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Challenges in Developing Aquaculture for Livelihood Enhancement in Bo City, Southern Sierra Leone

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ABSTRACT: *The study investigated socioeconomic characteristics, aquacultural practices and constraints among smallholder fish farmers in the study location of Bo City, Southern Sierra Leone. The present study employed a survey research design. The smallholder farmers who were growing food for themselves, for sale, and for consumption by others as well as those who were primarily growing it for the market were each given 40 questionnaires in total. The results revealed that most of the respondents were male (90.0%), married (60.0%), lacked training in fish farming (57.5%) and the household income of most (60.0%) ranged from NLe600-NLe1,000. The farmers mostly opined low fish farming experience (70.0%), Semi-intensive fish farming (67.5%), low aquaculture development (57.5%), predominantly seasonal fish pond irrigation (77.5%). All of the respondents' view fish farming as an economically viable enterprise as well as a profitable (87.5%) entity. The mean rank of constraints was significantly ($p \leq 0.006$) differed among fish farmers. The key fish farming constraints included culturing fish, fish feed in culturing fish, less interest, fewer fish farmers, high inputs, high cost of fish pond construction and intensive capital investment that could be exploited for improved productivity. The outcomes of these recent studies imply that fish farmers should receive training and funding for their operations to improve their competitiveness in their smallholder fish businesses as well as in the local and international aquaculture industries. Also, the governments and other practitioner authorities ought to implement policies and initiatives that would support fish farming activities, further research development in aquaculture, the development of the nation, and the fish farmers themselves.*

KEYWORDS: smallholder aquaculture, household consumption, fish farming constraints, Bo city, Sierra Leone.

INTRODUCTION

Globally, aquaculture has gained greater momentum in recent years in saving the world's increasing population in the global food security crisis, particularly with the emergence of Covid 19 and Russia Ukraine invasion in providing food. Aquaculture will gain more ground in the development of hungry nations, especially in this period of crisis when it is considered a priority in solving the world food crisis by providing protein, economic development, and other essential nutrients for humans for healthy population growth in the world.

Despite the significance of this sector in the world, developing nations like Sierra Leone have not fully realized the great potential of the sector due to the inherent challenges and constraints in developing it, such as feed, improved varieties of seed, aquaculture infrastructure, and many others, which farmers in Bo City projected as cumbersome issues affecting the development of the sector. However, Sierra Leone's population has increased faster since the end of the rebel war, with an estimated 7.5 million people now living below the poverty line, according to the World Bank (2016).

Notwithstanding the numerous difficulties in developing aquaculture in the country, Seawright Mining Company in Sierra Leone stands out to provide the first modern recirculating aquaculture system at Njala University, which has begun, and other areas in Kono in order to boost aquaculture production in the country, with the help of the government and other non-governmental organizations, which have been relentlessly fighting to boost aquaculture in the midst of all arising challenges.

However, despite the government's and other donor partners' efforts to develop aquaculture in Sierra Leone, its citizens have yet to reap the full benefits experienced in other countries. Aquaculture production in Sierra Leone is still seen as a form of subsistence system, as many people rely on marine-captured fisheries, thereby putting more pressure on the sea for fish and other aquatic products. This has also been a major problem in the country, especially during the closure period of August to October of every year, as the country will be more dependent on the importation of ice fish at high prices to ease the burden of this rapidly growing population. Many aquaculture projects have been implemented at the university and ministry levels in recent years, but their impact was not felt in most areas of the country until they stopped operating. Most investors will want to go into aquaculture considering all the available raw materials such as suitable land, available water, feed ingredients, etc., but there is a lack of a fish feed mill industry and improved broodstock and fish seed unless formulated feed is imported into the country from Ghana or Nigeria, as the case may be. The Worldfish project at Makeli was responsible for giving aquaculture incentives to farmers such as fingerlings and fertilizers and in turn obtained the raw materials from farmers such as cassava, rice bran, and cowpea, but this project also folded out due to mismanagement. As of now in the country, formulated fish feed and fish seed are issues, as this

was established to investigate these issues and their impact on the livelihood enhancement of people in the study location.

