Willingness of marine artisanal fishermen to integrate aquaculture in enterprise mix: Evidence from Ghana

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Abstract

Marine resources are depleting, making the dependence of economies on fish from such sources no longer the best option. Aquaculture has been suggested as an alternative livelihood. This study assesses the willingness of marine artisanal fishermen in the coastal region of Ghana to adopt aquaculture. The Effutu municipality in the central region of Ghana was purposely selected for the study. A multi stage cluster sampling procedure was used to randomly select150 artisanal fishermen from two communities in the coastal area of the district. Data was collected using semi structured questionnaire. The study employed the Binary Logit model to assess the influence of technical, socioeconomic and institutional factors on the decision to integrate the aquaculture enterprise into household enterprises of fishermen. The results of the study showed that about62 percent of the marine fishermen were willing to adopt and integrate aquaculture into their enterprise mix. The Logit estimation results reveal that fishermen who lacked savings, had difficulty in accessing credit, did not belong to fishermen's association, and were new in marine fishing were more likely to be convinced about integrating aquaculture. There is potential for marine fishers to explore and use aquaculture to enhance their wealth. The study recommends that targeting marine fishers who are youthful and inexperienced for training and capacity building is the best policy option for stakeholders who are interested in aquaculture development.

Key Words: Marine artisanal fishermen, aquaculture, enterprise mix, Binary Logit Model, Ghana

1. Introduction

Fishing is an important economic activity in Ghana. It provides a source of dietary protein,and a range of livelihoods to a large number of households. Fish makes up about a fifth of Ghanaian food budget. In livelihood terms, fishing engages hundreds of people as fishermen, fish traders and fishing boat builders in Ghana (EPA, 1994).As part of its contribution to the Ghanaian economy, the fisheries sector contributed 4.2 percent to agriculture's contribution toGDP in 2008 (ISSER, 2008). Fish and sea foods isthe biggest contributor to non-traditional agricultural exports; it earned US48.1 million dollars out of the total US151

million dollar for agriculture in 2009 (ISSER, 2010). In 2008, fish/sea foods accounted for 32.52 percent of the total foreign exchange earnings from the non-traditional agricultural sub-sector (ISSER, 2008).

Artisanal fishing is a small-scale fishing activity in which wood dug-out canoes are used, and usually lands smaller quantities of fish than the large-scale commercial fishing boats. Artisanal marine fisheries provide an essential source of sustenance, employment and financial well-being for coastal populations of developing countries. However, there is over exploitationof the resources of the sea due to the open-access nature of fisheries which together lead to resource degradation, poverty and marginalization. Evidence from the Ghana living-standards surveys (GLSS 4), which rely on expenditure levels, persistently revealed that coastal fishing communities in Ghana are among the poorest in the country (Koranteng, 2002).It is against this background that aquaculture is being suggested for promotion in coastal Ghana to enhance wealth of the artisanal fishermen.

Aquaculture implies a management intervention such as feeding and private ownership of the stock being farmed. Management interventions may increase yields beyond the level achievable by capture and fishing regulation alone and are referred to as "enhancements", for example, stocking of seed-fish and habitat creation or restoration. Thus, within the aquaculture itself, there are so many areas of investment that can be considered to enhance wealth. Some of the artisanal fishermen can invest in Fish feed production; Fingerling production; Pond or Cage construction; Filleting; Consulting services; Aquaculture nucleus farm out grower; in addition to the food fish production itself.

According to Moehl*et al.*, (2001), aquaculture operations range from small, backyard water gardens to energy-intensive, large commercial farms encompassing hundreds of hectares. There are studies of integration of aquaculture into crop farming, as in rice-fish farming, or in duck–fish ponds. It is also practiced as **polyculture**, where a variety of species occupying different ecological niches are cultivated together. Aquaculture involves many levels of intensity and complexity, from gravity-fed ponds with little or no inputs, to intensive systems that use aeration, supplemental feeds, antibiotics, and genetically modified species. Systems for rearing fish depend on the environment and the objective of the aquaculture operation. In the United States and worldwide, the most common rearing unit is the pond, although other types of units are also used: cages, net pens, flow-through raceways, and recirculation tanks. When the pen system is practiced, it must be moved periodically to reduce negative impacts of fish waste on substrate environments below the pen. The pond system also requires extra care about the water quality. Fish exhibits higher incidence of disease when the water quality is poor (Hillary, 1997). In addition, poor water quality often yields effluents (waste water and by-products) that can have negative environmental effects.

