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Prospects, determinants and profitability of aquaculture insurance among fish farmers in the Eastern Region of Ghana

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Abstract

Purpose – Aquaculture insurance has the potential of redressing climate-change because it serves as an alternative source of finance in the event of unforeseen circumstances. To this end, the authors examine the prospects, determinants and profitability of aquaculture insurance among fish farmers in the Eastern region of Ghana.

Design/methodology/approach – A total of 140 fish farmers were sampled for the study. Thematic analysis was used to determine perceived aquaculture insurance prospects. The Heckman's two-stage model, profitability index (PI) and return on investment (ROI) was employed to respectively determine the factors influencing aquaculture insurance participation and amount intensity and the profitability of aquaculture.

Findings – The thematic analysis revealed three themes on the perception of aquaculture insurance prospects: loss recovery, farm renovation and promotes agriculture. Different sets of demographic and institutional factors have varying influences on aquaculture insurance participation and amount intensity. Profitability index (PI) and return on investment (ROI) were respectively 2.07 and 3.2%.

Originality/value – The research provides relevant information on perceived aquaculture insurance prospects, aquaculture insurance participation, and amount intensity and profitability of aquaculture which can contribute to enhancing aquaculture insurance and the aquaculture industry in Ghana.

Keywords Aquaculture, Insurance, Fish farmers, Profitability, Ghana

Paper type Research paper

1. Introduction

Aquaculture is burgeoning as a source of food in the world and is proliferating in virtually all countries (Whitmarsh and Palmieri, 2008; Subasinghe *et al.*, 2009). World fish production is 44.1% of the total production of both capture fisheries and aquaculture (FAO, 2004). The industry has seen significant growth worldwide from 1 million tonnes in the 1950s to 48.1 million tonnes in 2005 (Subasinghe *et al.*, 2009). As a consequence, every year the total production increases by 10% and has accounted for over 40% of the world's demand for seafood (Paptsov *et al.*, 2020). These statistics indicate the potentiality of aquaculture in meeting the world demand for fish.

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Similarly, in Africa, there is a growing demand for fish which has necessitated the need for African countries to import approximately 4.2 million tonnes of fish products at a tune of US$3,000,000,000 (Brummett *et al.*, 2008). Until recently, however, aquaculture is now gaining ground in Africa and has a marginal contribution to food security and economic development (Brummett and Williams, 2000). Undoubtedly, Ghana's aquaculture is still in the elemental stages of development. However, in the year 2003, there was an exponential production of aquaculture from less than one thousand tonnes to seven thousand tonnes in 2009 (Cobbina and Eiriksdottir, 2010). The fast growth was a result of the commercial operators producing on a large scale with the use of the semi-intensive system and extensive system such as earthen ponds and dams respectively (Cobbina and Eiriksdottir, 2010).

The industry value and supply chain consist of actors such as fish farmers, fish processors, wholesalers, retailers and consumers. Today, although not a panacea, aquaculture has substantially contributed to the development of food security by ensuring the continuous supply of nutritious food to the teeming world population (Swaminathan, 2012), served as a source of livelihood, promote social equity among rural folks (Bondad-Reantaso and Prein, 2009), an avenue for foreign exchange, reduction of poverty (Hiheglo, 2008) and contributed significantly to the economy of many nations (Kassam and Dorward, 2017).