The aquaculture industry in Sierra Leone is crucial for the food basket and addressing concerns about food security because a large portion of the population needs fish in their daily diets. Fish is very important in the meals of Sierra Leoneans, and due to its low cost, the majority of them cannot cook without it for more than a day or two. Fish also appears to be crucial for a healthy population as it contains omega-3 fatty acids, which are beneficial to the body and improve daily life and human function in numerous ways.

Every nation takes pleasure in having a healthy and functional populace because it promotes greater productivity and development. Sierra Leone has all it takes to turn the bad phases of aquaculture production around if only the challenges are overcome. As a result, this study will identify all the key problems that have an impact on aquaculture productivity in the region under review and will offer guidance to practitioners like funders from both the public and private sectors. As a result, the goal of the current study is to determine the difficulties and ascertain how aquaculture practices would affect the growth of aquaculture as a means of improving livelihood.

METHODOLOGY

Description of Research Location

The study location Bo City is well known for its successes in the business, especially for the gari product from cassava, on which many Sierra Leoneans depend for their livelihood. It is also recognized as an educational center, having one of the historical schools known as Bo Government Secondary School (in the past for paramount chief children), and the economic center of Southern Sierra Leone, as it has a total population of 22,3075 and the district has a total population of 756,975 (Bo population statistics, 2023). Recently, the city has gained some infrastructural attention in the areas of a good road network interconnecting one place to another and the hosting of the Njala University campus of the Paramedical School of Community Health Sciences and Towama. The city lies approximately 160 miles (250 km) east-southeast of Freetown and about 44 miles to Kenema, and is the principal home of the Mende people, who form the plurality of the city's population (https://www.britannica.com/place/Bo-Sierra-Leone). Bo. Other major towns include Baoma, Bumpeh, Serabu, Sumbuya, Baiima, and Yele.

The climate of Bo City is like any other place in the south: it comprises of two main seasons, dry and rainy. The dry season is characterized by the harmattan, a hot, dry wind that blows from the Sahara, and relative humidity may be as high as 90% for considerable periods. It also experiences an upper temperature of 70 °F (mid-20 °C) and a low temperature of about 27°C in low-lying coastal areas (https://www.britannica.com/place/Bo-Sierra-Leone).

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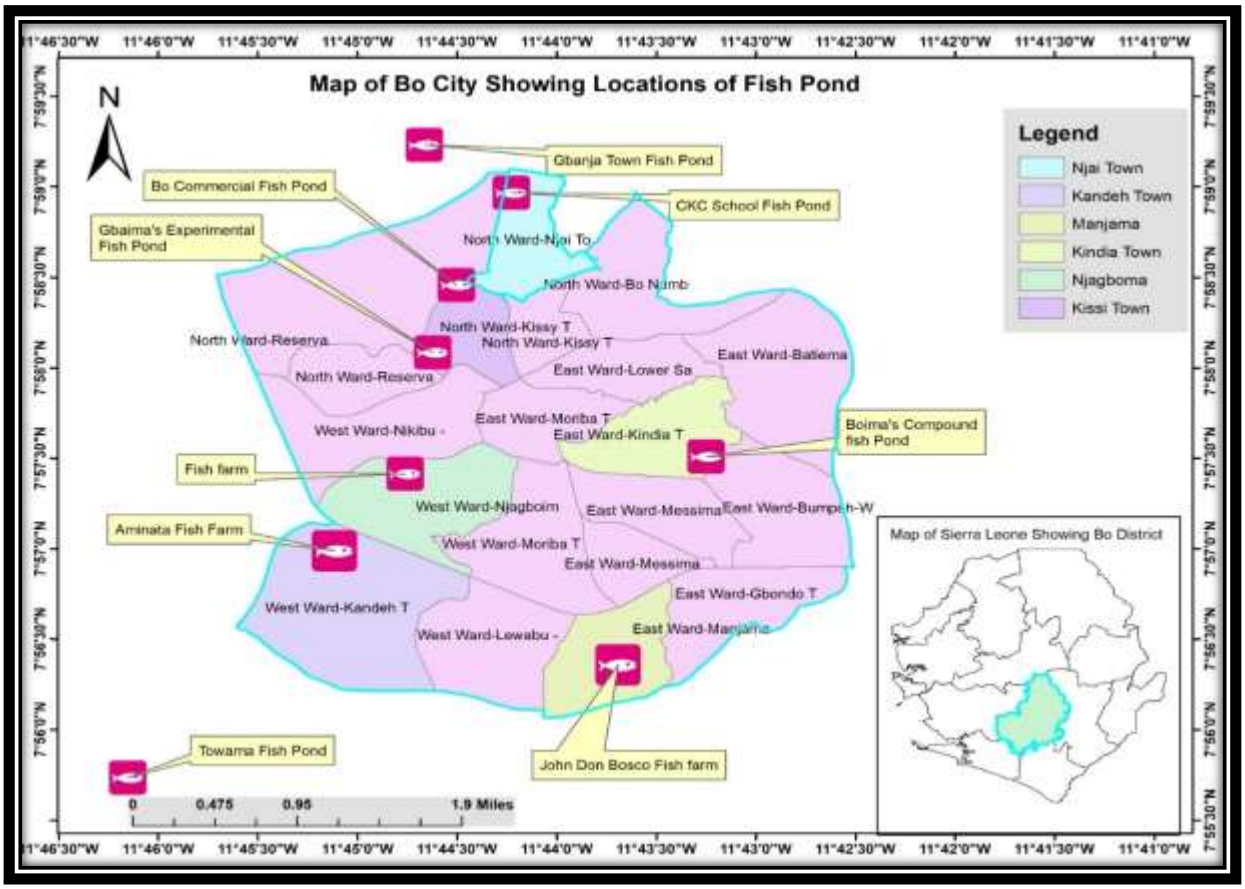

