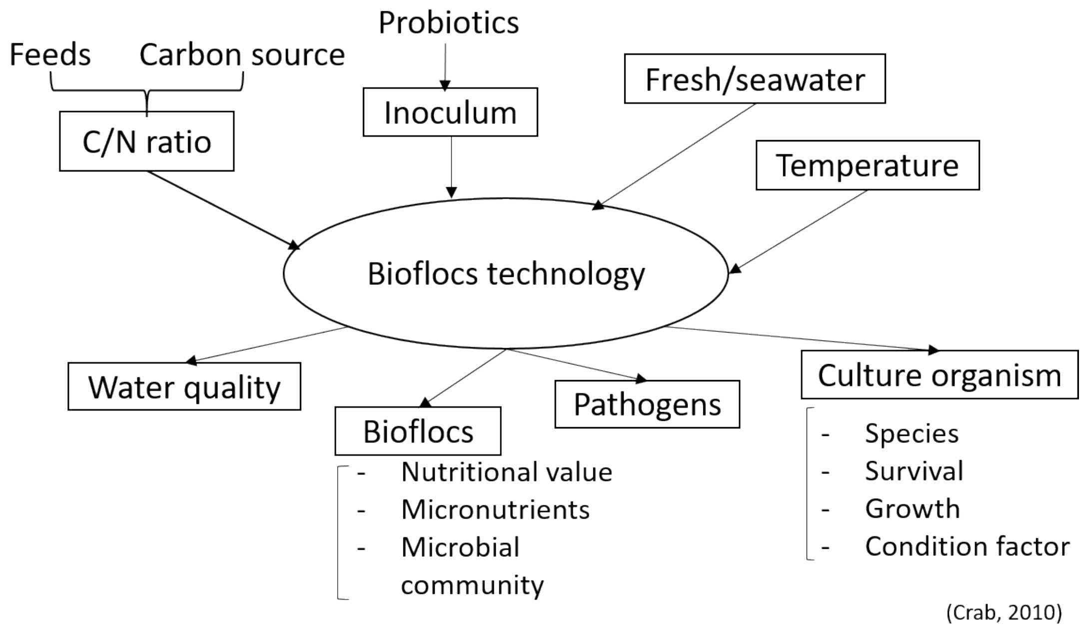

Figure 3 – The working process of Biofloc Technology

But bacteria are made of protein, so they need nitrogen. They use the chemical energy in organic substrates and consume oxygen (although there are anaerobic bacteria). Then heterotrophic bacterial growth is stimulated, and nitrogen uptake occurs through the production of microbial proteins. If carbon and nitrogen are well balanced in the solution, ammonium together with organic nitrogenous waste will be converted into bacterial biomass.

The bacteria then absorb nitrogen from the water and help maintain water quality. Microbial activity degrades waste, partly into CO_2 and approximately 59% into microbial biomass. Normally, there is not enough nitrogen in ponds for new cell production. However, carbon-rich and protein-poor materials (carbohydrates, CH compounds) such as starch or cellulose (flour, molasses, cassava) can be added. The additional purpose is to keep the C/N ratio higher than 10. The bacteria form an important part of the food chain. We can manipulate microbial activity to control nitrogen levels in the pond, and they also seem to improve disease protection.

2 Effectiveness of Biofloc Technology in the Bangladesh Economy

BFT has several benefits compared to semi-intensive ponds and Recirculating Aquaculture Systems (RAS). It can improve biosecurity, feed conversion ratio, water-use efficiency, land-use efficiency, water quality, and reduce sensitivity to light fluctuations. However, there are also some disadvantages: it requires high energy for mixing and aeration, it has a reduced response time because water respiration rates are elevated, it requires alkalinity supplementation, and it can cause an increase in nitrate levels within the system.