Given this, Ghana's aquaculture is saddled with insufficient financial investment as a result of some residual perils (Nunoo and Acheampong, 2014). Notable among these perils are flood or drought, the incidence of viral, bacteria, parasitic and fungal diseases (Parappurathu *et al.*, 2017), and climate change (Froehlich *et al.*, 2020). The outcome of these risks has a resultant effect of bankruptcy among fish farmers (Oglend and Tveteras, 2009). Ghana's fishery constitutes 4.5% of the GDP and the prime source of animal protein (Aggrey-Fynn, 2001; FAO, 2006). However, the contribution to Ghana's GDP is low and this is attributed to the exposure of aquaculture to the said residual perils and adverse climatic changes. The adverse climatic changes usually ravage fishes and seldom damage the earthen pond. Despite several effective measures, Georgina (2019) opined that 20–40% of produced fish would still be lost due to climate change. The aquaculture sector in Ghana is therefore susceptible to many residual perils that favour the loss of financial investment among aquaculturists (fish farmers). In consequence, it is therefore not surprising that agricultural credit of which fish farmers form part has become difficult to access in Ghana (Nunoo and Acheampong, 2014). The absence of sufficient protection for aquaculture risk which occurs periodically in Ghana has also caused an income loss among aquaculturists resulting in decreased productivity and the sector's growth rate. Thus, farmers would not be spurred to consider an extra financial risk by investing in the farm (Rosenzweig and Wolpin, 1993). Protecting the financial investment of fish farmers, aquaculture insurance as one modus operandi of risk management strategies is therefore indispensable to indemnify against climate change, flood or drought, and the incidence of disease among others. In effect, good management of the production risk would have a concomitant positive impact on fish farmer's income. This subsequently augments the sector's growth, since farmers are incited to produce more.

Therefore, there is a need to transfer the risk to other financial interventions like insurance to aid reduce the high preponderance of risk in the aquaculture sector (Lebel *et al.*, 2018). More so, relative to other sub-sectors of agriculture aquaculture insurance is by far underutilised. In so doing, Oppong Mensah *et al.* (2017) reported that the uptake of insurance would not only suffice as a risk management strategy for the fish farmers but could also mitigate exogenous shocks such as climate change or climatic-related risks and perils. Notwithstanding, there has been an increasing body of literature on aquaculture insurance. For instance, Beach and Viator (2008) conducted a study on aquaculture insurance in the United States, while Hong-ying (2013) explored the insurance for aquaculture in China. Similarly, Watson *et al.* (2018) examined cooperative insurance for aquaculture in Myanmar. Further, Zheng *et al.* (2018) evaluated the willingness to pay for aquaculture insurance in China whiles Han and Jiang (2019) analysed the insurance for Mariculture in China. However, to the best of our knowledge, there appears to be no empirical study on the prospects, determinants, and profitability of aquaculture insurance in Africa, particularly Ghana. We bridge the dearth in literature by investigating the same.

In the ensuing section, three guiding research objectives emerge: (1) To determine the perceptions of aquaculture insurance prospects among fish farmers (2) Analyse the factors influencing participation for aquaculture insurance and amount intensity, (3) Examine the profitability of aquaculture. The rest of the paper is structured as follows: (1) Introduction of the study (2) Literature review (3) Material and methods (4) Results and discussion and finally (5) Conclusions and recommendations.

2. Literature review

2.1 Prospects of aquaculture and aquaculture insurance

On the prospects of aquaculture, investment opportunities like fish feed production, fingerlings production, fish farming training, and diversifying products of aquaculture exist for potential agripreneurs.

2.1.1 Fish feed production. Locally produced fish feeds used by both semi-intensive and extensive farmers are in high market demand. This is because Raanan Fish Feeds (an Indian firm) appears to be the only largest feed mill in Ghana and accounts for 70% of total production. Intensive farmers produce their feed whereas most semi-intensive and extensive farmers are otherwise. Annually, 25,000 and 5,000 tons of fish feed are respectively produced for Ghana and the sub-region by Raanan Fish Feeds. Currently, the firm runs at full capacity and an additional market of 30,000 tons/year exists for locally produced feed. The consequence thereof is market monopoly however the emergence of another feed mill would encourage fish feed price competition.

2.1.2 Fingerlings production. The increase in private hatcheries has aided aquaculture development, yet, annually, there is an undersupply of 50 million fingerlings. The Akosombo strain of fish is the only legally authorised Tilapia strain for cultivation. The undersupply of fingerlings restricts the potential number of fish farmers in Ghana and again causes existing farmers to use redundant species for reproduction. A ready market, therefore, exists for potential agripreneurs who are willing and ready to invest in an authentic hatchery that produces high-quality fry and fingerlings.