Nearly all African fish farming is carried out by small-scale rural operators in small fresh water ponds as a secondary activity to agriculture (Coche *et al*., 1994; Harison*et al.,* 1994). Extensive and Semi- intensive culture systems are developing, but they generally produce limited fish yields that are mostly consumed directly or sold locally. In many parts of Africa, large scale operations have either been heavily subsidized or have been aimed at providing for the labour force where fish produced is sold to the workers at subsidized prices (Delince and Obiekezie, 1996).

One crucial factor which cannot be left out in the discussion of aquaculture operation leading to wealth enhancing is the work of institutions. No business can triumph without institutional aid. There are government and non-governmental institutions that are responsible for training and other service provisions. Some of the NGO's and Government institutions such as the Ministry of Local Government and Rural Development provide extension services which are responsible for adult literacy surveys and training. Here, the fishermen are trained on new technologies and innovations in aquaculture.

The objective of this study is to determine the factors that will influence the willingness of marine fishermen to adopt aquaculture.

2. Methodology
This study relied on primary data source through structured questionnaires which was issued to the artisanal fishermen. Information from secondary sources such as the Fisheries Commission, scientific journals and other published and unpublished materials were also used.

2.1 Sampling and Interview Procedure
2.1.1 Selection of communities

According to the last Population and Housing Census of Ghana (GSS, 2000), the municipality had a population of 169,972, which represent 10.7% of the population of the Central region (GSS, 2000). The Municipal has 168 settlements.Winneba is the capital town of the Municipality. Some of the major communities are Kasoa / Senya Bereku, Bawjiase, Bontrase, and Jeikrodua. Only Winneba was selected for its accessibility; it is the capital of the municipality.

2.1.2 Selection of respondents
A sample size of 150 was used for the study. Purposive sampling was used to select two marine fishing areas, the main fishing community at Wineba and Akosuabicommunity. The main fishing community consists of about seven hundred artisanal fishermen. The Akosuabicommunity (also known as *Tweeho*) is a small fishing community with about fifty fishermen. Simple random sampling was employed to select respondents who were engaged in marine fishing. One hundred and twenty-five (125) respondents were selected from the main fishing community whiles twenty-five (25) respondents were selected from Akosuabi. The collection of qualitative and quantitative data was guided by a questionnaire. Some opinion leaders and members of associations were interviewed in a focus group.

2.1.3 Method of Data Analysis
Willingness to invest in aquaculture refers to the possibility of fishermen committing funds and engaging in fish farming. Since the situation is not what pertains now in Effutu Municipality, it is a probability concept. In this study, the willingness to invest in aquaculture was measured as the ratio of the number of willing respondents to the total number of respondents. In addition to the level of willingness, the factors that influence a person's willingness to adopt is measured using the Logit regression model.

2.1.4 Theoretical Framework of Willingness to Adopt
The adoption decision as explained by Temu (1999) is often characterized as a 2-stage process in which first priority is given to meeting food security requirements. The second objective is then to maximize income using the remaining resources. In such a situation a balanced model using both on-farm and off-farm for aquaculture may be needed for improved household welfare (Edwards and Demaine, 1997). For the purpose of this study it was assumed that farmers make adoption decisions on the basis of utility considerations (Batz*et al*., 1999). Utility of an activity is measured by its contribution to household food and income security. The probability that a farmer adopts a technology is a function of its relative utility (Batz*et al*., 1999). Thus, comparing various technologies that are utilized, farmers will adopt a technology if its utility exceeds that of other activities and improves production and wealth or standard of living better than previous practice.

The influence of various socio-economic, cultural and political factors on the willingness of farmers to use new technologies has been investigated by so many researchers. In many of the adoption behaviour, the dependent variable is constrained to lie between 0 and 1 and the models used were exponential functions while univariate and multivariate logit and probit models including their modified forms have been used extensively to study the adoption behaviour of farmers and consumers (Strauss *et al.*, 1991; Polson and Spencer, 1992; Adesina and Zinnah, 1993).

