



## Sustainability of Fish Farming in Bucket (*Budikdamber*) of the Catfish (*Clarias gariepinus*) in Kediri, Indonesia

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### ABSTRACT

*Budikdamber* innovation represents a technological advancement that combines vegetable cultivation with fish farming in a single system. This initiative is aimed at enhancing food security while providing an alternative source of income for communities. The objective of this study was to assess the sustainability of the catfish *budikdamber* business. A purposive sampling technique was employed for data collection, and the analysis utilized the sustainable livelihood approach (SLA) with multi-dimensional scaling (MDS). The SLA measured five types of capital: human, natural, financial, physical, and social, using specific indicators. The results indicated that physical capital contributed the most to the sustainability of the business, with a score of 87.49. Conversely, human capital was the lowest, scoring 65.28, signaling a need for improvement in human resource capabilities, particularly in cultivation technology, to ensure long-term sustainability. The overall multimodal average score of 78.41 classified the business as sustainable, with robust support from all five capitals—natural, financial, physical, human, and social. This support helps create economic opportunities for the community, underscoring the potential of the catfish *budikdamber* business.

### INTRODUCTION

The fisheries sector is an industry that utilizes the outputs of both marine and inland fisheries. The catfish (*Clarias* sp.) is a highly promising fishery commodity that may be farmed on both industrial and domestic scales. The catfish farming can be conducted on small plots of land with a high number of fish stocked, which is anticipated to yield a substantial catfish production that can satisfy consumer demand and fulfil the requirement for animal protein (Arthatiani & Apriliani, 2019). *Clariid* catfishes are of great economic importance as protein food in adequate prices. For several years, species of the genus *Clarias* (Scopoli, 1777) have been used in local fish culture, where they proved to be a fast growing protein source (Mehanna *et al.*, 2018). The production of

fisheries is anticipated to contribute to the provision of animal protein food sources, hence enhancing nutrition and improving the quality of human resources (**Hasan *et al.*, 2020**). The Food and Agriculture Organization of the United Nations (FAO) has highlighted aquaponics as a promising method for sustainable food production in a small-scale setting (**Somerville *et al.*, 2014**). The simple processing methods of the fish can create an added value which is expected to increase the income of farmer households (**Intyas *et al.*, 2017**). Furthermore, the catfish cultivation has emerged as a worldwide major sector in food production, providing fish for public consumption (**Moroasui *et al.*, 2023**).

The availability of land and water for aquaculture processes is becoming more constrained due to population increase and development. Population activities will lead to pollution through the generation of both organic and inorganic waste. As technology advances, it is important to expect a decline in aquaculture yield due to limited farming space and declining water quality. An innovative technological application involves the use of an aquaponic system for fish farming with plants, specifically using a bucket media called *Budikdamber*. Aquaponic farming technique fundamentally conserves land and enhances the utilization of nutrients derived from feed waste and fish metabolism (**Lies & Chairulwan, 2015**).

The catfish is an edible fish that is a significant commodity in Indonesia (**Susadiana *et al.*, 2023**). The demand for the catfish (*Clarias* sp) in Indonesia is rising due to the increasing demand for culinary and processed fish products such as sausages, nuggets, and fillets. Additionally, the catfish production is also being increased to satisfy the requirements for export (**Fattah *et al.*, 2023a**). The catfish is a favored option due to its palatable flavor and reasonable cost, rendering it highly appealing to consumers (**Natalia *et al.*, 2021**). Moreover, it is renowned for its abundance of protein, omega-3 and omega-6 fatty acids, vitamins, and minerals, which make it a highly nutritious option for people of all age groups, especially youngsters in their developmental stage, expectant mothers, and older adults (**Dhar *et al.*, 2019**). The nutritional value of the catfish is further enhanced by its high protein (60%), calcium (8%), and phosphorus (4.2%) content (**Shidqi *et al.*, 2021**).

A thorough approach is necessary for the sustainability of the aquaponic catfish production. Aquaponics, an integration of aquaculture and hydroponics, is renowned for its capacity to recycle resources and its potential as a sustainable technique of urban farming (**Miličić *et al.*, 2017**). When evaluating the sustainability of aquaculture employing buckets as a rearing medium, it is important to consider several crucial factors. Gaining a comprehensive comprehension of the utilization of energy, water, and feed in an aquaponic system is vital for the purpose of fisheries business strategizing and maximizing the utilization of scarce resources (**Love *et al.*, 2015**). The growing demand for the catfish underscores its significance as a fundamental dietary item and a financially feasible aquaculture commodity. The economic significance of the catfish lies in its

potential for generating substantial profits and meeting the strong demand for the catfish products (Safitri & Prajanti, 2019). The assessment of managerial sustainability is a factor in the utilization of resources with the aim of minimizing harm (Fattah *et al.*, 2021). The sustainability of MSEs can be achieved by enhancing self-reliance, capacity, and empowerment. Efforts to ensure the sustainability of the MSEs fisheries sector are crucial in preserving the continuity of fisheries resources and livelihoods of fisheries communities (Siang *et al.*, 2023). By implementing innovative techniques in aquaponics, such as optimising resource utilization, guaranteeing water quality, and utilizing supporting facilities and infrastructure, the cultivation method of employing buckets as a maintenance medium can be both sustainable and cost-effective, while also being ecologically benign. Purwanti *et al.* (2023a) explained that housewives formed Poklahsar Bankid Sejahtera, a fish processing and marketing group, in 2020 as a forum to enhance the family economy during the COVID-19 pandemic. In addition to Poklahsar Bankid Sejahtera, the community of Bandar Kidul Village has established several other groups in various fields. These groups include Pokmas Bankid Lestari, which is specialized in the catfish cultivation, Pokdarwis, which processes telang flowers into herbal drinks, Mitra Tenun Ikat, which specializes in making traditional Kediri ikat weaving, and Sunny Side Creative Lab Studio, which provides advertising and videographer services. Poklahsar Bankid Sejahtera also aims to assist Pokmas Bankid Lestari in marketing the harvest of the catfish cultivation by processing it into the shredded catfish so as to increase the added value of the product and extend its shelf life. This study aimed to assess the sustainability of aquaponic fisheries enterprises using fish farming media in buckets (*Budikdamber*) for catfish fisheries commodities in Kediri, Indonesia.

