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PENTUPLE BOTTOM LINE IN SEAWEED CULTIVATION: AN ENVIRONMENTAL ACCOUNTING REVIEW

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Abstract:
In the modern era that increasingly demands transparency and accountability, environmental accounting has become a strategic tool to record, measure, and report the environmental impacts of economic activities. Meanwhile, sustainability accounting broadens its scope by integrating economic, social, and environmental dimensions in line with the Triple Bottom Line (TBL) framework and the development of the Pentuple Bottom Line (PBL) concept. This study provides insights into how the seaweed farming sector can improve its global competitiveness by supporting blue economy development and climate change mitigation. The research methodology uses a descriptive qualitative approach with in-depth interviews with seaweed farming business actors, academics, and other stakeholders. The results of the study indicate that the application of environmental accounting and sustainability accounting is still limited in the seaweed farming sector, although the potential impact is significant. Local cultural values such as Siri na pace become a strong moral foundation to strengthen social legitimacy in sustainability practices. This study provides a new contribution by integrating environmental and sustainability accounting approaches within the Pentuple Bottom Line (PBL) framework, which includes the dimensions of phenotechnology and prophet. This study emphasizes the importance of environmental accounting and the desire to create better governance of the seaweed farming sector. By increasing farmer awareness, adopting environmentally friendly technologies, and strengthening regulations, this sector can become a model for developing a globally competitive blue economy.

Keywords: Accounting, Interest, Pentuple Bottom Line, Seaweed Farming, Blue Economy, Legitimacy.

INTRODUCTION

Efforts to achieve sustainable development have become a global imperative. The balance between economic growth, environmental protection, and social welfare is the main focus in responding to global challenges such as climate change, declining biodiversity, and social inequality. The concept of sustainable development, in principle, states that the development of the current generation should not require compromise from future generations through their sacrifice in the form of lower social welfare than the welfare of the current generation. Seaweed is one of the most abundant biological resources in Indonesian waters, which is around 8.6% of the total biota in the sea (3). Behind its ecological and biological role in maintaining the stability of the marine ecosystem and as a habitat and protection for other biota, this group of macroalgae has economic potential, namely as a raw material in industry (4).

Seaweed is the main source of livelihood for coastal communities in various regions, such as South Sulawesi, East Nusa Tenggara, Bali, and East Java. Seaweed cultivation, which is generally carried out using simple methods such as longlines, floating rafts, or seabed methods, allows local communities to utilize the potential of vast coastal waters. According to the FAO report (2023),

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seaweed cultivation can increase the household income of farmers by up to 60% compared to other jobs in the fisheries sector. Seaweed has significant added value because it can be processed into various high-value products. In the food sector, seaweed is used as an ingredient in making agar-agar, carrageenan, and alginate. In the cosmetics sector, seaweed is used for skin care and anti-aging products. Even in the pharmaceutical sector, seaweed is used to produce bioactive ingredients that have health benefits.

Seaweed not only has high economic value but is also a commodity that supports environmental sustainability. As a marine plant, seaweed is able to absorb large amounts of carbon dioxide (CO2), thereby helping to reduce the impact of climate change. In addition, seaweed cultivation does not require fertilizers or pesticides, which are often the main causes of environmental damage in the inland agricultural sector. Seaweed cultivation has become one of the significant fisheries sectors in Indonesia, playing an important role in the coastal economy and the welfare of local communities. Indonesia itself is one of the largest seaweed producers in the world, with a significant contribution to the national economy and improving the welfare of coastal communities (Santoso & Purnomo, 2022). As the world's leading producer of seaweed, Indonesia has great potential to utilize this resource sustainably. However, sustainability is often a challenge, especially in ensuring that cultivation is not only economically profitable but also provides social benefits, maintains environmental sustainability, and adopts environmentally friendly technologies. Therefore, the concept of the Pentuple Bottom Line (PBL) is relevant to address various challenges in this industry (Garcia et al., 2023; Smith & Harris, 2022).

Seaweed farming often faces several challenges that hinder sustainability, both at local and global scales. Some of the main challenges identified in recent literature include: a) Environmental Impacts. Uncontrolled farming practices can cause environmental damage, such as water quality degradation, biodiversity decline, and waste accumulation. According to UNEP (2023), the environmental impacts of seaweed farming are often not transparently recorded in business reports, leading to suboptimal management decisions; b) Social Welfare. Although seaweed farming provides significant economic benefits, the distribution of profits is often unequal among farmers. A study by Smith & Harris (2022) showed that income inequality between small farmers and large entrepreneurs is one of the causes of social conflict in coastal communities; c) Technological Limitations. Most seaweed farmers in Indonesia still use traditional techniques, which tend to be less efficient and environmentally unfriendly.

In the context of sustainability, the Pentuple Bottom Line (PBL) concept is a relevant approach. PBL is a development of the Triple Bottom Line (TBL) by adding two additional elements, namely phenotechnology and prophet. This concept includes five main elements: profit (economic profit), people (social welfare), planet (environmental sustainability), phenotechnology (use of efficient and environmentally friendly technology), and prophet (spiritual or ethical values). This approach emphasizes that in addition to economic aspects, attention to social welfare, environmental sustainability, application of appropriate technology, and ethical or spiritual values must be considered in business management. With this approach, seaweed cultivation is not only oriented toward economic profit but also includes social, environmental, technological, and ethical aspects that support sustainability as a whole (Garcia et al., 2023; Lee & Park, 2023).

The PBL concept extends the Triple Bottom Line (TBL) approach by adding two new elements: phenomenology and prophet. The phenotechnology element emphasizes the importance of adopting technologies that support production efficiency, environmental sustainability, and product quality improvement (Lee & Park, 2023). In the context of seaweed farming, technologies such as Internet of Things (IoT)-based monitoring systems, tissue culture techniques, and

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wastewater treatment technologies can help farmers maximize yields while minimizing negative impacts on the environment (Chen et al., 2023).

The prophet element includes ethical, spiritual, and cultural values that must be the basis of every business activity. This value is very important in the context of Indonesian coastal communities, where many communities consider the sea as an integral part of their social and spiritual life. By integrating the prophet element, seaweed cultivation can be carried out by respecting local values and maintaining socio-ecological balance (Park et al., 2023). Seaweed cultivation in Indonesia is not only an economic activity that supports the welfare of coastal communities but also part of the local culture that has developed for centuries. In the context of Indonesian coastal communities, the sea has a value that is more than just an economic resource. The sea is considered an integral part of social, spiritual, and cultural life. It is reflected in various local pearls of wisdom that regulate the sustainable use of the sea, such as the philosophy of "siri' na pacce" in South Sulawesi and the principle of the sea subak in Bali, which emphasizes harmony between humans, nature, and God (Rizal & Hamid, 2022; Santoso & Purnomo, 2022).