On the other hand, if the adoption choice involves asking people to directly report their willingness to pay (WTP) to obtain a specified good, or willingness to accept (WTA) to give up a good, rather than inferring them from observed behaviours in regular market places, then contingent valuation method can be used to

estimate the value that a person places on the good (Carson *et al*., 1999). Since the willingness of artisanal fishermen in Effutu Municipality to invest in aquaculture does not involve placement of any value, a Binary Logit model was used.

2.1.5 Contribution of institutions towards the development of aquaculture among artisanal fishermen

Key institutions and the extent to which they contribute towards the development of agriculture were identified, following indicators developed byTechnical Centre for Agricultural and Rural Cooperation (CTA) (CTA, 2005).According to these indicators, the institution selected should have an active outreach programme with activities focused on strengthening services to farmers and fishermen. According to Uphoff (1986), local institutions by sector can be classified as: public, private or voluntary. The public institution comprises the local administration and the local government. The local administration includes the local agencies and staff of central government ministries accountable to the central government. The local government (LG) includes elected government such as district assembles and regional assemblies. The private institution comprises service organizations and private businesses.

Institutions whose activities are linked to the above were listed up from literature and Department of Fisheries (DOF) in Ghana.The artisanal fishermen were then asked, through a structured questionnaire, whether they have ever received assistance from the listed institutions, and the mode of assistance. Descriptive statistics was then used to analyze the data.

2.1.6 The Logit Regression Model:

The Logit regression model assumes that the underlying stimulus (Li) is a random variable which predicts the probability of aquaculture adoption. The formula can be used in predicting changes in the probability of adopting aquaculture. The responses recorded in this study were discrete (mutually exclusive and exhaustive) and therefore, a Binary Logit regression model was developed to analyze the willingness of fishermen to invest in aquaculture. The model, which is based on cumulative logistic probability functions, is computationally easier to use than other types of model and it also has the advantage to predict the probability of fishermen who are willing to adopt or not.

For estimation purposes, the Logit regression model is specified as:

$$Y = \ln(\frac{p_i}{1 - p_i}) = \beta_0 + \beta_i X_i + \varepsilon_i \qquad (1)$$

Where;

$Y = \ln(\frac{p_i}{1-p_i})$ denotes the log odds of the probability that artisanal fisherman will invest in aquaculture p_i denotes the probability of investing in aquaculture; $(1 - p_i)$ denotes the probability of not investing in aquaculture; β_i denote the coefficients of the explanatory variables; X_i= the explanatory variables; ε_i = the error terms.

The empirical model is specified in equation (2) as follows; and the descriptions of variables are presented in Table 1 below.

$$WTI = \beta_0 + \beta_1 Age + \beta_2 Edu + \beta_3 Hse + \beta_4 Exp + \beta_5 Sav + \beta_6 Ks + \beta_7 Ln + \beta_8 Fa + \varepsilon_i \qquad (2)$$

Definition and measurement of variables

The dependent variable takes the value of 1 if the artisanal fisherman is willing to adopt aquaculture and 0, otherwise.

Table 1: Definition and measurement of explanatory variables

Explanatory (Independent) Variables	Description	Expected sign
Age (AGE)	Age of respondents, measured in years	+/-
Education(EDU)	Formal educational level attained by respondents, measured in years	**+/-**
Household size(HHS)	Number of persons in the household	**+/-**
Experience(EXP)	Number of years respondents have been in marine fishing	**+/-**

		business	
Savings (SAV)		Fishermen were assigned 1 if they saved and 0 otherwise	**+/-**
Knowledge and Skills (KS)		Respondents were assigned 1 if they had knowledge in aquaculture and 0 otherwise	+/-
Access to credit/Loan (LN)		Respondents were assigned 1 if they had access to credit (loan) and 0 otherwise	**+/-**
Membership of fishermen's association (FA)		Respondents were assigned 1 if they were members of the FBO and 0 otherwise	**+/-**

Statement of hypothesis:

Null Hypothesis (Ho) and Alternate Hypothesis (H$_1$)

Ho: $\beta_i = 0$

Age, Education, Membership of fishermen Based Association, Household size, Knowledge and skills in aquaculture, Access to loan, Savings and Experience of fishermen in marine fishing have no significant effect on a fishermen's willingness to invest in aquaculture.

H$_1$: $\beta_i \neq 0$

Age, Education, Membership of fishermen Based Association, Household size, Knowledge and skills in aquaculture, Access to loan, Savings and Experience of fishermen in marine fishing have a significant effect on a fishermen's willingness to invest in aquaculture.