## MATERIALS AND METHODS

The study assessed the sustainability of aquaponic fisheries businesses that utilize fish cultivation media in buckets (known as *Budikdamber*) for the catfish farming. The sampling technique employed was purposive sampling from 30 members, specifically targeting catfish *Budikdamber* cultivators in Poklahsar Bankid Sejahtera Kediri, Indonesia. MDS data analysis involves the evaluation of the rapfish sustainable livelihood approach (SLA) technique, which takes into account many aspects such as natural capital, human capital, financial capital, social and institutional capital, and physical capital. Table (1) displays the measurements, characteristics, and scale used for assessing the quality.

**Tabel 1.** Dimensions, attributes and scale of assessment of sustainability of the catfish farming businesses

No.	Capital	Variable	Criteria		
			1	2	3
1	Natural Capital	Water Quality	Not Suitable Enough	Suitable Enough	Suitable
		Growth Rate (GR)	< 100	50-100	> 100
		Relative Growth Rate (RGR)	< 10	50 - 10	>10
		Feed Conversion Ratio (FCR)	> 1.5	1 - 1.5	< 1
		Feed Efficiency (EP)	< 100	50 - 100	> 100
		Survival Rate (SR)	<70%	70-90%	>90%
		Loan	Loan	Loan and Own	Own
2	Financial Capital	Production asset	Loan	Loan and Own	Own
		Fishery household income per cycle	< IDR500,000	IDR 500,000 - IDR2,000,000	> IDR2,000,000
		Non-fishery income	< IDR500,000	IDR 500,000 - IDR2,500,000	> IDR2,500,000
		Source of business expenses	Loan	Loan and Own	Own
		Fish selling price	below market price	at market price	Above market price
		Access to government assistance programs	difficult	medium	easy
		Profitability and Financial Viability	Low	Medium	High
		Business Sensitivity	High	Medium	Low
3	Physical Capital	Household food expenditure	<40% of total expenditure	40%-60% of total expenditure	>60% of total expenditure
		Accessibility of the cultivation area	uneasy	Moderately easy	easy
		Availability of water according to cultivation standards	inadequate	Moderately adequate	adequate
		Availability of high quality seeds	inadequate	Moderately adequate	adequate

### Sustainability of *Budikdamber* Catfish Farming in Kediri, Indonesia

No.	Capital	Variable	Criteria		
			1	2	3
4	Human Resource Capital	Availability of feed	inadequate	Moderately adequate	adequate
		Asset Ownership	Rent	Partial rent	Self-owned
		Farmers' Productive Age	Unproductive	Less productive	Productive
		Energy Adequacy Rate	<70%	70-80%	>80%
		Skills Improvement Training	Never	1-2 times in a year	> 3 times in a year
		Cultivation Technology Knowledge	Do not know CBIB	Knows CBIB but does not apply it well	Know and apply CBIB well
		Budikdamber cultivation experience	≤ 1 year	1 - 2.5 years	≥ 2.5 years
		Fishing labor time	<5 hours/week	5-10 hours/week	>10 hours/week
5	Social Capital	Non-fishery labor time	<50 hours/week	50-75 hours/week	>76 hours/week
		Participation of community group members	Low	Moderate	High
		Existence of community groups and level of influence on social networks	Low	Moderate	High
		Level of community conflict	Low	Moderate	High
		Local wisdom, norms, applicable laws	Does not exist	Exists but not applicable	Exists and applies
		Institutionalization of community groups	Does not exist	Exists but not applicable	Exists and applies

Source: ( Purwanti *et al.*, 2022; Tjahjono *et al.*, 2022; Purwanti *et al.*, 2024b).

The evaluation of the sustainability of the catfish *budikdamber* business is conducted by specialists using a questionnaire that assesses five capitals. Each indication of the five capitals is assigned at a score ranging from 1 (poor) to 3 (excellent). The higher score signifies that the catfish *budikdamber* business is in a favorable state. The

analysis step involves the process of analyzing data or information (**Kavanagh & Pitcher, 2004**):

1. Multi-Dimensional Scaling (MDS): The MDS analysis is used to identify the spatial arrangement of favorable and unfavorable locations in the ordination technique.
2. Monte Carlo (MC): Monte Carlo analysis assesses the impact of random errors included when estimating the value of the ordination being utilized.
3. Leverage: Leverage analysis to identify the sensitive attributes within each sustainability component that contribute to the growth of the measured index, specifically natural, financial, physical, human, and social resources.
4. The evaluation of goodness of fit in MDS analysis is performed using the S-stress value and the coefficient of determination ( $R^2$ ). A low S-stress value signifies a favorable match (**Fauzi & Anna, 2005**). A model is considered satisfactory or almost satisfactory if the analysis yields an S-stress value below 0.25 ( $S < 0.25$ ), and the  $R^2$  value is close to 1 (100%) (**Pitcher, 1999**).

In addition, the study was conducted using the rapfish software tool. The sustainability state of the Indonesian catfish *budikdamber* business was evaluated, and the results are presented in Table (2). The sustainability status is categorized into four groups: no, less, enough, and sustainable.

