AN INITIAL STUDY ON THE SUSTAINABILITY OF CLOWN KNIFE FISH (*Chitala chitala* Hamilton, 1882) IN FISHERY LIVELIHOODS IN THE MEKONG DELTA: A CASE STUDY IN AN GIANG PROVINCE

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ABSTRACT

This study was conducted to assess the sustainability of Clown knife fishery's livelihood through a survey of 364 individuals related to the fishery. The survey employed a questionnaire with a Likert 5-point scale for assessing factors related to livelihood sustainability. A total of 25 observed variables were considered, which evaluated the sustainability of Clown knife fishery as follows: (i) 4 observed variables on sustainability, (ii) 10 observed variables on the ability to ensure livelihood, and (iii) 11 observed variables on career development opportunities. The results indicate that the livelihood strategy of Clown knife fishery in An Giang province is generally evaluated at a high level, with scores ranging from 3.27 to 3.85. These scores suggest that the fishery adequately meets the living needs of households engaged in fish adoption. In terms of sustainability, the results demonstrate that Clown knife fish farming is capable of ensuring the livelihood of fish farmers, with ratings ranging from 3.55 to 4.07. Furthermore, it creates opportunities for career development, which helps meet the sustainability requirements of the aquaculture industry, with scores ranging from 3.82 to 4.24. The research results contribute to supplementing the scientific basis in researching and developing Clown knife fish fishery in An Giang province in the period of climate change.

BƯỚC ĐẦU TÌM HIỂU MỨC ĐỘ BỀN VỮNG CỦA SINH KẾ NGHỀ NUÔI CÁ NÀNG HAI (*Chitala chitala* Hamilton, 1882) Ở ĐỒNG BẰNG SÔNG CỬU LONG: NGHIÊN CỨU ĐIỂN HÌNH TẠI TỈNH AN GIANG

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TỪ KHÓA

Đảm bảo sinh kế
Đánh giá bền vững
Cá Nàng hai
Chiến lược sinh kế
Nuôi trồng thủy sản

TÓM TẮT

Nghiên cứu này được thực hiện nhằm tìm hiểu mức độ bền vững của sinh kế nghề nuôi cá Nàng hai thông qua khảo sát 364 người có liên quan về các yếu tố bền vững sinh kế thông qua khảo sát bằng bảng hỏi với thang đánh giá Likert 5. Tổng cộng 25 biến quan sát đánh giá về tính bền vững của nghề nuôi cá Nàng hai bao gồm: (i) 4 biến quan sát về mức độ bền vững; (ii) 10 biến quan sát về khả năng đảm bảo cuộc sống; (iii) 11 biến quan sát về cơ hội phát triển nghề. Kết quả cho thấy, về cơ bản chiến lược sinh kế nghề nuôi cá Nàng hai ở tỉnh An Giang được đánh giá ở mức cao với điểm đánh giá từ 3,27 đến 3,85, đáp ứng được nhu cầu sinh sống của hộ dân nuôi cá. Về mức độ bền vững cho thấy nghề nuôi cá Nàng hai có khả năng đảm bảo được cuộc sống hộ dân nuôi cá (điểm đánh giá dao động từ 3,55 – 4,07) và tạo ra cơ hội phát triển nghề nghiệp đáp ứng được sự bền vững trong ngành nuôi trồng thủy sản (điểm đánh giá từ 3,82 – 4,24). Kết quả nghiên cứu được góp phần bổ sung cơ sở khoa học trong nghiên cứu phát triển nghề nuôi cá Nàng hai tại tỉnh An Giang trong giai đoạn biến đổi khí hậu.

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1. Introduction

An Giang, as the upstream province of the Mekong River, benefits from a thriving fisheries sector with a remarkable annual growth rate of about 8-9% [1]. With the diverse and abundant fishery system in An Giang province, aquaculture development has thrived, leading to an annual seafood export turnover of over USD 280 million. This exceptional advantage highlights the region's potential. However, in order to ensure effective and sustainable utilization of the aquatic system, it is crucial to invest in comprehensive research, conservation, farming practices, exploitation, and conservation. Among the 236 freshwater fish species found in the area, more than 50 species are considered to possess high economic value [2]. Notably, Clown knife fish (*Chitala chitala* Halminton, 1822) (*C. chitala*) stands out as a species with significant potential for aquaculture development in the region [3]. *C. chitala* exhibits large size, rapid growth, delicious meat, adaptability to anoxic conditions, suitability for high-density culture, and a wide range of feed options [4]–[6]. Consequently, *C. chitala* has become a popular choice for cultivation in the Mekong Delta.