The application of PBL in seaweed cultivation is very important to ensure that this activity is not only economically profitable but also supports the welfare of coastal communities, maintains marine ecosystems, encourages technological innovation, and reflects ethical values that are relevant to the local cultural context (Smith & Harris, 2022). For example, cultivation practices that do not pay attention to environmental sustainability, such as uncontrolled waste disposal, can damage marine ecosystems, while social conflicts between seaweed farmers often arise due to unequal distribution of results (Prasetyo & Ananda, 2023).

However, implementing PBL in seaweed cultivation faces various challenges. Previous research revealed that most small and medium enterprises (SMEs) in seaweed cultivation in Indonesia do not fully understand the importance of environmental accounting as part of a sustainability strategy (Widjaja & Utama, 2022). In addition, the use of technology in seaweed cultivation is often still low due to limited access to innovation and funding (UNEP, 2023).

Environmental accounting plays an important role in implementing PBL. It helps organizations record, measure, and report the environmental impacts of seaweed farming activities. This information is essential for decision-making that supports sustainability and provides transparency to stakeholders. In this context, environmental accounting becomes a strategic tool to integrate all PBL elements into seaweed farming management (Indrawan & Putri, 2022).

Environmental accounting is an important tool for recording and reporting the environmental impacts of business activities. In the context of seaweed farming, environmental accounting can help: a) Measure and Monitor Environmental Impacts. Environmental accounting allows business actors to identify and measure the environmental impacts of farming activities, such as water consumption, carbon emissions, and waste production. Garcia et al. (2023) showed that transparent environmental impact reporting can increase accountability and trust from stakeholders and b) Support Decision-making. With the information obtained through environmental accounting, managers can make better decisions regarding resource allocation, waste management, and investment in environmentally friendly technologies (Lee & Park, 2023); c) Promote Transparency and Sustainability. The implementation of environmental accounting helps organizations demonstrate their commitment to sustainability, which in turn can improve the company's reputation in the global market (Smith & Harris, 2022).

The use of technologies such as IoT, blockchain, and wastewater treatment technology can support the implementation of PBL in seaweed farming. Chen et al. (2023) found that these technologies not only improve operational efficiency but also enable real-time tracking of

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environmental impacts. For example: a) IoT for Water Quality Monitoring. IoT-based sensors can be used to monitor water quality, such as temperature, pH, and oxygen levels so that farmers can optimize cultivation conditions; b) Blockchain for Supply Chain Tracking. Blockchain enables product tracking from the cultivation stage to distribution, providing transparency to consumers and increasing the added value of products (Park et al., 2023); and c) Integrated Wastewater Treatment. Wastewater treatment technology can be used to reduce negative impacts on the environment while producing by-products such as organic fertilizers.

To integrate the PBL concept in seaweed farming, support is needed from various parties, including the government, academics, and industry players. Some key recommendations include: a) Farmer Capacity Building. Provide training to farmers on sustainable farming practices and the use of modern technology; b) Incentives for Technological Innovation. The government can provide incentives, such as subsidies or soft loans, to encourage the adoption of environmentally friendly technologies; and c) Integration of Environmental Accounting. Create national guidelines on environmental accounting for the fisheries sector, including seaweed farming.

Seaweed is a strategic commodity with great potential to improve the welfare of coastal communities while supporting national economic growth. With high added value, large export opportunities, and positive environmental impacts, seaweed is one of the leading sectors that deserves to be continuously developed. To realize this potential, joint efforts are needed from the government, private sector, and community to ensure that seaweed cultivation is carried out sustainably and provides maximum benefits for all parties.

The Pentuple Bottom Line concept offers a holistic approach to supporting the sustainability of seaweed farming in Indonesia. By combining economic, social, environmental, technological, and ethical elements, this approach can provide long-term benefits for all stakeholders. However, the successful implementation of PBL requires a strong commitment from all related parties, including policy support, technological innovation, and the implementation of transparent environmental accounting.

John Ellington (6) introduced the Triple Bottom Line (TBL) concept that changed the global business perspective. TBL consists of three main aspects: people, planet, and profit, which are used to measure a company's success. This concept encourages companies to play a role in building society and protecting the environment rather than just focusing on profit. TBL emphasizes stakeholder interests in three areas: Profit to seek profit, People to protect the rights and security of workers, and Planet to protect the environment and natural resources (7). According to (8), sustainable organizations pay attention to three aspects: economic (profit), social (people), and environment (planet), which are referred to as the '3Ps'. The balance of these three aspects is the key to sustainable development and maintaining the financial stability of the organization, operations that are in accordance with community expectations, and minimizing negative impacts on the environment.

In the Pentuple Bottom Line, the spiritual aspect (Prophet) is added as a refinement of the Triple Bottom Line (TBL) paradigm (9). Spirituality plays a role in assessing the elements in the '3P' and underpinning good intentions. In 2019, he also added nanotechnology as an additional aspect. Nanotechnology emerged as a result of the Industrial Revolution and supports progress in a complex global era. In the new paradigm, referred to as the Pentuple bottom line (PBL), there are five aspects: economic, social, environmental, spirituality, and phenotechnology. PBL encourages behavior that respects and awakens divine awareness and prioritizes common interests. The goal is not only for capitalist profit, but for the preservation of nature and humans in seeking God's pleasure. This concept has the potential to change human behavior for the better (10).

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Legitimacy Theory. Legitimacy theory is one of the theoretical approaches used to understand the relationship between organizations and their environment, especially in the context of how organizations try to meet social, environmental, and economic expectations of society to gain legitimacy. According to Suchman (1995), legitimacy is defined as "a general perception or assumption that an entity's actions are in accordance with socially accepted norms, values, beliefs, and definitions." This theory emphasizes that legitimacy is an intangible asset that is very important for the survival of an organization.

Problem Formulation. Based on the background, the problem formulation in this research is:

1. How the implementation of environmental accounting can improve efficiency and transparency in seaweed farming practices.
2. How can the integration of local cultural values and ethics into the prophet dimension in PBL support the sustainability of this sector?
3. How technological innovation can be effectively applied to overcome challenges in environmental accounting reporting.
4. How fair profit distribution strategies can be implemented to improve the welfare of coastal communities.
5. How policy and regulatory support can accelerate the adoption of environmental accounting in seaweed farming practices.