3. Results and Discussion

3.1 Socioeconomic characteristics of fishermen

The fishing activity at Effutu Municipality in Ghana is gender specific and involves only men and/or boys. The women do the processing and selling at the various markets. The mean age of the fishermen was 41, with only 41.3% who had attained formal education. About 78% of the fishermen were married with average household size of 10 members (range of 1-19). 82.0% of the fishermen were indigenous of Effutu Municipality in Ghana with average experience of 26 years.

3.2 Willingness of artisanal fishermen to adopt aquaculture

Aquaculture has become a very lucrative area of investment and there is a growing awareness of the importance of aquaculture on human nutrition, employment, poverty reduction and even recreation in more developed societies (Bailey and Skladany, 1991; Jolly and Clonts, 1993). The contribution of aquaculture development to economic growth and to farmers' incomes is highly acknowledged nowadays and it is receiving much attention in Ghana. Yet, it has not been considered by the artisanal fishermen in Effutu Municipality in Ghana as an area of investment which will enhance their wealth. Assuming it is lucrative; will fishermen be willing to invest in it?

The artisanal fishermen in Effutu Municipality in Ghana were asked whether they had heard about the aquaculture technology. One hundred and ten (110) fishermen (73.3%) out of the 150 respondents had heard about it, whiles forty fishermen (26.7%) had not heard about it. However, only thirty-seven respondents (24.7%) had knowledge and skills in aquaculture. The remaining one hundred and thirteen (113) respondents (75.3%) had no knowledge and skills in aquaculture.

It is important to clarify that all the artisanal fishermen who responded that they had knowledge in aquaculture had not acquired any formal training. They were normally hired by other people involved in aquaculture elsewhere to help them harvest their fishes from the pond. It was through this exercise that they got to know how aquaculture was operated, and some of the items needed to go into it. Thirty two fishermen (86.5%) of the thirty-seven (37) respondents who had knowledge in aquaculture expressed that they were familiar with the pond technology. Five respondents (13.5%) of those who had knowledge in aquaculture were familiar with the cage system of aquaculture, as shown in table 3.

Table 2: The Socioeconomic characteristics of respondents

Characteristics	Frequency	Percentage
I. Age of Respondents		
15-24	16	10.7
25-34	49	32.7
35-44	48	32.0
45-54	29	19.3
55-64	8	5.3
Total	**150**	**100**
II. Household Size of Respondents		
1-4	72	48.0
5-8	56	37.3
9-12	16	10.7
13-16	4	2.7
17-20	2	1.3
Total	**150**	**100**
III. Marital Status of Respondents		
Single	33	22.0
Married	117	78.0
Total	**150**	**100**
IV. Educational Levels of Respondents		
None	88	58.7
Primary	45	30.0
Middle Sch. / JSS	17	11.3
Total	**150**	**100**

Characteristics	Frequency	Percentage
V. Ethnic group of Respondents		
Akan	2	1.3
Ewe	25	16.7
Guan (Effutu)	123	82.0
Total	**150**	**100**
VI. Religious Background of Respondents		
Christians	89	59.3
Islamic	2	1.3
Traditional	4	2.7
Pagan	55	36.7
Total	**150**	**100**

Table 3: Type of aquaculture technologies that some of the respondents (37) were familiar with

Type	Frequency	Percentage
Pond	32	86.5
Cage	5	13.5

3.3   Empirical results in relation to willingness to invest

The fishermen who answered that they were not willing to invest in aquaculture gave reasons such as: Not interested in the business (10.5%); lack of knowledge (21%); lack of money (5.3%); lack of time (50.9%); and 12.3 percent were afraid that the investment may not be successful (Table 5). When the fishermen who were willing to invest in aquaculture were asked why they were not doing it now, they answered that lack of capital to start the business (59.1%) was the major problem, whiles 40.9% said they had not heard about it before and for that matter, they had no knowledge about it (Table 6).