**Table 2.** Sustainability status categories

Index value	Category
0 – 25	Unsustainable
>25 – 50	Less sustainable
>50 – 75	Moderately sustainable
>75 – 100	Sustainable

Source: (**Pitcher & Preikshot, 2001**)

## RESULTS AND DISCUSSION

Various parameters, including dissolved oxygen levels, pH, and ammonia content, are crucial factors to be taken into account when assessing the impact of natural capital on the well-being and development of the catfish (**Setyono *et al.*, 2023**). During the raising phase, the water quality measures in natural capital were found to be within the acceptable range. The natural capital parameters produce an average water temperature of around 27-31°C, a pH value of between 6.8-7.2, dissolved oxygen of around 5 – 6mg/ l, and ammonia of 0.5-1.0mg/ L. The mean water temperature during the raising period varied between 27-31°C and remained within the typical range. The pH value recorded during maintenance varied between 6.8 and 7.2, which falls within the usual range. This has been verified by SNI.6484.1, 2000. The optimal temperature range for the catfish growth is typically between 25 & 30°C, with a pH range of 6.5-8.5 and a minimum

dissolved oxygen level of 4mg/ L. Moreover, the concentration of dissolved oxygen was between 5-6mg/ l, which falls within the normal or sufficient range. The ammonia levels obtained were between 0.5-1.0mg/ L, which is considered to be relatively high. The acceptable range for ammonia levels is less than 1mg/ L. This is in conformity with research carried out by **Rachmawati et al. (2015)**, namely with an ammonia value of 0.01mg/ L.

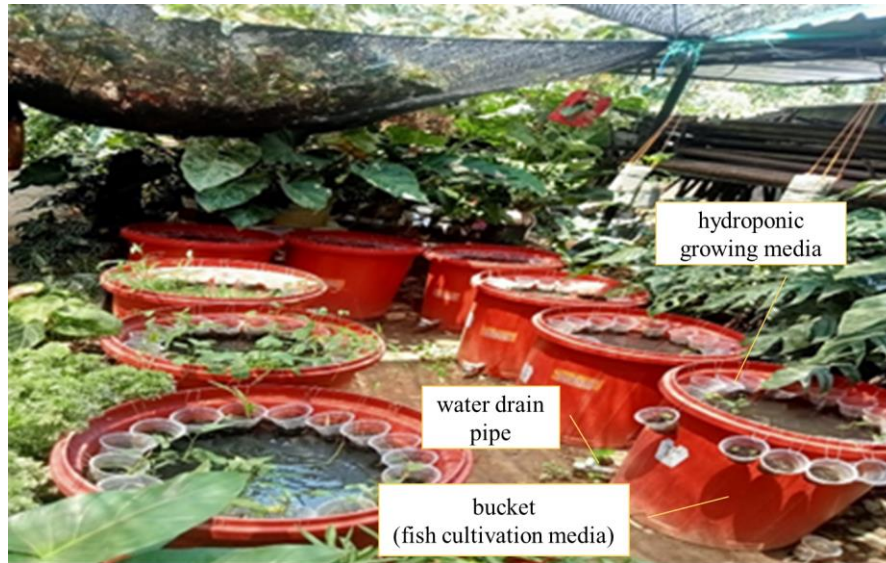
The maximum growth rate observed during the raising period was 96 grams. The length growth was precisely 27cm. The duration of the growing process ranges from 75 to 90 days, depending on the desired weight at the harvest of the fish. The feeding frequency is twice daily, with a quantity of 20 grams each time. This is in agreement with SNI.6484.1, 2000. The feed utilized consists of produced pellets, specifically kinds 781-1, 781-2, and 781-3. The feeding regimen is tailored to accommodate the size of the fish. According to the collected results, group 1 had the highest fish survival rate at 75%, while group 6 had the lowest rate at 55%. **Scabra and Setyowati (2019)** conducted a study that identified two feeding techniques that impact the growth and water quality of culture media. Providing fish with a high amount of food can result in maximum growth. Conversely, the cultivation media's water quality deteriorates more rapidly as a result of metabolic waste, leading to a negative impact. Conversely, if the quantity of feed is modest, fish growth will be sluggish, but the water quality can be maintained at a satisfactory level for an extended duration.

Financial feasibility study is a component of business planning that seeks to ascertain the viability of a business (**Anandya et al., 2023**). Optimal water quality yields profitability indicators such as an R/C ratio of 2.98, profits amounting to Rp. 6,665,467, BEPs valued at Rp. 512,687, BEPu of 26 Kg, and a profitability rate of 174%. The financial feasibility parameter yields an NPV value of Rp10,660,120, an IRR of 22%, a B/C of 1.41, and a payback period of 1.4 years. These profitability and financial feasibility metrics show that *budikdamber* cultivation is both profitable and viable. Furthermore, the catfish *budikdamber* business exhibits low sensitivity to fluctuations in operating costs and reduced profits. In scenario 1, costs increase by 40% and benefits fall by 47.8%. In scenario 2, costs increase by 63.3% and benefits decrease by 40%. In scenario 3, costs increase by 183%. Lastly, in scenario 4, benefits decrease by 61.2%. This aligns with research conducted by **Purwanti et al. (2024a)**, *Budikdamber* catfish business demonstrates profitability and financial feasibility based on the factors.