METHODS

Research Approach. This research uses a qualitative approach, focusing on exploring and understanding the application of the Pentuple Bottom Line (PBL) concept in seaweed cultivation and processing. This approach was chosen because it can explore the perspectives, experiences, and interpretations of business actors, local communities, and stakeholders on economic, social, and environmental goals and sustainability issues.

Type of Research. This study uses exploratory, descriptive research. It aims to describe how the elements of the Pentuple Bottom Line, namely Profit, People, Planet, Purpose, and Prosperity, are applied in seaweed cultivation and processing practices. In addition, it identifies the contribution of environmental accounting in recording and reporting the impacts caused by these activities.

Research Location. The research was conducted in coastal areas that have great potential in seaweed cultivation and processing. The research locations were selected purposively based on the following criteria: 1) Areas with significant levels of seaweed production and 2) Areas that are socially and environmentally impacted by seaweed cultivation activities. The research locations are seaweed production centers in South Sulawesi, such as Takalar Regency and Pangkep.

RESULT AND DISCUSSION

Seaweed and Its Benefits. Seaweed is a biological resource with high economic, ecological, and social value. As one of the leading commodities of the fisheries sector in Indonesia, seaweed is not only a raw material for industry but also provides great benefits for human health, the environment, and the economic development of coastal communities.

Seaweed cultivation has become one of the strategic sectors in Indonesian fisheries. With its large production potential, Indonesia is one of the world's major seaweed producers, contributing more than 50% of global production (Ministry of Maritime Affairs and Fisheries, 2023). South Sulawesi is one of the largest seaweed production centers in Indonesia. However, cultivation practices in this region often have environmental impacts such as decreased water quality and ecosystem damage. The application of environmental accounting in South Sulawesi can help

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identify these impacts and encourage more environmentally friendly practices. For example, water quality monitoring with technology-based sensors can be included in environmental accounting reports to increase transparency and accountability (Indrawan & Putri, 2022).

South Sulawesi is one of the provinces that significantly contributes to seaweed production in Indonesia. According to data from the Ministry of Maritime Affairs and Fisheries (KKP), South Sulawesi contributed around 35% of the total national seaweed production in 2022. It makes this province one of the largest seaweed producers in Indonesia, with the main results being raw materials for the food, cosmetics, and pharmaceutical industries (KKP, 2022).

Traditional methods, such as the longline method and the floating raft method, dominate seaweed cultivation practices in South Sulawesi and floating raft methods. Although these methods have helped increase production, most farmers have not adopted modern technology to monitor water quality, land productivity, or harvest efficiency. Garcia et al. (2023) stated that adopting technologies such as the Internet of Things (IoT) to monitor environmental conditions can help improve production efficiency and sustainability.

Seaweed is a biological resource that has enormous economic, health, and environmental benefits. To maximize this potential, collaboration between government, academia, and the private sector is needed to address existing challenges, encourage technological innovation, and ensure that cultivation practices are carried out sustainably.

Despite providing significant economic benefits, seaweed cultivation practices in South Sulawesi often have environmental impacts, such as:

- Water quality degradation: Waste from unmanaged seaweed residue can pollute the waters.
- Marine ecosystem degradation: The use of non-environmentally friendly farming equipment can disrupt the habitat of fish and other marine life.
- Overcrowding: Some areas experience excessive farming density, which can reduce productivity and the quality of the harvest.

Research by Indrawan and Putri (2022) shows that the application of environmental accounting can help identify the environmental impacts of cultivation practices and provide recommendations to reduce them. In addition to environmental impacts, seaweed cultivation in South Sulawesi also faces social and economic challenges, including:

- Income inequality: Profits from the harvest are often not distributed fairly between small farmers and large businesses.
- Fluctuating prices: Farmers often have difficulty selling their harvests due to unstable seaweed prices in the market.
- Lack of access to technology and education: Most farmers still lack training on sustainable and efficient farming practices.

A study by Smith and Harris (2022) suggests the need for community-based training to increase farmers' capacity and ensure equitable access to resources and technology.

Government Support and Policy. The South Sulawesi regional government has attempted to increase seaweed production through various programs, such as:

- Procurement of superior seeds: Providing disease-resistant and high-quality seaweed seeds to farmers.
- Provision of technological assistance: Providing modern cultivation tools to increase productivity.
- Training and extension: Providing training to farmers on sustainable cultivation practices

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However, this support still needs to be improved, especially in terms of environmental monitoring and stabilization of seaweed prices in local and global markets (KKP, 2022).

Seaweed cultivation in South Sulawesi has great potential to support the economy and welfare of coastal communities. However, environmental, social, and economic challenges require serious attention to ensure the sustainability of this sector. By integrating modern technology, local cultural values, and religious principles into cultivation practices, South Sulawesi can become a model of sustainability for the seaweed industry in Indonesia and the world.

Triple Bottom Line (TBL) Concept. Triple Bottom Line (TBL) is a framework introduced by John Elkington (1997) to evaluate organizational performance not only in terms of economic profit (profit) but also in terms of social impact (people) and the environment (planet). This concept is known as the "3P" which includes: a) Profit -- Financial performance that reflects the organization's ability to create profit; b) People -- Social impact that focuses on the welfare of society, workers, and local communities; c) Planet -- Environmental responsibility that includes efforts to protect and preserve ecosystems. Triple Bottom Line emphasizes that the sustainability of an organization depends not only on achieving economic profit but also on how the organization has a positive impact on society and the environment.

Triple Bottom Line is a very important framework in the modern era where sustainability is a major issue. Focusing on sustainability is not only a moral demand but also an essential business strategy to survive in the global market. Chen et al. (2023) emphasize that organizations that integrate TBL principles tend to be better able to face global challenges such as climate change, social inequality, and market pressures.

The main benefits of implementing TBL are: a) Improved Reputation -- Organizations that support sustainability gain greater trust from consumers and stakeholders; b) Improved Operational Efficiency -- Efforts to reduce waste and carbon emissions often result in cost savings; and c) Competitiveness in the Global Market -- Environmentally friendly and socially supportive products and services have greater appeal in international markets.

TBL implementation requires a holistic and integrated strategy. Organizations need to establish Key Performance Indicators (KPIs) for each dimension of TBL and measure their impact transparently. Smith et al. (2023) provide examples of how TBL is implemented in the fisheries and aquaculture sector, including:

- Profit: Increase production efficiency and added value of products.
- People: Provide training to farmers and improve the quality of life of local communities.
- Planet: Adopt environmentally friendly technologies to reduce negative impacts on the ecosystem.