Use of 30% protein feed resulted in 55 tons/ha in 51 days; use of 20% protein feed resulted in 76 tons/ha in 51 days — a 31% reduction in feed cost. Use of 40% protein feed produced 448 kg/ha in 94 days; use of 25% protein feed plus tapioca flour produced 644 kg/ha in 94 days, increasing nitrogen retention from 20% to 45%. Supplementation of 30% protein feed with molasses had no effect on growth. At a C/N ratio of 10, production reached 445 kg/ha in 120 days; at a C/N ratio of 20 (by addition of tapioca starch), production reached 583 kg/ha in 120 days. Feeding 35% protein feed resulted in 21 tons/ha in 84 days. Addition of starch and labeled 15N showed that 25% of feed protein could be replaced with Biofloc-derived protein. Feed plus wheat flour resulted in 31 tons/ha in 84 days, while 35% protein feed plus wheat flour produced 30 tons/ha in 84 days. Normal feed produced 3.1 tons/ha in 35 days. Biofloc incorporation in feed at 7.8% resulted in 4.7 tons/ha in 35 days, and 15.6% incorporation produced 4.6 tons/ha in 35 days. Increasing the C/N ratio by carbohydrate addition enhanced shrimp production, increasing nitrogen retention from added feed by 13%.

Glycerol-grown Biofloc controlled quorum-sensing-regulated bioluminescence in *Vibrio harveyi*, demonstrating the probiotic effect of Biofloc. PL-15 grown for 45 days in BFT systems with and without artificial substrate at higher stocking densities showed higher weight in substrate-added treatments (0.40 g) without affecting water quality. Inclusion of whole shrimp floc and floc fractions in formulated diets improved shrimp growth rates without affecting survival. Ammonia reduction through improving the C/N ratio by addition of tapioca flour resulted in higher growth rates at C/N ratios of 10 and 20, with ratios of 20 and 30 being even more effective.

Regarding finfish species, Biofloc Technology was effective in combinations with tilapia, producing good yields. Maize was used as the carbohydrate source. Bioflocs developed using different carbohydrate sources (glycerol, acetate, and glucose) were also used as feed. Glycerol-based Bioflocs had higher protein content and resulted in higher prawn survival. The study concluded that the selection of carbohydrate sources determines floc quality.

BFT application at different stocking densities showed that 200 BFT produced the highest survival rate (60%), with the condition index remaining the same across all BFT tanks (18/20). The lowest RNA/DNA ratio was reported at 200 BFT. The influence of BFT on prawn growth at 32%, 28%, and 24% protein levels indicated that the highest growth rate occurred at 24% protein.

Application of BFT in mixed culture and optimization of bioflocculation at different hydrogen ion concentrations showed that pH 7.5 produced good flocculation both qualitatively and quantitatively. Major carps exhibited higher prawn growth rates when 100% *Catla* was added to treatments. BFT increased weight by 50% and biomass by 80% in early post-larval stages compared to conventional clear-water systems.

Application in nursery rearing systems improved survival rates ranging from 55.9% to 100%, achieving 97% and 100% survival in some cases. BFT systems with and without pelletized feed addition performed better than conventional clear-water systems. Juveniles fed with 35% CP pelletized feed grew significantly better under BFT conditions than in clear water. BFT helped reduce feed conversion ratio (FCR) and feed cost. Heterotrophic bacterial-based systems showed no negative influence on growth or FCR values with 30% and 45% crude protein diets and 39% and 43% CP in diets.

Evaluating the performance of various locally available carbohydrate sources as bioflocculating agents showed that tapioca flour was the most effective. Addition of tapioca flour increased larval survival rates.

Conclusion

Biofloc technology is not new to the world. It was invented in the 1970s at Ifremer-COP (French Research Institute for the Exploitation of the Sea, Oceanic Center of the Pacific). However, in Bangladesh it is relatively new. People have been using this technology for almost four years, and most of them are responding positively. This is because it allows higher production compared to traditional pond fish culture, which the majority of people in Bangladesh rely on. For a certain amount of fish, the pond-culture system requires 5 to 10 times more space than a biofloc tank. According to comparative assessments, biofloc technology is a more cost-effective process. Since it requires less space and lower investment, anyone—especially young people—can start fish farming using this technology. They cannot afford the consequences of unemployment, so this method is particularly beneficial for them.