Table 5: Reason why fishermen were not willing to invest in aquaculture

Reason for not willing to invest	Frequency	Percentage
Not interested	6	10.5
Lack of knowledge	12	21
Lack of time	29	50.9
Lack of money	3	5.3
It may not be successful	7	12.3

Table 6: Reason why fishermen who were willing to invest had not invested yet

Reason of not yet invested	Frequency	Percentage (%)
Lack of Money	55	59.1
Lack of Knowledge	38	40.9

3.4 Logit Regression Results
The Logit regression results are presented in table 4.

Table 4: Logit regression results of the factors influencing the willingness of artisanal fishermen to adopt aquaculture

Variable	Coefficient	Std. Error	*P*-value	Marginal Effect
C	5.671067	1.242827	0.10564	1.22722
AGE	-0.052393	0.043073	0.11452	-0.01134
EDU	-0.017543	0.080538	0.13110	-0.00380
EXP	**-0.077023***	**0.041525**	**0.08156**	**-0.01667**
FA	**-2.583794***	**1.425181**	**0.06723**	**-0.56040**
HHS	0.118096	0.090174	0.21371	0.02556
KS	0.652575	0.608012	0.11232	0.13139
LN	**-1.666933*****	**0.519362**	**0.00012**	**-0.38432**
SAV	**-1.676066***	**0.863338**	**0.07864**	**-0.26908**

LR statistic (8 df) = 68.02994   Probability (LR stat) = 1.21×10^{-11}
McFadden R-squared = 0.349148

The LR statistic of 68.03 which is significant at 1% means that at least one or all the explanatory variables jointly explain the dependent variable(Willingness of artisanal fishermen to adopt aquaculture).Also, McFadden R-squared of 0.3491 means that, about 35 percent of variation in the dependent variable is explained by the variations in the explanatory variables.The experience of artisanal fishermen in fishing (EXP) is significant at 10 percent, Fishermen Association is significant at 10 percent, access to loan by the fishermen (LN) is significant at 1.0 percent and the savings by fishermen (SAV) is significant at 10 percent. However, the age of fishermen, household size (HHS), and the knowledge and skills of fishermen are all statistically insignificant.

The marginal effect of experience (EXP) which is -0.01667 means that, an additional year of experience of artisanal fishermen in marine fishing business decreases the willingness to invest in aquaculture by 1.7 percent. This might be due to the fact that the fisherman gets an appreciable benefit from the marine fishing which enhances their wealth as a result of increase in experience. They therefore see no need to go into any other investment again. This confirms the conclusion made by Ikiara and Odink (2000) that the reluctances of fishermen to accept alternative livelihood investment or exit the fishery was related to the opportunity cost of exiting, fishing experience and vessel ownership.

Fishermen association (FA) also has an inverse relationship with the willingness of artisanal fishermen to invest in aquaculture. The marginal effect of -0.56040 means that, being a member of fishermen association in Effutu Municipality is likely to result in a decrease in the willingness to invest in aquaculture by 56 percent. This might be due to the fact that the artisanal fishermen get certain help from the association such as financial assistance in times of need or any form of credit. Credit in the form of canoe and out-board motor for instance will enhance the wealth of the fishermen tremendously. This is because it will enable them go to deep sea fishing which will increase their catch levels and for that matter, increases their income. They therefore see no reason for investment in aquaculture.

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The marginal effect of loan (LN) which is -0.38432 means that having access to loan leads to a decrease in the willingness of artisanal fishermen to invest in aquaculture by 38 percent. This might be due to the fact that the artisanal fishermen who have access to loan do not encounter difficulties in feeding and engaging in other domestic activities during the off-peak season. Thus, they borrow money which is used for consumption smoothening. As one fisherman put it, "I normally borrow from the market women to feed my family during the off-peak season." Such fishermen see no need to invest in aquaculture which will yield them additional income to enhance their wealth. If fishermen know where to turn to for financial support in time of need they do not seek alternative livelihood. This practice does not encourage adoption of wealth enhancing activities.

Savings also had inverse relationship with the willingness of artisanal fishermen to invest in aquaculture. The marginal effect of savings (SAV) which is -0.26908 means that, the willingness of artisanal fishermen who were able to save enough money to invest in aquaculture is lower than those who were not able to save by 27 percent. This might be due to the fact that the artisanal fishermen who are able to save get enough money for consumption smoothening and other purposes. It was observed that the amount of money saved was directly proportional to the disposable income of the fishermen. Thus, fishermen who saved more perhaps had the appropriate gears and nets that enabled them to earn more catch and hence, more income to enhance their wealth. They therefore see no need to invest in aquaculture. This observation is in consistent with the observation made by Pollnac*et al.,* (2001) about the artisanal fishers in the Philippines, Indonesia and Vietnam, which indicated that most fishers who earn appreciable income would not leave fishing for an alternative occupation.