Although the TBL concept offers many benefits, its implementation is not without challenges. Some of the main challenges include: a) Conflicts Between Dimensions. In some cases, efforts to increase profits may conflict with environmental or social goals. For example, increased production often results in greater waste; b) Lack of Awareness and Capacity. Not all organizations understand the importance of TBL or have the resources to implement it; and c) High Implementation Costs. Some TBL initiatives, such as the adoption of green technologies, require large upfront investments.

Seaweed farming is a relevant example of the application of TBL. In this sector, the profit dimension can be seen from the increase in income of coastal communities, the people dimension from empowering local farmers, and the planet dimension from efforts to preserve marine ecosystems. Prasetya et al. (2023) showed that by integrating the TBL principle, the seaweed farming sector can become one of the main pillars of economic and environmental sustainability.

Triple Bottom Line Dimensions in Seaweed Cultivation.

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a. Profit (Economic Profit). The profit dimension in TBL refers to achieving economic goals, such as increasing the organization's revenue and profits. In the context of seaweed cultivation, profit is obtained from the harvest, which becomes raw material for the food, cosmetics, and pharmaceutical industries. According to Prasetya et al. (2023), seaweed cultivation can increase the income of coastal communities by up to 60% compared to other fisheries sectors.
b. People (Social Welfare). The people dimension encompasses the social impact of an organization's activities on local communities and other stakeholders. In seaweed farming, this dimension is seen from:
   - Empowering local farmers through cultivation skills training.
   - Creating jobs for coastal communities.
   - Equitable distribution of profits to reduce economic disparities.

   According to Rizal and Hamid (2022), empowering coastal communities through seaweed cultivation not only improves their standard of living but also strengthens social relations.
c. Planet (Environmental Sustainability). The planetary dimension is at the heart of environmental accounting within the TBL framework. Seaweed farming has great potential to support environmental sustainability because it can:
   - Absorb large amounts of carbon dioxide (CO2), thereby helping mitigate climate change.
   - Improve water quality by absorbing excess nutrients.
   - Reduce pressure on overfishing.

However, if not managed properly, seaweed farming activities can also cause negative impacts such as decreased water quality and damage to marine ecosystems due to waste. Chen et al. (2023) suggest that the use of environmentally friendly technologies, such as Internet of Things (IoT)-based water quality monitoring systems, can help minimize these negative impacts.

Environmental accounting plays an important role by:

- Record carbon emissions resulting from cultivation activities.
- Identify organic waste that must be managed.
- Provide transparent reporting on environmental impact mitigation efforts.

Triple Bottom Line is a framework that integrates economic, social, and environmental dimensions to create organizational sustainability. In an era where sustainability is a global priority, implementing TBL is a strategic step that not only supports organizational goals but also has a positive impact on society and the environment. By addressing existing challenges, organizations can leverage TBL to create long-term value for all stakeholders.

Deconstructing the TBL Line Concept into the Pentuple Bottom Line. The Triple Bottom Line (TBL), introduced by John Elkington (1997), is an early framework that defines sustainability through three main dimensions: economic (profit), social (people), and environmental (planet). TBL provides a holistic view of organizational performance by focusing not only on financial profit but also on social and environmental impacts. This concept emphasizes the importance of a balance between economic sustainability, social welfare, and environmental protection in business decision-making. However, with the increasing complexity of global sustainability challenges, such as technological disruption, social inequality, and climate change, TBL is becoming less comprehensive in covering all aspects relevant to modern sustainability. However, with the increasing complexity of global sustainability issues, this framework is considered necessary to be expanded to capture more dynamic and relevant dimensions in facing modern challenges.

Pentuple Bottom Line (PBL) emerged as a development of TBL by adding two new dimensions, namely phenomenology (innovative technology) and prophet (ethics, spirituality, and culture). PBL expands the view of sustainability by integrating elements of technology and moral

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values to create a more holistic impact that is relevant to the needs of modern society (Smith & Harris, 2022). This addition reflects the need to integrate technology as a driver of sustainability and moral values that are increasingly relevant in the management of natural resources and the environment.

The PBL framework aims to create a holistic approach to sustainability that is not only oriented towards outcomes but also towards processes and their impacts on society and ecosystems (Smith & Harris, 2023). This change not only supports adaptation to global challenges but also provides a more inclusive and futuristic approach to resource management.

a. Addition of Phenotechnology Dimension. The phenomenology dimension in PBL reflects the importance of technological innovation in supporting sustainability. In the TBL framework, technology is often an integrated part of the planet or profit dimension. However, in PBL, technology has a strategic role as a key element that can create efficiency, increase productivity, and reduce environmental impact. Technology is given special space as a stand-alone element, considering its crucial role in creating efficiency, innovation, and solutions to various sustainability challenges. For example, in the seaweed farming sector, the adoption of technologies such as the Internet of Things (IoT) for water quality monitoring or blockchain for supply chain transparency allows organizations to increase productivity while minimizing environmental impact (Chen et al., 2023). Technology not only supports sustainability but also provides greater competitiveness in the global market. Garcia et al. (2023) stated that technology allows business actors to reduce environmental impact while increasing yields, thereby creating sustainable value.
b. Addition of the Prophet Dimension. The prophet dimension highlights the importance of ethics, spirituality, and cultural values in sustainability. This dimension recognizes that sustainability is not only about economic, social, or environmental outcomes but also involves morality and ethical responsibility towards the community and the planet. The addition of this dimension reflects the view that sustainability is not only material but also moral. Rizal and Hamid (2022) emphasize that local cultural values and spirituality are often key factors in community acceptance of sustainability programs. In the Indonesian context, for example, local values such as Siri na pace in South Sulawesi or Tri Hita Karana in Bali reflect how communities view the balance between humans, nature, and God as part of sustainability. The addition of this dimension in PBL provides a richer and more relevant perspective on sustainability, especially in a region as culturally rich as Indonesia (Rizal & Hamid, 2022). This dimension helps strengthen the legitimacy of the organization in the eyes of the local community.