Figure 1: Map of the study area

Data Collection and procedures.

The document evaluation regarding secondary data sources, official documents and scientific publications were consulted to learn more about fish production inputs and output, problems, opportunities or benefits, socioeconomics, and the growth and sustainability of aquaculture. Information on fish farmers was also gathered from the seven earthen fish pond locations in Bo town, where there were eight (8) fish farmers per location and 40 fish farmers overall. From past dissertation work of other students in the library were consulted and conclusions served as a reference for creating a questionnaire for gathering field data, as well as for gathering data from farmers about sample selection and farm accessibility, all of which were entered into the KOBO COLLECT APP.

This current research survey adopted purposive sampling techniques in which respondents engaged in fish farming or related activities were identified based on the pond fish farming operation in all the selected locations in the study area, whether active or inactive. The

identification of the respondents in the study area was based on their engagement in fish farming and related activities. The inactive are selected to know the challenges faced by the fish farmers that led to the closure or discontinuity of fish farming, and the active are selected to know the aquaculture status in study location development.

The closed-ended questions that were entered into a mobile app called KOBO Collect Tool Box were utilised as the primary data sources to gather information from respondents. The questionnaires were entered into the mobile tablets, the staff received training on how to correctly grasp the questions, and one-on-one interviews with respondents were conducted in Krio, the local language, for them to provide their responses, which were afterwards translated and transcoded. However, the research targeted eight (8) fish pond sites in Bo City engaging in fish farming, which resulted in an overall number of 40 respondents engaged in fish farming activities.

Data Analysis

The Statistical Package for Social Scientists (SPSS), 16th version, was used to examine the qualitative and quantitative data (Carver and Nash, 2009). Also, descriptive statistics, such as frequencies and percentages, were used to present the results. Using Kendall Concordance Analysis (Kendall and Smith, 1939), data on the ranking of limitations for fish producers was studied. The most to least influential constraints and farmer preferences were identified and ranked using the Kendall's Coefficient of Concordance statistical procedure, and the degree of agreement or concordance among the respondents on the ranking of constraints and preferences was also measured. The identified preferences were ranked using a Likert scale, which uses the numbers (1, 2, 3, 4.... N) to score them from most to least desired. The factor with the lowest score was ranked as the most preferred or the greatest constraint, while the factor with the highest score was ranked as the least desired. The mean rank score for each preferred character or constraint was determined. The coefficient of concordance (W), which assesses the degree of agreement among the respondents in the rankings, was then determined using the overall rank score (Kendall, 1945). The following relationships were used to estimate the coefficient of concordance:

$W = \frac{12[\sum T^2 - \frac{(\sum T)^2}{n}]}{nm^2(n^2-1)}$ (Kendall and Smith, 1939)

where W is the Kendall's value, N is the sample size, and R is the rank's average.

Thus m is the number of respondents (fish farmers), n is the number of elements being ranked, W is the coefficient of concordance, and T is the sum of the ranks of the factors being ranked. The W's relevance in relation to the F distribution was examined.