2.1.3 Fish farming training. Fish farmers from areas that consider aquaculture as their major livelihood would need training and capacity building to aid manage the cages/ponds for optimal impact. Instances wherein farms were abandoned were mainly due to low productivity and low returns on investment. Some fish farmers appear to follow a trial-and-error approach which lacks clarity. Training and educating the youth on the whole value chain, new technology, fish farming methods, ponds draining, harvesting, maintenance of the fish farm, and stocking ponds and cages are important skillsets required in the sector. This gap presents several agripreneur opportunities to the potential agripreneur.

2.1.4 Diversifying products of aquaculture. Tilapia predominates Ghana's aquaculture, yet an opportunity exists for the introduction of other species. Expanding the domestic and regional markets, catfish production, coupled with crustaceans such as shrimps and crabs would aid market expansion. Having subsidised rates for catfish fingerlings would spur catfish farming. Introducing crustaceans into the local culture is imperative to feed the increasing diaspora community working and living in Ghana. The introduction of crustaceans would likely result in price competition as there is currently a 15% tax on imported seafood. Within the ECOWAS region, an opportunity also exists for export.

Notwithstanding the plethora of prospects/benefits that aquaculture offers, the financial investment in the sector is fraught with risk and perils that tend to be systemic or idiosyncratic and needs to be managed with insurance contract *ex ante* and ex-post through insurance claims (Mensah, 2017). Precisely, farmer's financial investment would be protected with aquaculture insurance. In China, using aquaculture insurance, the death of fishes due to the lack of oxygen and thunderstorms were covered as the residual risk (Lou *et al.*, not dated). Maroti (not dated) maintained that, in India and Bangladesh external pollution, poisoning, volcanic eruptions, typhoons, tempest, inundation, and cyclones, together with tidal borne floods were covered respectively as residual risk. Similarly, in Ghana, although aquaculture insurance is nonexistent, the residual risk covered by the discussed countries could be covered in the event of designing aquaculture insurance for fish farmers. The preceding backdrop reveals an enormous prospect for the aquaculture sector.

2.2 Profitability of aquaculture

The major objective of a business is to attain a profit. As such, augmenting profitability is one key driver of business managers who perpetually seek ways to change the business to achieve sufficient profit (Nunoo *et al.*, 2014). A genuinely conducted profitability analysis would therefore furnish practical evidence on the potential earnings of a business and management effectiveness (Mantey, 2019). Based on data availability, time frame selected and selected activity scope, business profitability could be estimated with several approaches (Engle and Neira, 2005). Among these approaches, the profitability index (PI) and return on investment (ROI) are no exception (Kaske *et al.*, 2012; Magni, 2015). In the Ghanaian context, Aheto *et al.* (2019) employed the ROI, payback period (PBP), and the benefit-cost ratio (BCR) as profitability metrics to investigate the profitability of small-scale aquaculture farms. Study findings revealed that over 5 years, the mean BCR was 1.14. In detail, tilapia had high profitability (BCR = 1.16) likened to catfish (BCR = 1.11). Additionally, there was a positive ROI for both tilapia and catfish. However, considering the long term, catfish profitability was high (ROI = 0.74) compared to tilapia (ROI = 0.73). The payback period for tilapia was 7 years relative to catfish computed at 9 years. On the effects of environmental and seasonal changes on the production of aquaculture (Nile tilapia) in Ghana, Mensah *et al.* (2018) found that the PI and ROI were high for Nile tilapia production, particularly during dry seasons due to high survival rates. Given the profitability of aquaculture, Mensah *et al.* (2018) and Mantey (2019) professed that fish production is often challenged by water quality, predators, and poaching. Hence, protecting farmer's financial investment, aquaculture insurance is inextricably linked. This would therefore ensure the sustainable development of aquaculture in Ghana.

3. Material and methods

Employing a mixed-method approach, the study uses the quantitative (Heckman's two-stage model) and qualitative (Thematic analysis) research approach to achieve the given objectives. The results of each approach are considered independently and jointly to aid triangulate and give comprehensive meaning.