Simultaneously, Vietnam has been identified by the World Bank (2010) as one of the five countries with the most vulnerable and unsustainable livelihoods due to the severe impacts of natural disasters, storms, floods, and rising sea levels resulting from climate change. Among the affected occupations, aquaculture is particularly vulnerable. To address these challenges, the Vietnamese government issued Decision 1445/QD-TTg on August 16, 2013, approving the Master Plan on Fisheries Development until 2020, with a vision for 2030. This plan emphasizes the need for sustainable fisheries development, aiming to improve living standards and increase income for farming households while ensuring harmonious relationships with other industries in terms of benefits. By addressing the four pressing issues faced by Vietnam today as climate change, resource depletion, environmental pollution, and unsustainable production and consumption plan strives to provide solutions [7], [8].

Livelihood encompasses the capabilities, resources, and activities necessary for individuals to sustain their lives [9]. Sustainable livelihoods have a comprehensive meaning that encompasses various aspects such as providing basic human needs, ensuring food security, practicing sustainable agriculture, and reducing poverty [9]. The sustainability of a livelihood is demonstrated through the following elements: (1) the ability to adapt and recover from shocks or changes; (2) not relying solely on external support; (3) maintaining the long-term productivity of natural resources; and (4) not adversely affecting other livelihoods [10]. Despite the recent strong development of *C. chitala* fishery in An Giang, there is a scarcity of basic information concerning *C. chitala* farming. Therefore, this study was conducted to investigate the sustainable livelihood characteristics of *C. chitala* fishery in An Giang province. The research findings will contribute to the scientific knowledge base for the research and development of *C. chitala* fishery in An Giang province.

2. Methods

2.1. Scale construction

The present study employs a 5-level Likert scale ranging from 1 to 5, representing "Strongly disagree," "Disagree," "Neither agree or disagree" "Agree," and "Strongly agree" respectively, to assess the level of agreement among the survey participants regarding the observed variables. The average scores of the observed variables are presented in Table 1.

Table 1. *Observed variables employed in the present study*

No	Variable	Explaination	References
Sustainability of *C. chitala* fisheries livelihood strategies			
1	ST1	The aquaculture industry develops stably, in the long term, has the ability to adapt and recover from shocks or mutations arising.	[9] – [12]

No	Variable	Explaination	References
2	ST2	Capable of self-balancing resources, developing based on input resources, not depending on outside support.	
3	ST3	Capable of conserving resources, maintaining long-term productivity of natural resources for future generations.	
4	ST4	Ensure social justice, farming activities are not invasive, harming other livelihood resources.	
Capable of ensuring the sustainability of *C. chitala*'s livelihood outcomes			
5	CE1	Farming helps households meet basic consumption needs at a good level.	[9], [10], [13], [14]
6	CE2	Farming households have a certain amount of savings, in case of risks.	
7	CE3	Households feel satisfied with their present life, no worries or insecurities about the future.	
8	CE4	Income per capita meeting new rural standards (from 59 million/year, equivalent to 5 million/month).	
9	CE5	Have standard housing, not temporary, dilapidated houses.	
10	CE6	Children can study, have conditions to raise children to finish high school (high school).	
11	CE7	Get good medical care, afford basic medical services.	
12	CE8	Farming households have conditions and time to exercise and exercise. Healthy lifestyle, no use of addictive substances such as drugs, alcohol,…	
13	CE9	A nutritious diet, the family has no children with malnutrition and rickets.	
14	CE10	There is no risk of serious diseases, occupational accidents, exposure to toxic substances.	
Career development opportunities in *C. chitala* fish farming livelihood outcomes			
15	CD1	Enjoy many development priority policies from the government, for example loan incentives, price subsidies, tax reductions.	[9], [10], [13] – [15]
16	CD2	Have the right to access resources, buy or rent land, expand the legal farming area.	
17	CD3	There is no restriction in exploiting and using natural resources such as water, food, and energy.	
18	CD4	Have the opportunity to receive technical training, skills training to improve farming better.	
19	CD5	Farming is less likely to suffer from reduced yields and incomes due to crop failures, devaluations, and trade and technical barriers.	
20	CD6	Less risk of shrinking farming area due to sea level rise causing salinization, flow blocking, drought, landslides.	
21	CD7	Less risk of losing markets due to dependence on export markets and pressure from international organizations.	
22	CD8	Satisfies the requirement of high protein conversion ratio because the cultured animals use feed with low protein ratio (for example, plants, organic humus, ...).	
23	CD9	Meet the requirements for sustainable use of water and environment. The culture system requires little water change, and the cost of water supply for the farming system is low. The amount of excess nutrients from food, solid waste of the outflow water is equivalent to the intake water.	
24	CD10	Satisfies the requirement of using a balanced lime.	
25	CD11	Meeting the requirements of efficient use of energy, the cost accounts for no more than 30% of the total production cost.	