Table 1. Key Differences between TBL and PBL

Aspect	Triple Bottom Line (TBL)	Pentuple Bottom Line (PBL)
Dimensions of Sustainability	Profit, People, Planet	Profit, People, Planet, Phenotechnology, Prophet
Technology Focus	Not the main focus	Technology is considered a key element of sustainability
Ethical and Cultural Values	Not explicitly	Integrating ethical, spiritual and cultural values

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Complexity of the Issue	Focus on fundamental sustainability issues	Capturing more complex and multidimensional issues

Smith and Harris (2022) emphasize that PBL not only develops the dimensions of TBL but also provides a more relevant framework for addressing global challenges such as climate change, technological disruption, and social inequality.

Relevance of Concept Change to the Pentuple Bottom Line;

a. Adapting to Global Challenges. Modern sustainability challenges such as climate change, economic inequality, and accelerating technological innovation require a more comprehensive framework. The addition of a phenomenology dimension to PBL enables organizations to be more responsive to these challenges through the use of innovative technologies that support sustainability (Garcia et al., 2023). Chen et al. (2023) show that the use of advanced technologies such as IoT, artificial intelligence (AI), and blockchain in the fisheries sector has accelerated production processes, increased efficiency, and reduced waste, making it more in line with global sustainability demands. For example, in seaweed farming, the use of IoT technology to monitor water quality and blockchain for the supply chain helps create efficient and transparent farming practices.
b. Connectedness to Local Values and Ethics. The prophet dimension in PBL pays attention to spiritual and cultural aspects that are often overlooked in traditional sustainability approaches. These values are essential to creating sustainability that is not only physical but also moral and social. Rizal and Hamid (2022) emphasize that sustainability, which involves cultural and ethical values, tends to be more accepted and supported by local communities. Conversely, sustainability approaches that ignore cultural and ethical aspects tend to fail because local communities less accept them.

The Pentuple Bottom Line (PBL) Concept. The Pentuple Bottom Line (PBL) concept is a development of the Triple Bottom Line (TBL) which was originally introduced by John Elkington (1997). TBL emphasizes three main elements in sustainability, namely profit (economic benefit), people (social welfare), and planet (environmental sustainability). In PBL, two additional elements are included, namely phenotechnology (use of innovation-based technology) and prophet (ethical, spiritual, and cultural values) (Smith & Harris, 2022). The PBL approach provides a holistic view of sustainability, especially in economic activities that have a direct impact on the environment, such as seaweed farming.

The Pentuple Bottom Line (PBL) concept offers a comprehensive sustainability approach by integrating five main dimensions, namely profit, people, planet, phenotechnology, and prophet. Chen et al. (2023) stated that the application of PBL in the marine sector can help overcome multidimensional challenges in natural resource management, including seaweed cultivation. The phenomenology dimension, for example, encourages the adoption of innovative technologies to increase productivity and efficiency, while the prophet dimension strengthens ethical and spiritual aspects of economic practices.

Research by Garcia et al. (2023) shows that PBL can provide a holistic solution to ensure that economic practices are not only profit-oriented but also have a positive impact on the environment and society. In the context of seaweed farming, this includes efficiency in the cultivation process, reducing environmental impacts, and improving the welfare of coastal farmers.

Ethics and Culture in PBL. The prophet dimension in the PBL concept highlights the importance of ethical, cultural, and spiritual values in natural resource management. In the

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Indonesian context, cultural values such as Siri na pace in South Sulawesi and the Tri Hita Karana principle in Bali are important foundations in sustainable cultivation practices (Rizal & Hamid, 2022).

Cultural and ethical values play an important role in the sustainability of seaweed farming, especially in coastal areas of Indonesia. Local philosophies such as Siri na pace in South Sulawesi and the Tri Hita Karana principles in Bali reflect the prophet element in PBL, which emphasizes the importance of spiritual and ethical values in natural resource management (Rizal & Hamid, 2022).

In the context of seaweed farming, the application of PBL allows the integration of economic, social, environmental, technological, and ethical aspects so that farming practices are not only financially profitable but also environmentally friendly and support the welfare of coastal communities. Garcia et al. (2023) showed that PBL can be an important tool in measuring and evaluating the sustainability of the fisheries and marine sectors. Although PBL offers a holistic framework, its implementation in seaweed farming still faces various challenges. Chen et al. (2023) identified several major obstacles, such as:

1. Lack of awareness of farmers on the importance of sustainability.
2. High cost of adopting environmentally friendly technologies.
3. Lack of uniform reporting standards for the seaweed farming sector.

To address these challenges, Park et al. (2023) recommend several strategies, including:

1. Education and training to improve farmers' capacity to understand the concept of sustainability.
2. Provision of incentives by the government to encourage the adoption of environmentally friendly technologies.
3. Development of national standards for environmental accounting reporting in the fisheries sector.

The application of the PBL concept in seaweed cultivation faces various opportunities and challenges. The main opportunity is the increasing global market demand for sustainable seaweed products, as well as government support in the form of regulations and incentives. However, challenges such as the lack of farmer awareness of the importance of sustainability and the cost of implementing modern technology are still major obstacles (Prasetya et al., 2023; UNEP, 2023).

Pentuple Bottom Line in the Context of Seaweed Cultivation. Seaweed cultivation is one of the sectors that is very relevant for the implementation of PBL, especially since this sector has significant economic, social, and environmental impacts. Here is the implementation of PBL in the context of seaweed cultivation:

1. Profit (Economy): Increasing production efficiency and global market access to create greater economic value. Seaweed cultivation makes a significant economic contribution by creating jobs for coastal communities and increasing the income of local farmers. Prasetya et al. (2023) showed that with the application of modern technology, harvest yields can increase by up to 40%, thereby increasing competitiveness in the international market.
2. People (Social): The social dimension of PBL includes providing training to seaweed farmers and ensuring a fair distribution of income. Empowering local communities through skills training and fair profit distribution are key elements. Corporate social responsibility (CSR) programs involving coastal communities can improve welfare and support social sustainability.
3. Planet (Environment): Protecting marine ecosystems through waste management and the application of environmentally friendly technologies. Seaweed has a high ability to absorb carbon dioxide (CO2), thus contributing to climate change mitigation. However, the management of organic waste from seaweed cultivation is a challenge that requires the application of effective waste treatment technology (Chen et al., 2023).

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4. Phenotechnology (Technology): Using IoT technology to monitor water quality and blockchain for supply chain transparency. IoT and blockchain technology have been used to monitor water quality and ensure supply chain transparency. This technology improves operational efficiency while reducing environmental impacts. 5. Prophet (Ethics and Culture): Integrating local cultural values and ethics into cultivation practices, such as maintaining a balance between humans and nature. Integrating local cultural values such as Siri na pace creates a sustainability approach that is more acceptable to local communities. It strengthens the legitimacy and success of sustainability programs (Rizal & Hamid, 2022).