Aquaculture provides a significant role in the fisheries sector, exhibiting annual growth in production (**Anandya et al., 2023**). The catfish *budikdamber* production process at Poklahsar Bankid Sejahtera operates in a manner consistent with the standard flow of *budikdamber* production. Nevertheless, there are multiple phases in the manufacturing process that encounter an issue, specifically in the container preparation, medication administration, and water drainage. An error occurs during the container preparation stage when receiving information. The pertinent information is that the



*budikdamber* container is prepared by thoroughly cleansing the bucket three times. Subsequently, the bucket is filled with water and left undisturbed for a duration of three consecutive days. Nevertheless, there exists a cultivator who allows the water to remain in the bucket for a mere duration of 2 days. The administration of the cultivation business encompasses several stages, including preparation, technical assembly of fish equipment, feeding management, water quality control, and harvest management. The cultivation media contained in the catfish buckets is depicted in Fig. (1).



**Fig. 1.** Catfish *budikdamber*

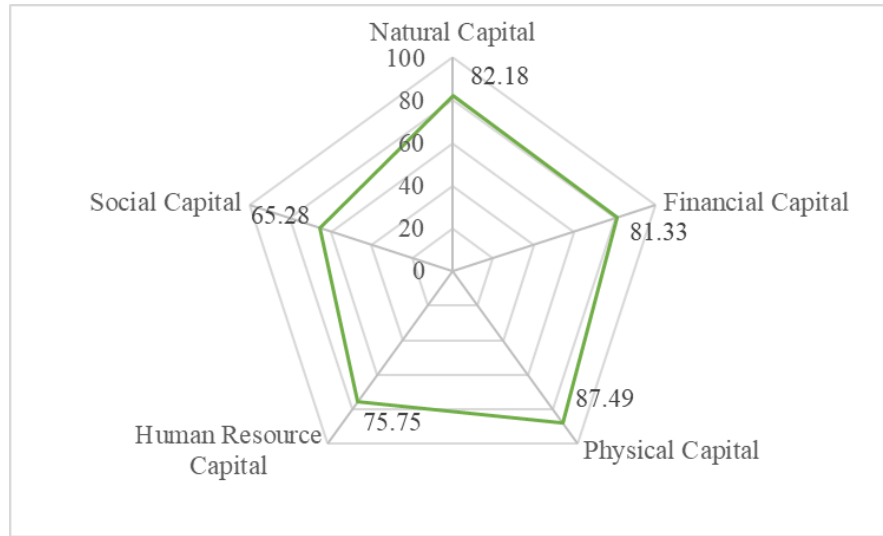
Labor time in fisheries refers to the duration of time dedicated to cultivation activities. As stated by **Asmaida and Rogayah (2020)**, the cultivation work time is divided into five categories based on the activities involved. These activities include pond preparation (equipment preparation, fertilizing, water filling). The cultivation activity that requires the greatest work time per week is feeding, with an average of 0.61 hours of work per week. Feeding, which must be done twice a day in the morning and evening, requires the highest amount of work time compared to other activities. The activity with the lowest average weekly labor time is seed stocking, which amounts to 0.26 hours of effort each week. The duration of the *budikdamber* activity is governed by various elements, including fishery revenue, family dependents, age, education level, experience, and the number of buckets owned. Aside from the time spent on fisheries-related labor, cultivators also have other occupations unrelated to fisheries. The combined weekly work time for non-fisheries cultivators amounts to 188.125 HOK. The occupation with the highest work time value per week is that of a driver, with a work time value of 10.5 hours per week. Retired workers and unemployed workers spend the least amount of time working per week, with both groups having 0 hours of labor.

The cultivation of the catfish in families in Poklahsar Bankid Sejahtera can serve as an indicator of food security circumstances. This can be determined by assessing if their



consumption meets 80% of the recommended calorie intake rate of 2,150 kcal per capita per day. The analytical results of the distribution of households of catfish *budikdamber* cultivators based on energy uptake are as follows: According to reports, 50% of catfish *budikdamber* farmer households in Poklahsar Bankid Sejahtera have an energy adequacy rate (EAR) that is considered insufficient. This is because the EAR value is less than or equal to 80% of the recommended energy adequacy level of 2,150 kcal/kap/day. This can be taken as indicating that 50% of the total households engaged in cultivation, or up to 15 household groups, have an energy uptake that is deemed sufficient, reaching or above 80%. This suggests that these households fall into the category of food security. The catfish cultivators in Poklahsar Bankid Sejahtera have a low food share, accounting for 70% of the spending of 21 households. 30% of the leftover amount is classified as a significant proportion of food. A high proportion of food expenditure indicates that a smaller portion of overall spending is allocated to meeting food demands, in comparison to the allocation of spending for non-food items. The majority of catfish grower households in Poklahsar Bankid Sejahtera are classified as being in the food security category. Consequently, households engaged in cultivation have a minimal proportion of their budget allocated to food expenses and an adequate intake of energy. A low expenditure share indicates that farmer households are able to sufficiently cover their food requirements, allowing them to allocate a portion of their expenditure towards non-food necessities.

The significance of sustainability states that if the value is closer to 100, then the level of sustainability is improving. Conversely, if the value is closer to 0, then the level of sustainability is deteriorating. The sustainability status of catfish farming households using the *budikdamber* approach is measured based on five SLA sustainability capitals. Among these capitals, the physical capital has the highest value of 87.49, while the human capital has the lowest value of 65.28. The multimodal average yields a sustainable result of 78.41, as depicted in Fig. (2). The multimodal value shows that the *budikdamber* catfish cultivation business managed by Poklahsar Bankid Sejahtera is not experiencing problems, but it still needs to be repaired and improved to achieve an optimal level of sustainability.