The F-ratio is given by

$F = \frac{(m-n)\times(1-W)}{(1-W)}$ …… (2) (Kendall and Smith, 1939) with numerator and denominator degrees of freedom being $(n-1)-(\frac{2}{m})$ and $m-1[(n-1)-\left(\frac{2}{m}\right)]$, respectively.

The null and alternative hypotheses of this study were stated as follows: H_0: There was no agreement between the respondents on the ranking of the factors; H_1: There is agreement between the respondents on the ranking of the factors.

RESULTS AND DISCUSSION

Socioeconomic characteristics and perceived knowledge on fish farming

The results in Table 1 display the findings about the socioeconomic characteristics of the pond fish producers in Bo City. The findings revealed that most (90.0%) of the fish farmers are male, whereas 10.0% of them were female. Majority of the respondents are at least 46 years old (55.0%), with 6-10 dependents (45.0%) family size. It was also established that the majority of the respondents (60.0%) were married, while 37.5% and 2.5% were single and separated, respectively. The majority of the fish pond farmers or respondents who were involved in fish farming had stabilised, were entitled to societal respect, and had a sense of responsibility, according to their marital status. The fact that the respondents are married may indicate that they are trustworthy and have earned respect in their community. Each household member helps the others with farming tasks and other household responsibilities related to fish pond farming activities. Marriage is extremely important in farming communities because most farmers rely heavily on their families for labour, especially the women engaged in selling farm products.

The level of education and religion of most of the respondents are secondary education (35.0%) and Christianity (70.0%), respectively, with 47.5% of them occupied with farm care. These findings indicate that both higher numbers of young and older people are involved in fish farming. The results imply that aquacultural knowledge could be transferred from the older generation to the younger generation. According to Rahman (2008), farmers in their 40s are enthusiastic and have a lot of good effects on crop and animal production. The result also projected that only 10.0% of respondents had no formal education, whereas the majority (35.5%) had a secondary education, followed by primary school (30.0%) (Table 1). However, the majority (57.5%) of the respondents had no formal training in fish farming. This finding indicates training needs for the high proportion of smallholder fish farmers. Bala et al. (2010) claimed that illiteracy was a major barrier to institutional support for agriculture, while Nyagaka et al. (2010) found that education had a favourable association with agricultural efficiency and productivity. The annual household income of most (60.0%) of the respondents in the studied communities ranged from NLe600-NLe1,000 (New currency) compared to only 1 person who received more than NLe1600. The findings on household income indicate that fish farming and trading contribute to the stabilization and buffering of the household economic livelihood of smallholder fish farmers. Therefore, any

risk exposure to agriculturally susceptible people, along with slight climatic fluctuations and political unrest, can have a negative impact on household food security and create economic imbalances.

The majority of responders said they had not received any outside funding (82.5%) and that the trade of fish products provided them with most of their income instead (100%) (Table 2). The majority (70.0%) of the respondents interviewed have taken 1-5 years in the fish farming business, while only 1 (2.5%) of them have spent more than 10 years. The semi-intensive fish farming method is predominantly (67.5%) utilized by the farmers. Income accrued from business is mainly expended on income and food (50.0%), followed by aquaculture (25.0%) and lowest on school (5.0%). Findings also showed that the majority of fish farmers (57.5%) agreed that aquaculture has not yet developed to its full potential in the nation, as the percentage of respondents who don't realize that aquaculture is a risky practice was the largest (37.5%), followed by the percentages of those who agree, strongly disagree, and disagree (27.5%, 22.5%, and 12.5%, respectively) (Table 2). The results indicate that the sampled population is not well-experienced in fish farming. This indicates that future interventions and planning in aquaculture should strongly feature more young people and encourage fish farmers, processors, markers and other relevant stakeholders, including the government, to increase funding for increased production and productivity.