According to Prasetya et al. (2023), the application of PBL in seaweed farming not only increases productivity but also helps create a sustainable and socially acceptable business model. The change in concept from Triple Bottom Line to Pentuple Bottom Line reflects the need to accommodate new dimensions in sustainability that were previously under-appreciated. By adding the dimensions of phenotechnology and prophet, PBL provides a more comprehensive and relevant approach to addressing modern sustainability challenges. In the seaweed farming sector, PBL provides a framework that can help organizations not only achieve economic benefits but also create positive social, environmental, and cultural impacts.

The shift from a Triple Bottom Line to a Pentuple Bottom Line reflects the need to accommodate broader dimensions of sustainability, including innovative technology (nanotechnology) and moral values (prophet). In the context of seaweed farming, the implementation of PBL not only supports productivity but also creates positive social, environmental, and cultural impacts. By utilizing modern technology and local values, seaweed farming can be a relevant sustainability model for the future. However, the success of this implementation requires collaboration between the government, communities, and the private sector.

The Pentuple Bottom Line concept provides a comprehensive framework for integrating economic, social, environmental, technological, and ethical dimensions in seaweed farming management. With the adoption of modern technology, implementation of environmental accounting, and integration of local cultural values, seaweed farming can become a sector that is not only economically profitable but also supports the sustainability of marine ecosystems. However, the successful implementation of PBL requires collaboration between government, communities, academia, and the private sector to overcome challenges and capitalize on opportunities.

Environmental Accounting: Concept, Application, and Benefits. Environmental accounting is a field of accounting that records, measures, and reports the impact of an organization's activities on the environment. In the modern era, where sustainability issues are a global focus, environmental accounting has evolved into a strategic tool that helps organizations manage their environmental impacts more transparently and responsibly. According to Burritt et al. (2023), environmental accounting is not only important to meet legal obligations but also becomes a tool to improve the reputation, efficiency, and sustainability of an organization.

According to Schaltegger and Burritt (2023), environmental accounting is the process of identifying, recording, analyzing, and reporting information related to the costs and benefits associated with the environmental impacts of an organization's activities. Environmental accounting focuses on two main aspects:

1. Environmental Financial Accounting involves integrating environmental costs, such as waste management and pollution reduction costs, into the organization's financial statements.
2. Environmental Managerial Accounting: Providing relevant data for decision-making related to resource efficiency, investment in green technologies, and sustainability strategies.

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UNEP (2023) emphasizes that environmental accounting is an important component in achieving organizational sustainability, as it provides data that can be used to evaluate and reduce environmental impacts.

Benefits of Environmental Accounting

a. Transparency and Accountability. Environmental accounting increases transparency by providing clear information about an organization's environmental impact. It is important for building trust among stakeholders. Garcia et al. (2023) noted that organizations that transparently report their environmental impact tend to have a better reputation in the global marketplace.
b. Increased Operational Efficiency. By recording and analyzing environmental data, organizations can identify opportunities to improve efficiency, such as reducing waste or saving energy. Research by Chen et al. (2023) shows that implementing environmental accounting helps organizations save up to 20% in operational costs through better energy efficiency and resource management.
c. Regulatory Compliance. Environmental accounting helps organizations comply with applicable environmental regulations, such as ISO 14001 for environmental management. Thus, organizations can avoid fines or sanctions associated with environmental violations (Rizal & Hamid, 2022).
d. Data-Based Decision Making. Data generated from environmental accounting allows organizations to make better decisions regarding investments in environmentally friendly technologies, environmental risk mitigation strategies, and sustainability programs.

Environmental Accounting Components

a. Environmental Costs: Environmental accounting records various costs related to environmental protection, such as:
- Waste management costs.
- Carbon emission reduction costs.
- Investments in green technology.

b. Environmental Revenue: In addition to costs, environmental accounting also records revenues earned from environmentally friendly activities, such as:
- Sales of carbon credits.
- Products produced from waste recycling.

c. Environmental Performance Indicators: Environmental accounting uses indicators such as carbon footprint, energy consumption, and waste generated to evaluate an organization's environmental performance.

Environmental Accounting Implementation. Environmental accounting implementation requires an integrated system to collect, analyze, and report environmental data. Some implementation steps include:

1. Environmental Impact Identification: Organizations need to identify all environmental impacts of their activities, such as carbon emissions, water use, and waste.
2. Measurement and Recording: Relevant data, such as the amount of waste generated or energy used, must be recorded accurately.
3. Reporting: Environmental data is reported in sustainability reports or included in the organization's financial statements.

Schaltegger et al. (2023) argue that transparent reporting on environmental performance helps organizations build trust with stakeholders and meet regulatory demands.

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Environmental Accounting in the Aquaculture Sector. In the seaweed farming sector, environmental accounting plays an important role in ensuring sustainability. The implementation of environmental accounting in this sector includes:

1. Carbon Footprint Recording: Seaweed is known as an effective carbon sink. Environmental accounting can record the amount of carbon absorbed during the cultivation process.
2. Waste Management: Organic waste from seaweed farming can cause pollution if not managed properly. Environmental accounting records the cost of waste management to ensure that environmental impacts are minimized.
3. Sustainability Reporting: Environmental data from environmental accounting is used to prepare sustainability reports that cover economic, social, and environmental impacts.

Garcia et al. (2023) showed that environmental accounting improves operational efficiency and supports long-term sustainability in seaweed farming.

Implementation of Environmental Accounting in Indonesia. In Indonesia, environmental accounting has begun to be implemented by several large companies, especially those engaged in the energy, fisheries, and manufacturing sectors. Rizal and Hamid (2022) noted that these companies are beginning to realize the importance of environmental reporting to comply with government regulations and improve market reputation. Examples of environmental accounting implementation in Indonesia include:

- Pertamina: As the largest energy company in Indonesia, Pertamina has adopted sustainability reporting that includes environmental data, such as carbon emissions and water consumption.
- Seaweed Cultivation Companies: Many seaweed cultivation companies in South Sulawesi have begun using environmental accounting to record the impact of their activities on marine ecosystems, including organic waste management.

However, the main challenges in implementing environmental accounting in Indonesia are the lack of awareness among small and medium enterprises (SMEs) and the limited supporting technological infrastructure.