**Fig. 2.** Multidimensional sustainability of catfish *Budikdamber* farming business

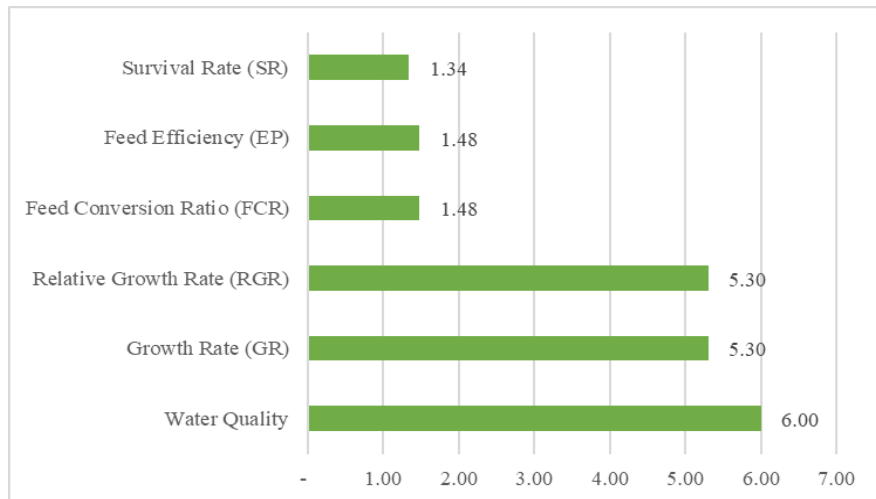
### Prioritization of catfish culture business sustainability

Every species of fish has a unique tolerance for specific water quality characteristics. Consequently, it is necessary to implement water quality control in the cultivation media. The selection of suitable culture media is a crucial factor to be taken into account when conducting the fish cultivation procedure. The growth and survival of cultivated aquatic organisms depend heavily on the water quality of the cultivation container. This includes factors such as the source of water used, as well as various physical, chemical, and biological parameters. Therefore, it is essential to have knowledge and understanding of water quality management in order to ensure optimal conditions for these organisms.

In addition to being influenced by ambient conditions and maintenance media, fish growth is also affected by factors such as fish genetics and the feed delivered throughout the maintenance process. Growth is the augmentation in the weight of fish that occurs during the maintenance period. The achievement of optimal fish weight gain is indicative of the success of fish farming, since it demonstrates the effectiveness of feeding practices and the preservation of the growing environment. Effective water quality management is essential in fish farming media. This is to ensure the attainment of success in fish farming endeavors (Scabra *et al.*, 2022).

Natural capital refers to the primary kind of capital considered when striving to maintain the equilibrium of natural resources and the environment through the implementation of catfish farming, with the aim of achieving sustainability. The study defines natural capital as comprising six components: fish survival rate (SR), feed use efficiency (EP), feed conversion ratio (FCR), relative growth rate (RGR), absolute

growth rate (GR), and water quality. The graphic displays the outcomes of the sustainability leverage analysis of natural capital, which identifies the most influential components.



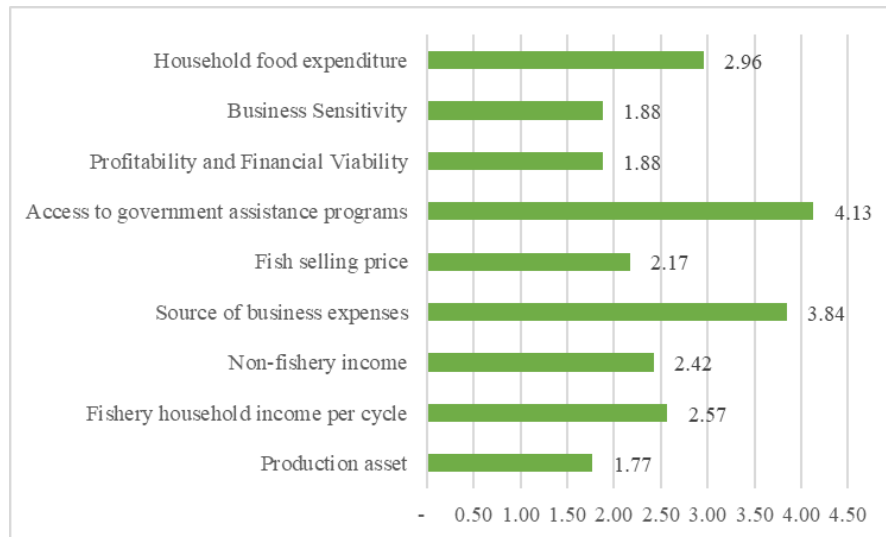
**Fig. 3.** Leverage of natural capital

According to Fig. (2), the sustainability level of natural capital in the catfish *budikdamber* business application in Poklahsar Bankid Sejahtera is 82.12%. This indicates that the indicator is classified as very sustainable. Regarding the key factors that significantly impact the sustainability of natural capital in the catfish *budikdamber* industry at Poklahsar Bankid Sejahtera, three crucial components are water quality, relative growth rates, and absolute growth rates. The study conducted at 6.003 identifies water quality as a highly relevant and sensitive aspect of sustainability. This phenomenon is supported by empirical evidence, which indicates that the quality of water has a direct impact on the survival, growth, and productivity of fish. Poor water quality in the catfish culture chamber will adversely impact the growth rate, both in relative and absolute terms, ultimately leading to mortality. Furthermore, the cultivators in Poklahsar Bankid Sejahtera lack sufficient water quality assessment equipment, resulting in a lack of regular monitoring. Consequently, they simply engage in the customary practice of changing water once a week without doing any formal checks. According to **Harahap *et al.* (2023)**, water quality is a critical factor in the success of catfish cultivation. Several studies emphasize the importance of water quality in catfish farming systems. The quality of water directly affects the growth and survival of catfish.