2.2. Survey methods

This study involved surveying 364 individuals in An Giang province who possessed knowledge about the subjects and fish farming of *C. chitala*. The information regarding the survey participants within the scope of the study is presented in Table 2.

Table 2. *Demographic characteristics*

Individuals characteristics	Number (n)	Frequency (%)
Sex		
Male	289	79.40
Female	75	20.60
Age		
Under 25 years old	83	22.81
From 25 to under 45 years old	210	57.69
From 45 to under 60 years old	45	12.36
Over 60 years old	26	7.14
Occupation		
Fish framing	210	57.70
Businessman	12	3.30
Fisherman	100	27.47
Manager, support and technical consultant	22	6.04
Researcher, teacher	20	5.49
Work experience		
Under 5 years	103	28.30
From 5 to under 15 years	246	67.58
From 15 to under 25 years	10	2.75
Over 25 years	5	1.37

2.3. Statistical analysis

The collected data were processed using SPSS 26.0 software to calculate the mean score of the observed variables in the sample set, which are measured on a Likert scale. The data of observed variables of each group were tested. The one-way ANOVA with a significant level of 5% ($p < 0.05$) was used to compare the mean values at each observed variable. These analyses were performed on the SPSS statistical software to test the significant difference at probability $P < 0.05$. All data were presented as mean ± standard deviation (SD).

3. Results and discussion

3.1. Sustainability of C. chitala fisheries livelihood strategies

The survey results on the sustainability of *C. chitala* fisheries livelihood strategies in An Giang povince are presented in Figure 1.

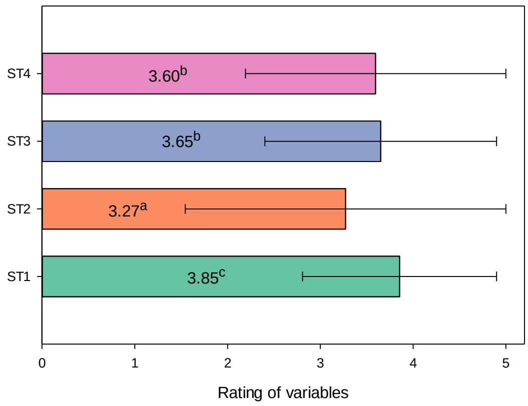

Figure 1. *Rating of assessment of C. chitala fisheries livelihood strategies (ST). Values are Mean ± SD, different letters indicate significant differences between variables (p < 0.05).*

The survey results indicate that *C. chitala* farming is evaluated as meeting the sustainability criteria for a livelihood, as expressed by the majority at level 4, with scores ranging from 3.27 to 3.85 in the observed variables. The first factor discussed in the study is the resilience of farming, which refers to the ability to return to equilibrium after events such as natural disasters, global pandemics, or civil unrest [16], [17]. Additionally, the following factors do not rely on external support: maintaining long-term productivity of natural resources and avoiding harm to other livelihoods [10], [11]. Based on the survey findings, *C. chitala* farming in An Giang fully satisfies these requirements.

3.2. Capable of ensuring the sustainability of C. chitala's livelihood outcomes

Figure 2 displays the data regarding the capacity to ensure the sustainability of *C. chitala*'s livelihood outcomes in An Giang province.