3.5 Empirical results in relation to institutions
3.5.1 Fisheries Commission
The mandate of the Fisheries Commission of the Ministry of Food and Agriculture is to develop and manage the fisheries of the country. It ensures that the environment, the fishing industry, and the resource base on which they depend are managed in a sustainable manner for the greatest possible benefit of the people of the Country. However the Commission has been unable to enforce some of the fisheries regulations such as the mesh size of net and the use of destructive chemicals and light in marine fishing. This has resulted in the depletion of the marine resources. The Commission's campaign in the development of aquaculture has not got to the artisanal marine fishermen in the Effutu Municipality. Most of the fishermen therefore do not have knowledge in aquaculture.
Out of the 150 respondents, only 4 fishermen, representing 2.7% had ever received assistance from the Fisheries Commission. The mode of assistance in this case, was an award for motivation and out board motors, which were given free of charge to some of the fishermen through their association. According to the beneficiaries, the last time such assistance was received was 2 years ago.

3.5.2 Ministry of Local Government and Rural Development
The total number of fishermen who have ever received assistance from this Ministry was two, out of the 150 respondents. This represents only 1.3%. The mode of assistance in this case was loan acquisition which they repaid. The last time such assistance was obtained was 3 years ago.
3.5.3 Financial Institutions
Financial institutions here include the Banks and Savings and Loans companies. As part of the responsibilities of these institutions, they give loans to farmers (both crop and fish farmers) to develop or expand their businesses and also provide technical advice concerning the implementation and development of specific projects.

Out of the one hundred and eleven fishermen who had ever requested for loans, only nine (8.1%) acknowledged receipt of loans from formal financial institutions (Banks and Savings and Loans companies). The last time such assistance was obtained was two years ago. According to the fishermen, there has never been any other form of assistance to the fishermen by these institutions. This shows that the

support of these institutions to the wealth enhancement of the artisanal fishermen at Effutu municipality in Ghana is not encouraging.

3.5.4 Fishermen Based Organizations (FBOs)

Among other duties, FBOs are supposed to be the mouth piece of the fishermen so that their grievances can be channeled to the appropriate quarters. This is done with a view to improving their socio-economic conditions based on sustainable development of fisheries. The fishermen association can also invite extension officers to give advice and also train the fishermen in new areas of investment such as aquaculture in order to sustain their livelihoods and enhance their wealth.

Only four (4) fishermen of the 150 respondents, representing 2.7% said they have ever received assistance from the FBO in the form of credits such as out-board motor which they paid for. Only fourteen (14) fishermen of the 150 respondents, representing 9.3% were members of the fishermen association in Effutu Municipality.

4. Conclusions

This study assesses the willingness of marine artisanal fishermen in the coastal region of Ghana to adopt aquaculture. The Effutu municipality in the central region of Ghana was purposely selected for the study. A multi stage cluster sampling procedure was used to randomly select 150 artisanal fishermen from two communities in the coastal area of the district. Data was collected using semi structured questionnaire.

The study employed the Binary Logit model to assess the influence of technical, socioeconomic and institutional factors on the decision to integrate the aquaculture enterprise into household enterprises of fishermen. The results of the study showed that about 62 percent of the marine fishermen were willing to adopt and integrate aquaculture into their enterprise mix. From the Logit estimation results, it appeared that fishermen who lacked savings, had difficulty in accessing credit, did not belong to fishermen's association, and were new in marine fishing were more likely to be convinced about integrating aquaculture. There is potential for marine fishers to explore and use aquaculture to enhance their wealth. The study recommends that targeting marine fishers who are youthful and inexperienced for training and capacity building is the best policy option for stakeholders who are interested in aquaculture development.

This study has shown that the key motivator to integrating aquaculture in marine fisheries enterprise mix is, support for the inexperienced fishermen who lacks personal savings, access to credit and association. The provision of such support rests on the private and public sector institutions in the municipality. The financial institutions such as rural banks, credit unions and Savings and Loans companies should develop a special product for fishermen. The government's extension services should provide training sessions on aquaculture as well as follow-up visits. The Department of Cooperative and Community Development of the Effutu Municipal Assembly should facilitate the organization of associations in aquaculture to ensure continuous learning and further external support.

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