Fish weight is calculated at each growth stage to determine the fish growth rate. Whereas the fish's genetic makeup, the food they consume, and their comfort levels in relation to water quality management can all contribute to their rapid development rate. The addition of fish weight to each growth offers a measure of an aquaculture business's performance in managing water quality and providing the best possible nutrition. Fish growth is impacted by both internal and external variables. Internal parameters include

age, sex, and heredity, which are all connected to the fish's internal health. External elements are those that have to do with the fish's surroundings, specifically the feed and water quality (Karimah, 2018).

Related to the financial resources, the farmer commonly rely on personal fund, pengamba, KUB and cooperative institutions (Intyas *et al.*, 2018). Financial capital refers to the capital associated with the economic advantages of establishing and maintaining a catfish farming business in order to ensure its long-term viability. The study defines financial capital as comprising nine components: household food expenditure, business sensitivity, profitability and financial viability, access to government assistance programs, fish selling prices, sources of business costs, fishery and non-fishery household income, and production assets. The image displays the outcomes of the sustainability leverage analysis, which assesses the impact of financial capital on various components to identify the most relevant ones.



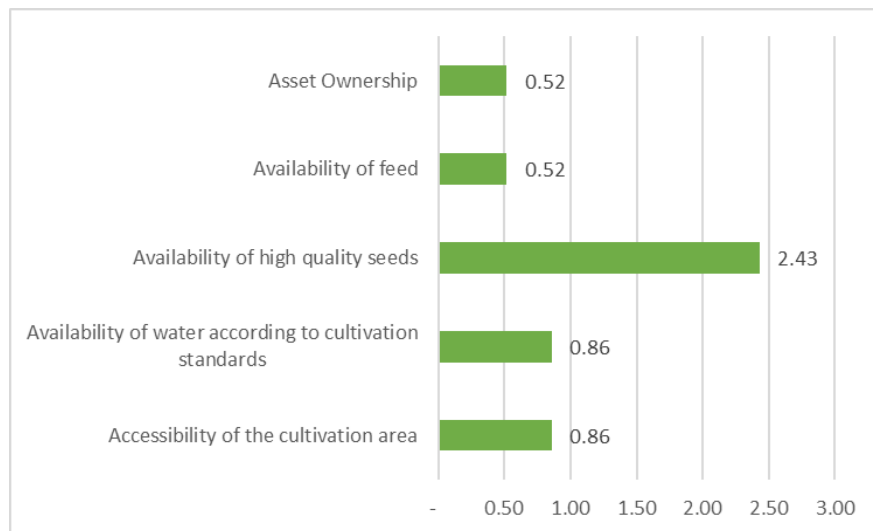
**Fig. 4.** Leverage of financial capital

According to Fig. (2), the financial capital sustainability level in the implementation of the catfish *budikdamber* business at Poklahsar Bankid Sejahtera is 81.33%. This indicates that the indication is rated as highly sustainable. The key factors that significantly impact the sustainability of financial capital in the catfish *budikdamber* business at Poklahsar Bankid Sejahtera (Fig. 4.) are access to government assistance programs, business costs, and fishery household income. The availability of government support programs is a crucial and delicate aspect of sustainability in this study, with a significance level of 4.131. Direct interviews with the head of Poklahsar Bankid Sejahtera confirm that the *budikdamber* business began with the socialization efforts of the Food Security and Fisheries Office (DKPP) of Kediri City. Additionally, this government agency provided assistance in the form of cultivation buckets and fish seeds. Having easy access to government support will be advantageous for obtaining financial

resources to sustain business operations. According to **Dama (2024)**, access to government assistance is crucial for the development of micro, small, and medium enterprises (MSMEs). Government support programs are designed to empower MSMEs by providing facilities, guidance, and strengthening assistance to enhance their competitiveness.

Farmers typically rely on loans and personal funds as the primary sources of business expenses. The two types of business led to a divergence in fisherman household income, both for personal use and to repay the loan. Furthermore, the level of revenue that fisheries households allocate for their own food consumption expenses. If there is a decrease in the allocation of fisheries income for personal use in the form of small food, it will have an impact on the food security of aquaculture households. According to a study conducted by **Umaru *et al.* (2021)**, it is suggested that the catfish farming enterprises can be supported by implementing measures such as offering low-interest loans and promoting the formation of cooperatives to enhance economies of scale.

Physical capital refers to the tangible assets used in the catfish cultivation industry that contribute to its ongoing sustainability. The study defines physical capital as comprising five components: asset ownership, feed availability, quality seed availability, water availability according to cultivation standards, and simple accessibility to production areas. Fig. (5) displays the outcomes of the sustainability leverage analysis of physical capital, which identifies the most influential components.

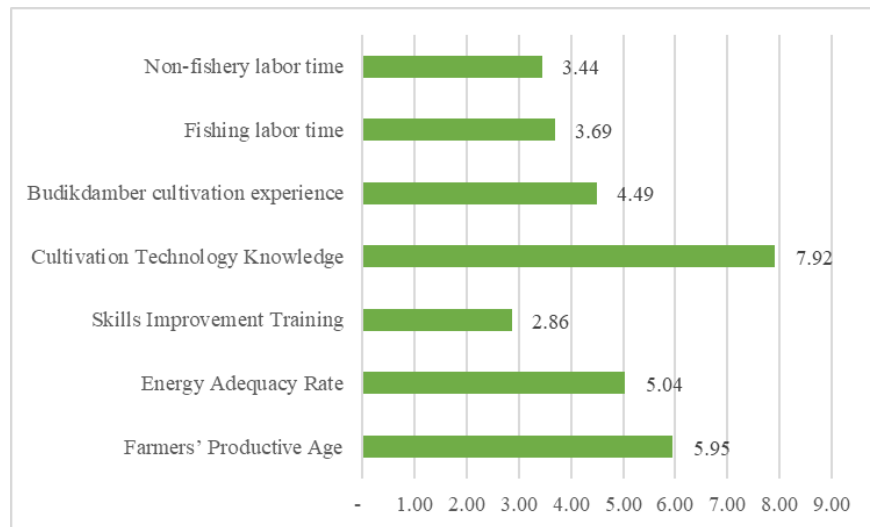


**Fig. 5.** Leverage of physical capital

Fig. (2) demonstrates that the level of sustainability in the catfish *budikdamber* business application at Poklahsar Bankid Sejahtera is 87.49%. This indicates that the business is very sustainable. Regarding the key factors that greatly impact the sustainability of physical capital in the catfish *budikdamber* business in Poklahsar Bankid Sejahtera, three crucial components stand out (Fig. 5): The presence of high-quality