Environmental Accounting and the Triple Bottom Line Dimension. The Triple Bottom Line (TBL), introduced by John Elkington (1997), is a framework that emphasizes three main elements of sustainability: Profit (economic), People (social), and Planet (environmental). In the TBL framework, an organization's sustainability is not only assessed from its economic success, but also from the social and environmental impacts it generates. In the context of modern business, TBL becomes a relevant framework to ensure that sustainability does not only focus on economic profit, but also includes social and environmental responsibility. To support the effective implementation of TBL, environmental accounting plays an important role as a tool to record, measure, and report environmental impacts arising from organizational activities.

Environmental accounting acts as a tool to support the implementation of TBL, especially in the planetary dimension, by providing relevant information on the environmental impacts of organizational activities. Environmental accounting enables organizations to understand the ecological impacts of their operations, assisting in more sustainable decision-making and increasing transparency and accountability in the eyes of stakeholders. In recent decades, the application of environmental accounting within the TBL framework has become standard practice in various sectors, including the fisheries and aquaculture sectors, such as seaweed farming (Garcia et al., 2023). By integrating TBL and environmental accounting, organizations can measure, record, and report economic, social, and environmental impacts transparently to support more sustainable decision-making (Garcia et al., 2023).

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Research by Garcia et al. (2023) shows that organizations that integrate TBL and environmental accounting are more competitive because they can meet the global market demand for sustainable products.

According to UNEP (2023), environmental accounting provides data that can be used to evaluate the impact of business activities on ecosystems and develop effective mitigation strategies. In the seaweed farming sector, for example, environmental accounting can help record the amount of carbon absorbed by seaweed, which can be used to support climate change mitigation initiatives. A real example is a sustainability report that presents data on carbon footprints and steps to reduce them.

The Triple Bottom Line and environmental accounting support each other in efforts to realize organizational sustainability. Environmental accounting provides data that supports the implementation of TBL by:

1. Providing Information for the Planetary Dimension. Environmental accounting helps to quantitatively record environmental impacts, such as carbon emissions and energy consumption, which are key elements in TBL's planetary dimension.
2. Increasing Transparency and Accountability. Information generated from environmental accounting supports transparency in sustainability reporting, which includes economic, social, and environmental impacts (Lee et al., 2023).
3. Supporting Data-Based Decision Making. Data from environmental accounting allows organizations to identify areas for improvement in the TBL dimension, such as energy efficiency to reduce operational costs while reducing carbon emissions.
4. Meeting Stakeholder Expectations. By implementing environmental accounting and TBL, organizations can meet consumers', governments', and society's expectations regarding their social and environmental responsibilities.

Seaweed farming is an example of a relevant sector for the implementation of TBL and environmental accounting. In this sector, the integration between TBL and environmental accounting can be done in the following ways:

1. Profit Dimension. Increasing production efficiency through the adoption of environmentally friendly technologies, such as IoT-based monitoring systems, to minimize waste and improve product quality.
2. People Dimension. Providing training to seaweed farmers to improve their skills in sustainable farming practices. In addition, fair income distribution can improve the welfare of coastal communities.
3. Planet Dimension. Adopting waste management technology to minimize negative impacts on marine ecosystems. In addition, the use of environmental accounting helps record and report data related to carbon emissions and energy consumption (Chen et al., 2023).

According to Prasetya et al. (2023), the combination of TBL and environmental accounting in the seaweed farming sector can increase product competitiveness in the global market, especially among consumers who are increasingly concerned about sustainability.

The Role of Environmental Accounting in TBL Implementation;

a. Transparency and Accountability. Environmental accounting allows organizations to transparently report their environmental impacts to stakeholders, including governments, communities, and consumers. Sustainability reports that include environmental accounting data help improve organizations' accountability for their social and environmental responsibilities (Lee et al., 2023).

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b. Data-Based Decision Making. Data generated from environmental accounting allows organizations to make better decisions regarding operational efficiency and environmental risk management. For example, by recording carbon emissions and energy consumption, organizations can identify areas for improvement to reduce environmental impacts.
c. Compliance with Regulations and International Standards. Environmental accounting helps organizations comply with applicable environmental regulations and meet international standards, such as ISO 14001 for environmental management. Garcia et al. (2023) noted that the implementation of international standards through environmental accounting improves an organization's reputation in the global market.

Triple Bottom Line and environmental accounting are two complementary concepts in supporting organizational sustainability. Environmental accounting plays an important role in supporting the implementation of the Triple Bottom Line by providing relevant data to understand and manage the environmental impact of organizational activities. By integrating the dimensions of profit, people, and planet through environmental accounting, organizations can understand the impact of their activities on the economy, society, and environment more comprehensively.

In the seaweed farming sector, the implementation of TBL supported by environmental accounting can improve operational efficiency, coastal community welfare, and marine ecosystem sustainability. Environmental accounting allows organizations to improve operational efficiency, minimize negative environmental impacts, and support the welfare of coastal communities.

Although challenges such as implementation costs and lack of awareness still exist, the opportunities resulting from the adoption of environmental accounting, such as improved market reputation and policy support, provide a strong basis for wider adoption. To overcome the challenges, organizations need to invest in environmentally friendly technologies and raise awareness of the importance of sustainability.

Environmental Accounting in Seaweed Cultivation. Seaweed cultivation is an economic activity with great potential for coastal communities, but it also has a significant impact on the environment. To manage this activity sustainably, the application of environmental accounting is very relevant. Environmental accounting is an important tool that can help measure, record, and report the environmental impacts of seaweed cultivation activities, thus enabling better decision-making for sustainability.

The Importance of Environmental Accounting in Seaweed Cultivation. Environmental accounting focuses on identifying, measuring, and reporting the impact of economic activities on the environment. In the context of seaweed cultivation, environmental accounting is important because:

1. Measuring Environmental Impact. Seaweed cultivation can cause impacts such as decreased water quality, degradation of marine ecosystems, and accumulation of organic waste from seaweed residues. Environmental accounting helps record these impacts so they can be analyzed for future improvements.
2. Supporting Sustainability. Recording and reporting environmental impacts helps business actors understand their contribution to sustainability, which in turn helps create more environmentally friendly business strategies.
3. Increasing Transparency. The information provided by environmental accounting can be used to increase transparency to stakeholders, such as local communities, governments, and international consumers.