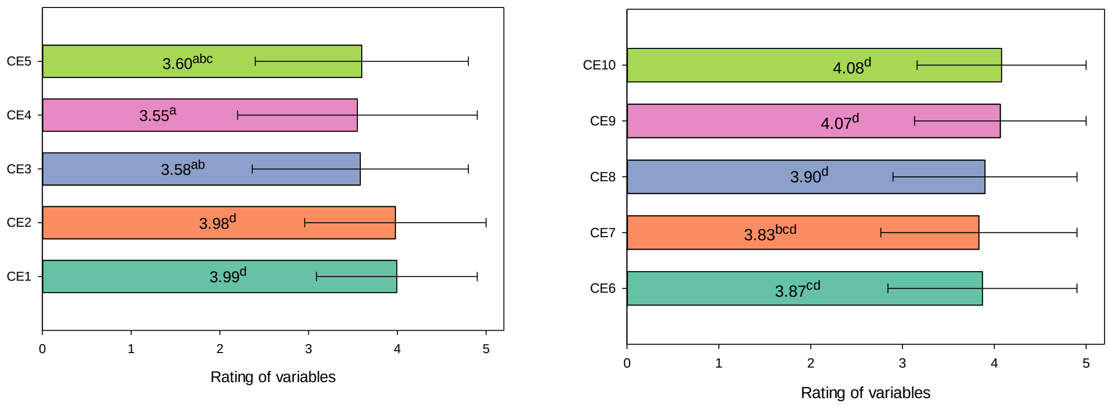

Figure 2. *Rating of assessment of capable of ensuring (CE) the sustainability of C. chitala's livelihood outcomes. Values are Mean ± SD, different letters indicate significant differences between variables (p < 0.05)*

The majority of these variables received ratings of 4 and 5, with scores ranging from 3.55 to 4.08. The present results demonstrate that *C. chitala* fish farming holds promising potential for ensuring the livelihood of fish farmers. The observed variable with the highest value is CE10, which indicates "There is no risk of serious diseases, occupational accidents, exposure to toxic substances". Research of Le (2009) on livelihood outcomes in the Mekong Delta also revealed that 95.6% of farming households have favorable conditions to enhance their children's education, while 93.3% of farming households receive full medical care [18]. On the other hand, the observed variable with the lowest value is CE4 "Income per capita meeting new rural standards (from 59 million/year, equivalent to 5 million/month)". These findings bear similarities to the study conducted by Mondal et al. (2012), which reported that 88% of survey participants agreed that sustainable aquaculture livelihoods contribute to improving socio-economic conditions among farming households [18]. Specifically, such livelihoods help increase food production, enhance social status, improve living conditions, ensure access to education for children, and provide adequate healthcare. However, Le (2009) found that it is worth noting that 27.1% of impoverished households or those affected by crop failure and loss of income expressed the belief that they lack sufficient funds to improve their meals and healthcare as desired due to the low productivity of their production system [19]. For semi-subsistence farmers, aquaculture may not significantly contribute to improving the living conditions of the majority of rural individuals [15].

3.3. Career development opportunities in C. chitala fish farming livelihood outcomes

The survey results concerning the career development opportunities in *C. chitala* fish farming in An Giang are illustrated in Figure 3.

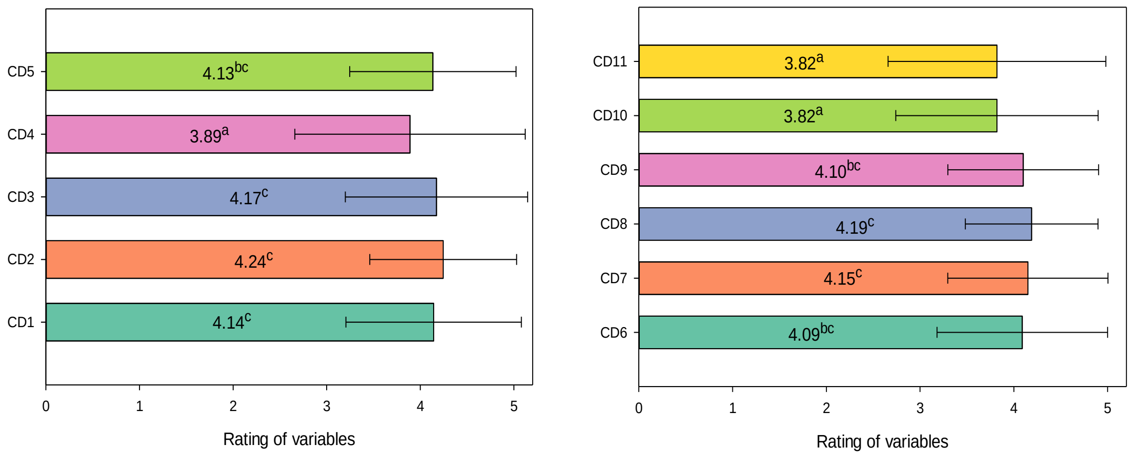

Figure 3. *Rating of assessment of career development (CD) opportunities in C. chitala fish farming livelihood outcomes. Values are Mean ± SD, different letters indicate significant differences between variables ($p < 0.05$).*