Bangladeshi people are regionally more dependent on fish. Here, individuals need approximately 200 grams of protein per day, which is most commonly obtained from fish. However, only 6% to 7% of the required protein intake is fulfilled on average by fish consumption. Therefore, demand for fish consistently exceeds production, as is the case in many parts of the world. Given this high demand, fish-culture businesses can be operated more effectively, and biofloc technology offers a modern and efficient method of fish farming where physical labor is minimal, with the focus shifting to care and maintenance. This will directly contribute to GDP growth and strengthen the economy. It will undoubtedly reduce unemployment and encourage greater youth participation in the fisheries sector by providing an accessible, low-investment, and profitable entrepreneurial opportunity. As more individuals adopt Biofloc technology, overall fish production will continue to rise, helping to meet national nutritional needs while simultaneously promoting sustainable economic development.

Funding

This study received no specific financial support.

Competing interests

The authors declare that they have no competing interests.

References

Crab, R., Defoirdt, T., Bossier, P., & Verstraete, W. (2012). Biofloc technology in aquaculture: Beneficial effects and future challenges. *Aquaculture, 356*, 351–356. https://doi.org/10.1016/j.aquaculture.2012.04.046

Hargreaves, J. A. (2013, April). *Biofloc production systems for aquaculture* (SRAC Publication No. 4503). Southern Regional Aquaculture Center. https://aquaculture.mgcafe.uky.edu/sites/aquaculture.ca.uky.edu/files/srac_4503_biofloc_production_systems_for_aquaculture.pdf

Nahar, A., Abu, M., & Siddik, B. (2015, January). Biofloc technology in aquaculture systems generates higher income in mono-sex Nile tilapia farming in Bangladesh [Supplemental material]. *Advances in Biological Research, 9*(4), 236–241. https://doi.org/10.5829/idosi.abr.2015.9.93142

BD Fisheries Sector. (2020). *Aquaculture practices of Bangladesh*. Dhaka, DC: Government Fisheries Site.

Halim, M. A., Nahar, S., & Nabi, M. M. (2019, August 3). Biofloc technology in aquaculture and its potentiality: A review. *International Journal of Fisheries and Aquatic Studies, 7*(5), 260–266.

Satish, G. G. (2014, September 27). Biofloc technology in aquaculture. [Web article].

Shoib, S. (2019, December 24). Fish culture at SAU using Biofloc Technology. [Supplemental material]. *Bangladesh Post*.

Sontakke, R., & Haridas, H. (2018, November 8). Economic viability of biofloc based system for the nursery rearing of milkfish (*Chanos chanos*). *International Journal of Current Microbiology and Applied Sciences, 7*, 2960–2967.

Seraj, S. (2019, July 25). Modern fish farming technologies shaping the cultivation. *The Daily Star*.

Список використаних джерел

Crab, R., Defoirdt, T., Bossier, P., & Verstraete, W. (2012). Biofloc technology in aquaculture: Beneficial effects and future challenges. *Aquaculture, 356*, 351–356. https://doi.org/10.1016/j.aquaculture.2012.04.046

Hargreaves, J. A. (2013, April). *Biofloc production systems for aquaculture* (SRAC Publication No. 4503). Southern Regional Aquaculture Center. https://aquaculture.mgcafe.uky.edu/sites/aquaculture.ca.uky.edu/files/srac_4503_biofloc_production_systems_for_aquaculture.pdf

Nahar, A., Abu, M., & Siddik, B. (2015, January). Biofloc technology in aquaculture systems generates higher income in mono-sex Nile tilapia farming in Bangladesh [Supplemental material]. *Advances in Biological Research, 9*(4), 236–241. https://doi.org/10.5829/idosi.abr.2015.9.93142

BD Fisheries Sector. (2020). *Aquaculture practices of Bangladesh*. Dhaka, DC: Government Fisheries Site.

Halim, M. A., Nahar, S., & Nabi, M. M. (2019, August 3). Biofloc technology in aquaculture and its potentiality: A review. *International Journal of Fisheries and Aquatic Studies, 7*(5), 260–266.

Satish, G. G. (2014, September 27). Biofloc technology in aquaculture. [Web article].

Shoib, S. (2019, December 24). Fish culture at SAU using Biofloc Technology. [Supplemental material]. *Bangladesh Post*.

Sontakke, R., & Haridas, H. (2018, November 8). Economic viability of biofloc based system for the nursery rearing of milkfish (*Chanos chanos*). *International Journal of Current Microbiology and Applied Sciences, 7*, 2960–2967.

Seraj, S. (2019, July 25). Modern fish farming technologies shaping the cultivation. *The Daily Star*.