seeds, the availability of water that meets cultivation standards, and the convenient accessibility of cultivation sites. In this study, the presence of high-quality seeds is identified as a crucial factor for sustainability, with a significance level of 2.428. Direct observation and interviews conducted in the research location provide a clear evidence that the cultivation of fish seeds has a significant impact on the resulting yield. Thus, the catfish farmers in Poklahsar Bankid Sejahtera employ high-quality catfish seeds of the pearl catfish variety sourced from Sukabumi, West Java. The seeds of this fish species exhibit a high level of resistance to the prevailing conditions and possess a sluggish disposition, enabling them to readily acclimate to their surroundings. According to **Wang *et al.* (2022)**, the utilization of high-quality catfish fingerlings exhibiting enhanced development rate, survival rate, and carcass output has exerted a notable influence on the practice of catfish farming, resulting in heightened production efficiency and profitability. The flexible habitat requirements of various fish species necessitate the utilization of water that conforms to aquaculture regulations. Farmers are required to ensure that the water they give or utilize meets aquaculture standards, which includes having water flow that is freely available. The cultivation site offers ample space and convenient access.

Human capital is a form of capital that plays a crucial role in determining the productivity of the catfish *budikdamber* business, ensuring its long-term sustainability. The study defines human capital as comprising seven components: The allocation of working time in both fisheries and non-fisheries, experience in *budikdamber* cultivation, understanding of cultivation technology, training to enhance skills, energy sufficiency rate, and the productive age of cultivators. Fig. (6) displays the outcomes of the sustainability leverage analysis of human capital, which identifies the most influential components.



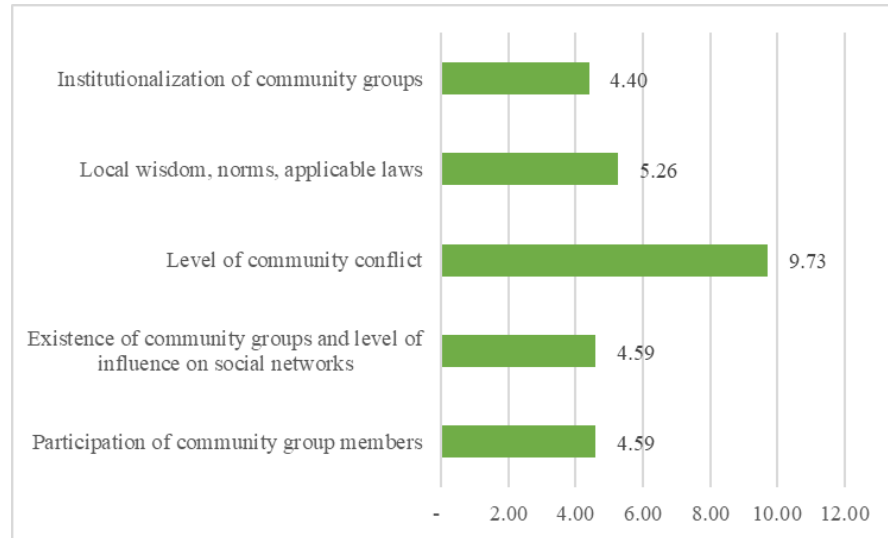
**Fig. 6.** Leverage of human resource capital

The sustainability level of operating a catfish *budikdamber* business in Poklahsar Bankid Sejahtera is 65.28% (Fig. 2.) indicating a relatively high degree of sustainability. The key factors that significantly impact the sustainability of human capital in operating a catfish culture business in Poklahsar Bankid Sejahtera (Fig. 6) are the knowledge of cultivation technique, the productive age of cultivation, and energy sufficiency. The understanding of agricultural technique is a highly significant and delicate aspect of sustainability in this study, with a value of 7.919. An individual's knowledge serves as the foundation for their ability to engage in both novel and familiar cognitive processes. The progression of time continues to bring up advancements that are both beneficial and practical, one of which is the introduction of cultivation improvements using the *budikdamber* technique (fish farming in buckets). Hence, it is imperative for growers to possess expertise in this cultivation technology to ensure the long-term viability of the catfish *budikdamber* enterprise. According to research conducted by **Nahji *et al.* (2018)**, the distribution of working time is influenced by factors such as productivity, knowledge, and experience. The study found that experience has a favorable and significant impact on the allocation of working time. **Purwanti *et al.* (2023b)** explains that technology has become a stimulant for the community in utilizing fishery resources.

The age at which a person is most productive is a significant determinant of their ability to effectively absorb new knowledge or advances. Furthermore, the acquisition of knowledge is not only facilitated, but physical stamina is also required to effectively carry out tasks associated with the catfish breeding and farming endeavors. These findings align with the research conducted by **Fay *et al.* (2018)**, which suggests that as individuals grow older, their skills and knowledge tend to improve, resulting in a decrease in the amount of time they spend on cultivation activities. The quality of food consumed is one factor that can contribute to increasing physical strength. The food quality can be assessed by examining the rate at which farmers absorb energy from the food they consume.