The observed variables in this study received ratings of 4 and 5, with scores ranging from 3.82 to 4.24. The present study indicates that *C. chitala* farming holds significant potential for sustainable development. Among the variables, CD4 received the highest rating of 4.24. This aligns with the findings of Patrick and Kagiri (2016), 93.2% of respondents agreed that with adequate training in knowledge and skills, farming can ensure sustainable farming outcomes [20]. Conversely, the underrated variable in the study is CD2, which received a rating of 3.89 because Vietnam's agricultural production is increasingly reliant on non-renewable energy sources, and the utilization rate is projected to increase eightfold from 2005 to 2025 [8]. As the population grows, energy reserves are depleting, and instead of being an exporter, Vietnam may need to import coal, oil, and gas in the coming decades. This situation will raise input costs and reduce the income of approximately half of the population directly involved in agricultural production in Vietnam. Therefore, the efficient use of energy in agricultural production is one of the commitments Vietnam has made at the Rio+20 conference, in line with the global pursuit of sustainable development [8].

The observed variables related to factors of food, environment, and energy used for fish farming (CD8 – CD11) were evaluated with scores ranging from 3.82 to 4.19. According to Patrick and Kagiri (2016), feed costs make up 40-70% of total farming expenses [20]. Ogello et al. (2013) argue that reducing feed costs by leveraging the organic resources available in ponds can help farmers increase profits [21]. Apart from cost reduction, the utilization of organic resources also holds significant ecological importance. Nguyen and Le (2020) emphasized that factors namely feed quantity, culture density, lime powder usage, water exchange in the pond, and organic matter oxidation play a crucial role in the production of CO_2 and CH_4 in *C. chitala* ponds [22]. Balancing the use of lime by farming households is essential for the long-term sustainable development of the profession, as the current overuse of aquaculture resources is causing serious problems. Martinez-Cordova et al. (2009) have highlighted that widespread alkalosis of topsoil, resulting from aquaculture abuse, severely impacts agricultural viability [23]. The lowest rated variable, with a score of 3.82, is PT11. Vietnam has a land area of 33,120,000 hectares, ranking 58th among the world's agricultural producing countries. However, due to widespread pollution, the available farming area per person is only 0.11 hectares, ranking 159th globally, which accounts for 1/6 of the world average. Concerningly, this ratio is shrinking due to various factors, including loss of arable land caused by saltwater intrusion, erosion, changes in physicochemical properties due to alkaline, acidic, saline, and alum intrusion, discoloration, heavy metal pollution, agrochemicals, and desertification [8].

The use of water in *C. chitala* farming and its contribution to environmental sustainability are highly valued for their role in promoting aquaculture development while minimizing environmental pollution, which has become a significant concern due to the overload on natural water basins. Findings from a study conducted by Le et al. (2009) in the Mekong Delta, Vietnam, indicate that 20% of untreated shrimp farming wastewater is directly discharged into the surrounding environment [18]. Furthermore, the expansion of aquaculture in freshwater and brackish water areas in our country has reached its limits, resulting in degradation and decline in some brackish water farming regions. The vulnerability survey conducted by Brugere (2015) in six aquaculture areas worldwide reveals that the Mekong region faces the highest risks of vulnerability, including shrinking farming areas and rising sea levels [14]. Similarly, the sustainable livelihood outcomes of farming households in the coastal area of Nam Dinh are directly affected by vulnerability risks such as drought, storms, floods, temperature rise, sea level rise, and saline intrusion [23]. Additionally, aquaculture households currently face threats namely (1) crop failure and income loss due to market instability, (2) occupational safety risks at sea, (3) loss of farming areas, and (4) international trade and technical barriers [9].

4. Conclusion

Research results indicate that, according to 364 survey respondents, *C. chitala* farming in An Giang province generally achieves a sustainable level of livelihood development. The variables used to assess the sustainability of the *C. chitala*'s livelihood strategy ranged from 3.27 to 3.85. Overall, the livelihood strategy of *C. chitala* fishery received high evaluations, with observed variables scoring between 3.55 and 4.07 in terms of their ability to ensure people's well-being. Furthermore, the assessed variables related to the potential for developing *C. chitala* fishery ranged from 3.82 to 4.24.

To comprehensively evaluate the aquaculture industry's overall performance in relation to *C. chitala* farming in An Giang province, future research should explore various aspects such as inputs, outputs, institutions, policies, habits, and practices. Analyzing these factors will enable the application of the SWOT model to provide a comprehensive assessment of the aquaculture industry.

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