Benefits of Environmental Accounting for Seaweed Cultivation. The application of environmental accounting in seaweed cultivation brings various benefits, including:

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1. Improved Market Reputation. International consumers tend to choose products that have sustainability certification. Environmental accounting helps ensure that the seaweed production process meets global environmental standards.
2. Operational Efficiency. By recording environmental impacts, business actors can identify inefficient practices and make changes to reduce operational costs.
3. Contribution to SDGs. Environmental accounting helps business actors demonstrate how their activities support the achievement of the Sustainable Development Goals (SDGs), such as sustainable water resource management (SDG 6) and action on climate change (SDG 13).

Environmental Accounting: Strategic Applications Supporting Sustainability. Environmental accounting has evolved along with the increasing global attention to sustainability and the environmental impacts of human activities. In the modern industrial era, organizations are increasingly aware of the importance of considering the ecological impacts of their business activities. According to Burritt et al. (2023), environmental accounting has become more relevant as society and governments begin to demand greater transparency regarding organizations' environmental responsibilities. In this context, environmental accounting is not only aimed at complying with government regulations but also becomes an integral part of a broader business strategy. It is evident how global companies such as Unilever, Toyota, and Nestle have adopted environmental accounting reporting to increase public trust and build competitive advantage in the market.

Implementation of Technology in Environmental Accounting. Technological innovations have accelerated the implementation of environmental accounting, especially in data collection and analysis. Some relevant technologies include:

1. Internet of Things (IoT): IoT technology enables the collection of real-time environmental data, such as carbon emissions, energy consumption, and water quality. In the seaweed farming sector, IoT is used to monitor environmental parameters such as water temperature and oxygen levels, which are essential for sustainability (Chen et al., 2023).
2. Blockchain: Blockchain provides transparency in the tracking of the supply chain of environmentally friendly products. This technology allows consumers to ensure that the products they purchase are produced sustainably.
3. Artificial Intelligence (AI): AI analyzes complex environmental data and identifies patterns that can help organizations manage their environmental impact more effectively.

According to Schaltegger & Burritt (2023), the application of modern technology in environmental accounting not only increases efficiency but also expands the scope of data that can be accessed and analyzed by organizations. Environmental accounting is expected to become a mandatory component of an organization's financial and sustainability reporting. According to UNEP (2023), the adoption of international standards such as ISO 14001 and the Global Reporting Initiative (GRI) will further encourage organizations to integrate environmental accounting into their operations.

In addition, collaboration between government, private sector, and academia will be key in accelerating the implementation of environmental accounting in various sectors, including fisheries, manufacturing, and energy.

Recommendations for Sustainable Cultivation. Based on conditions in South Sulawesi, here are some recommendations to improve the sustainability of seaweed cultivation:

1. Adoption of Eco-Friendly Technologies. Encourage the use of technologies such as IoT to monitor water quality and blockchain to increase transparency in the supply chain.

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2. Integration of Cultural and Religious Values. Strengthen local wisdom and religious values in cultivation management, such as maintaining ecosystem balance and sharing profits fairly.
3. Farmer Education and Training. Provide intensive training to farmers on efficient and environmentally friendly cultivation practices.
4. Strengthening Government Policies. Develop policies that support price stabilization, incentives for small farmers, and strict environmental monitoring.

Environmental accounting is a strategic tool that helps organizations record, manage, and report their environmental impact. With increasing global pressure for sustainability, environmental accounting has become a critical component of modern business strategies. The adoption of technologies such as IoT, blockchain, and AI has accelerated the implementation of environmental accounting, providing more accurate data and supporting better decision-making. While challenges such as implementation costs and lack of awareness still exist, the benefits derived from implementing environmental accounting, such as increased efficiency, market reputation, and regulatory compliance, make it a top priority for organizations looking to stay relevant in the sustainability era.

Seaweed Cultivation as a Solution for Sustainable Development. Seaweed cultivation is increasingly recognized as a solution for sustainable development, especially in developing countries such as Indonesia. Park et al. (2023) emphasized that seaweed not only functions as a source of economic income but also provides ecological benefits, such as absorbing large amounts of carbon dioxide (CO2) and mitigating the impacts of climate change. In addition, seaweed cultivation integrated with a multispecies aquaculture system can increase space efficiency and protect marine biodiversity.

Research by Lee and Park (2023) shows that seaweed cultivation can be integrated with the blue economy approach, where the utilization of marine resources is based on the principle of sustainability. Thus, seaweed cultivation is not only relevant to meet market needs but also becomes part of a global strategy to protect marine ecosystems.

Environmental accounting plays a vital role in the sustainable management of seaweed farming. By recording and reporting environmental impacts, businesses can ensure that farming practices support environmental sustainability while improving operational efficiency and market reputation. While challenges such as lack of awareness and reporting standards still exist, measures such as education, technology adoption, and policy support can help overcome these barriers. With the implementation of environmental accounting, seaweed farming can become a sector that is not only economically profitable but also environmentally friendly and sustainable.

CONCLUSION

This study shows that seaweed cultivation has a significant contribution to the economy of coastal communities. Not only does it increase household income, but this sector also contributes to the country's foreign exchange through stable exports. Informants emphasized that income from seaweed can improve the quality of life of coastal communities by up to 60% compared to other jobs in the fisheries sector. From an environmental perspective, seaweed plays an important role in mitigating climate change. Its ability to absorb carbon dioxide in the ocean supports global efforts to reduce carbon emissions. However, challenges such as organic waste polluting the waters and excessive cultivation density need to be addressed immediately to ensure environmental sustainability.

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The application of the Pentuple Bottom Line concept, which includes profit, people, planet, phenotechnology, and prophet, is the basis for managing the seaweed farming sector holistically. The prophet dimension, which integrates local spiritual and cultural values, has proven to create practices that are more acceptable to local communities, according to the results of interviews with academic informants.

Environmental Accounting Environmental accounting plays a vital role in ensuring transparency and accountability in the seaweed farming sector. Recording and reporting environmental impacts helps businesses identify areas for improvement, increase operational efficiency, and strengthen legitimacy in the eyes of the global market and society.

The challenges and Barriers to Implementing Sustainability are large. The implementation of environmental accounting faces various obstacles, including high implementation costs and low business actors' awareness of sustainability. Lack of training and technology are also major obstacles for seaweed farmers in adopting more environmentally friendly cultivation practices.

Government programs, such as sustainable cultivation training, have had a positive impact on the sector. However, price stabilization and environmental impact monitoring still need to be improved to ensure the sustainability of the seaweed sector in Indonesia.

This study recommends collaboration between the government and the community to support the development of sustainable seaweed farming. By integrating modern technology, empowering local communities, and using environmental accounting reporting standards, this sector can continue to develop sustainably in terms of economy, society, and environment.

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