Table 1. Demographic attribute of respondent

Variables	Proportion	Percent
Gender		
Female	4	10.0
Male	36	90.0
Age (years)		
35 years	8	20.0
36-45 years	10	25.0
≥46 years	22	55.0
Family size		
1-5 dependents	17	42.5
6-10 dependents	18	45.0
Above 10 dependents	5	12.5
Marital status		
Married	24	60.0
Single	15	37.5
Separated	1	2.5
Level of education		
No-formal	4	10.0
Primary	12	30.0
Secondary	14	35.0
Technical/vocational	5	12.5
University	5	12.5
Training in fish farming		
No	23	57.5
Yes	17	42.5

Occupation status		
Civil servant	5	12.5
Farm care	19	47.5
Farm head	3	7.5
Farm manager	1	2.5
Farming	11	27.5
Retired civil servant	1	2.5
Religion		
Christianity	28	70.0
Muslim	12	30.0
Monthly household income (NLe)		
Above 1600	1	2.5
1100-1500	8	20.0
600-1000	24	60.0
Below 500	7	17.5

Table 2. Perceived knowledge of funding source, expenditure, experience and risk in aquaculture

Parameter	Proportion	Percent
External source of funding		
None	33	82.5
Organization	7	17.5
Internal source of funding		
Alternative livelihood	0	0.0
Trading	40	100.0
Fish farming experience		
1-5 years	28	70.0
6-10 years	11	27.5
>10 years	1	2.5
Fish farming method		
Extensive	13	32.5
Semi-intensive	27	67.5
Cooperative society membership		
No	20	50.0
Yes	20	50.0
Expenditure		
Aquaculture	10	25.0
Food	8	20.0
Income and food	20	50.0
School	2	5.0
Aquaculture development		
No	23	57.5
Yes	17	42.5
Aquaculture development status		
Fast	4	10.0
Moderately	2	5.0
I don't know	23	57.5
Slowly	11	27.5
Aquaculture as a risky practice		

Agree	11	27.5
Disagree	5	12.5
Not sure	15	37.5
Strongly disagree	9	22.5

The most common cultured fish species in the studied area were tilapia and catfish (75.0%), tilapia exhibiting the most difficult species management (67.5%). The majority (77.5%) of farmers explore no formulated fish-feed pattern as they predominantly utilize premix local feeding techniques (75.0%) (Table 3).

Table 3. Perceived knowledge on fish species, management and disease outbreak

Parameters	**Proportion**	**Percent**
Most common cultured fish species		
Both tilapia and catfish farming	30	75.0
Tilapia farming	10	25.0
Specie management difficulty		
Both	8	20.0
Catfish	5	12.5
Tilapia	27	67.5
Fish formulated feed		
No	31	77.5
Yes	9	22.5
Type of local feed		
Premix	30	75.0
Termites and rice bran	10	25.0
Disease outbreak		
No	40	100.0
Yes	0	0.0

The majority of the land was owned by purchase (67.5%), whereas only a few (7.5%) obtained their land through communal for fish farming (Table 4). Majority (52.5%) of the respondents opined that the roads are structured, but untarred (50.0%).

The main source of water for irrigation is swamp (87.5%), which is dependent on rain-fed, while streams contribute 12.5%. The findings indicate that small area fish production and heavy dependence on rain-fed swamp irrigation make smallholder fish farmers more vulnerable to climate shocks, variability and change. These results are in line with the theory put forth by Apata et al. (2009) that smallholder farmers in semi-arid regions mostly engage in rain-fed farming and have limited access to irrigation systems, as smallholder farmers find it difficult to adjust to climatic shocks as they may not only affect the crop yield but have a greater influence on the economy's status. Furthermore, due to their poor educational backgrounds, low incomes, already degraded ecosystems, unsuitable institutions and primary healthcare, lack of markets, and lack of infrastructure (Osbahr et al., 2010), this will boost farmers efforts. The fish pond irrigation frequency is predominantly seasonal (77.5%).

The majority of the farmers (47.5%) revealed that households consume small quantities of fish. With regards availability of high-quality fingerlings, 62.5% strongly disagree with the notion, compared to the lowest of 5.0% of them that were not sure. All of the respondents view fish farming as an economically viable enterprise as well as a profitable (87.5%) entity. The majority of the studied fish ponds employed at most five workers (87.5%). These results highlight the nation's meager fish farming industry. Increased output and productivity could result from business expansion, providing greater prospects for employment for various parties involved in the value chain of fish products. This will create future sustainability in aquaculture, which gives farmers the energy to increase production.