Social capital refers to the value derived from the interactions and connections between individuals and social institutions within a given society. Social change is more or less determined by how massive technology impacts society (**Intyas *et al.*, 2022**). Social capital refers to the value derived from the interactions and connections between individuals and social institutions within a given society. In the context of the catfish farming, it encompasses the relationships between farmers and government agencies, which are crucial for the long-term viability of the business. The study defines social capital as comprising five components: community group institutions, local wisdom, norms and applicable laws, the level of community conflict, the presence of community groups and their level of influence on social networks, and the participation of community group members. The outcomes of the sustainability leverage analysis on social capital, which identify the most influential elements, are displayed in Fig. (7).





**Fig. 7.** Leverage of social capital

Fig. (2) indicates that the level of sustainability in implementing the catfish *budikdamber* business in Poklahsar Bankid Sejahtera is 75.75%. This suggests that the social capital in this endeavor is highly sustainable, yet it is approaching the threshold of being sufficient. The key factors that significantly impact the sustainability of social capital in implementing catfish culture businesses in Poklahsar Bankid Sejahtera (Fig. 7) are community conflict levels, adherence to local wisdom, norms, and applicable laws, and the presence of community groups and their influence on social networks. In this study, the level of community conflict is identified as a very relevant and sensitive factor in determining sustainability, with a value of 9.727. Considering the circumstances in the field, it is inevitable that the catfish farming business will generate waste in the form of fish excrement resulting from cultivation. Effective waste management is essential to prevent any adverse impacts or disputes in the cultivation site ecosystem. The community strife in Poklahsar Bankid Sejahtera is intricately linked to the catfish culture industry. **Purwanti *et al.* (2021)** elucidated that the availability of conflict handling mechanisms through collaboration between local governments and community monitoring groups is expected to resolve conflicts of interest. **Farid *et al.* (2024)** added the explanation that conflicts that occurring in fisheries businesses due to misunderstandings, non-compliance with applicable regulations or business activities that damage the environment.

Hence, it is imperative for every grower to be mindful of the indigenous knowledge, customs, and regulations that are applicable to the cultivation site in order to avoid any potential disputes with the neighboring community. The presence of community groups, such as Poklahsar Bankid Sejahtera, is seen as a significant factor in enhancing social networks. The presence of these community groups is crucial as they help develop social networks and prevent conflicts within the cultivation location.

Monte Carlo analysis is employed to assess the impact of random errors made in estimating the ordination value. Monte Carlo analysis is a valuable tool for examining the

impact of attribute scoring errors, data entry problems, or missing data (**Kurniawan *et al.*, 2016**). The Monte Carlo analysis indicates that the sustainability status of catfish farming families using the *budikdamber* technique is comparable to the results obtained from the rapfish MDS analysis. The Monte Carlo analysis in this study was repeated 25 times, yielding minimal variations in the results. The analysis did not reveal any significant differences, indicating that the ordination determination successfully mitigated random errors caused by discrepancies in attribute scores assigned by different researchers or data entry mistakes. Therefore, it can be inferred that the research on the sustainability of the catfish *budikdamber* business is based on a sound and an accurate model.

**Table 3.** Comparison of multidimensional scaling with Monte Carlo and goodness of fit for sustainability of catfish farming businesses

Capital	MDS	MC	Reduction (MDS-MC)	Stress	R <sup>2</sup>
Natural	82.18214	82.18213	0.00000748	0.125487	0.9169
Financial	81.33198	81.33199	0.00000519	0.125028	0.91538
Physical	87.4857	87.4836	0.00209950	0.154593	0.94685
Human Resource	65.28448	65.28449	0.00000885	0.139968	0.93578
Social	75.74636	75.74638	0.00001524	0.144705	0.94284

The precision of the rapfish multidimensional scaling analysis is defined by the S-Stress value obtained from the calculation of the S value. Low S-Stress levels imply a great accuracy, or a strong goodness of fit, whereas high S-Stress values suggest the opposite, or a weaker goodness of fit. In the context of rap-beachtour, a model is considered good if its S-Stress value is less than 0.25 (<25%), and its coefficient of determination (R<sup>2</sup>) value is close to 1.0 or 100%. Conversely, if the S-Stress value is higher than 0.25 or 25%, the accuracy of the multidimensional scaling (MDS) calculation results is low (**Suwarno *et al.*, 2011; Fattah *et al.*, 2023b**). The S-stress value of the five sustainability capitals indicates outcomes that are less than or equal to 0.25, with a squared correlation value that is close to 1.00 or falls within the range of 0.90 to 0.95. Therefore, it can be inferred that all the features utilized in the investigation of the sustainability of the catfish farming with the *budikdamber* approach are effective in elucidating the five dimensions that were examined.

## CONCLUSION

*Budikdamber* catfish is an aquaculture practice that involves using bucket media to conserve land and enhance the consumption of nutrients from residual feed and metabolism. The sustainability rating of the multimodal catfish *budikdamber* business is inside the sustainable category, as it achieves a value of 78.41%. The primary focus in enhancing the sustainability of human resources lies in capital, specifically the understanding of cultivation technology for operating a catfish *budikdamber* business, as well as social capital, with an emphasis on mitigating community conflict. Recommendations for this study include providing training and technical support to cultivators to enhance their understanding of cultivation technology. This will ensure the long-term viability of the catfish *budikdamber* business and will create sustainable economic opportunities for the community. In addition to reducing community strife, we aim to enable the local community to engage in the catfish *budikdamber* commercial operations and to promote the management of cultivation wastewater preventing environmental damage.

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