Table 4. Perceived knowledge on land ownership, roads, water source, irrigation, consumption, employability and profitability

Parameters	**Proportion**	**Percent**
Land ownership		
No	13	32.5
Yes	27	67.5
Land tenure system		
Purchase	27	67.5
Communal	3	7.5
Lease	4	10.0
Rent	6	15.0
Structured road		
Yes	21	52.5
No	19	47.5
Road network		
Footpath	11	27.5
Tarred road	9	22.5
Untarred	20	50.0
Water source		
Stream	5	12.5
Swamp	35	87.5
Fish pond irrigation frequency		
Perennial	9	22.5
Seasonal	31	77.5
Household consumption of fish		
Almost all	10	25.0
Most of it	1	2.5
None	10	25
Small amount	19	47.5
Availability of high-quality fingerlings		
Strongly agree	25	62.5
Disagree	13	32.5
Not sure	2	5.0
Economic viability		
Agree	16	40.0

Strongly agree	24	60.0
Profitability		
Yes	35	87.5
No	5	12.5
Workers employed		
6-10 workers	5	12.5
<5 workers	35	87.5

Challenges faced by fish farmers in Bo district

Constraints of fish farming significantly ($p \leq 0.006$) differed among fish farmers with Kendall's coefficient value of 0.268 and value of 29.04. The means ranged from 1.0 for culturing fish to 2.8 for lack of knowledge and awareness. Findings reveal that the top seventh constraints of smallholder fish farmers include culturing fish, fish feed in culturing fish, less interest, fewer fish farmers, high inputs, high cost of fish pond construction and intensive capital investment. When evaluating the same sample, the level of correlation between the ordinal valuations provided by various appraisers is highlighted using Kendall's coefficient of concordance (W), which was adopted by the current research to ascertain the challenges encountered by fish farmers in the study location. Additionally, it shows the proportion between the total rank variability for the ranked entities and the maximum rank variability that can be achieved. The results of this study suggest that fish farmers generally agree on the ranking of the challenges they confront, as evidenced by Kendall's W=0.268.

Table 5. Mean and rank values of challenges faced by fish farmers in Bo district, southern Sierra Leone

Challenges	Mean	Rank
Culturing fish	1.0	1
Fish feed in culturing fish	1.5	2
Less interest	1.8	3
Less fish farmers	1.9	4
High inputs	2.1	5
High cost of fish pond construction	2.2	6
Intensive capital investment	2.3	7
Predators	2.4	8
Government policies	2.4	8
Poaching	2.4	8
Improved fish seed	2.5	9
More focus on marine fish than farmed fish	2.5	9
Lack of incentives	2.6	10
Lack of knowledge and awareness	2.8	11
P value**	0.006	
Chi-square	29.04	
Kendall's W[a]	0.268	

[a] W=Kendall's coefficient; **significant ($P< 0.01$). Source: Field survey 2018

CONCLUSIONS

This study identified aquacultural practices, fish production constraints and management strategies of smallholder fish farmers in Bo City, southern Sierra Leone that could be exploited for increased productivity and income levels of farmers. Findings established significant concordance among fish farmers about production constraints. The study detected key constraints including culturing fish, fish feed in culturing fish, less interest, fewer fish farmers, high inputs, high cost of fish pond construction and intensive capital investment that could be exploited for improved productivity.
The following recommendations can be drawn from the study's findings:

Elite aquacultural approaches aimed at enhancing productivity, livelihoods, and raising the revenue levels of fish farmers must be developed or made more widely known.
Indigenous knowledge system-based aquacultural practices, production constraints and mitigating measures of fish farmers should be considered in developing climate change support and interventions targeted at empowering farmers and other relevant stakeholders with the capacity to withstand challenges encountered in their fish farming activities.
Smallholder fish farmers should be motivated to adopt climate-smart agricultural technologies by creating an enabling environmental environment for adaptation.
The government should also fund a program for skill audits of smallholder fish farmers so that these farmers may transition from subsistence to commercial farming.
Governmental and non-governmental entities should look at aquaculture as a food source while addressing the nation's food security problems.
For the development of aquaculture, funds and initiatives need to be prioritized or given attention.
Universities should set up training facilities for fish farmers in rural areas, and the provinces should receive sub-hubs for fish farms because the necessary raw materials are more easily accessible and less expensive there.
To prevent white elephant projects, government-funded projects should be closely supervised.
To strengthen this industry, funds for research should be made available to researchers.

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