3.1 Theoretical framework

The study is grounded on the Lancaster random utility maximisation theory. In this study, it is assumed that y_z and y_m denote the two utility choices for the aquaculturist, which is the decision to participate in aquaculture insurance and otherwise (Greene, 2003). The two utility choices are represented by U^z and U^m, with U^z representing the aquaculturist utility expected from aquaculture insurance and U^m representing the utility for the existing status of the aquaculturist for not participating in the aquaculture insurance.

Therefore, the observed indicator = 1 if $U^z > U^m$ and 0 if $U^z \leq U^m$. Maximising the utility condition reveals that an aquaculturist will participate in aquaculture insurance if the utility expected is more than the existing status, i.e. $U^z > U^m$; otherwise the aquaculturist will not participate in aquaculture insurance given $U^z \leq U^m$. Accordingly, Greene (2003) modelled the linear random utility theory as:

$$U^z = X'\beta_z + \varepsilon_z \text{ and } U^m = X'\beta_m + \varepsilon_m \tag{1}$$

If we denote $Y = 1$ the aquaculturist choice of alternative *z*, is specified as:

$$\begin{aligned} Prob = [Y = 1|X] &= Prob\ [U^z > U^m] \\ &= Prob[X'\beta_z + \varepsilon_z - X'\beta_m - \varepsilon_m > 0|X] \\ &= Prob[X'(\beta_z - \beta_m) + \varepsilon_z - \varepsilon_m > 0|X] \\ &= Prob[X'\beta + \varepsilon > 0|X] \end{aligned}$$

where X is a vector of farm level and socio-economic variables.

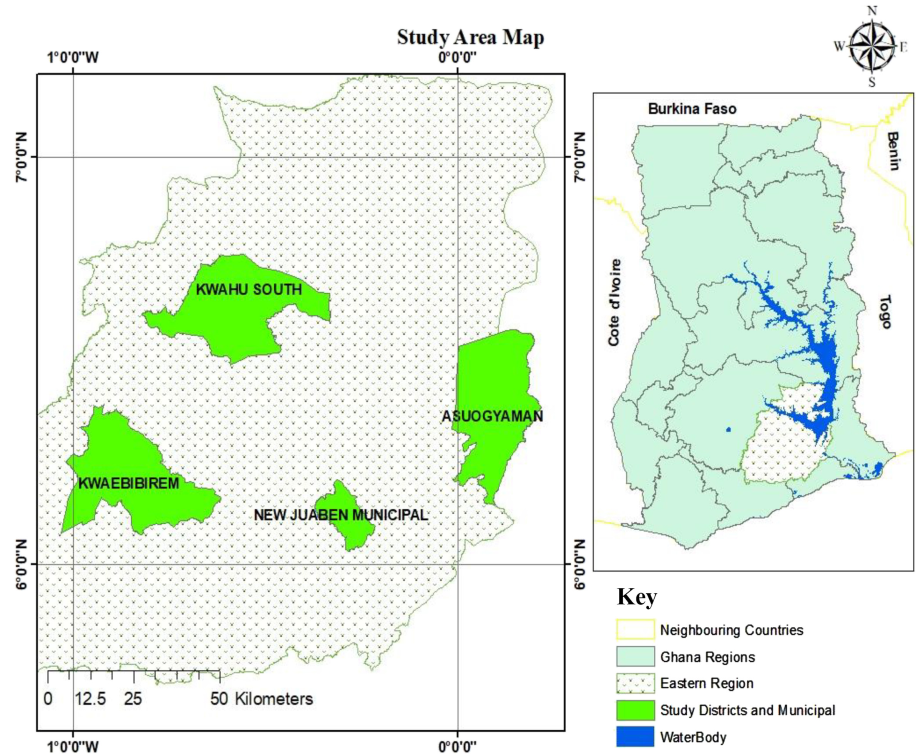
3.2 Study area

The Eastern region of Ghana has a total land area of approximately 19, 323 kilometres square and it accounts for 8.9% of Ghana's land area (Adjei *et al.*, 2016). The population of the region is 2,633,154 which represents 10.7% of Ghana's total population of which 1,290,539 and 1,342,615 are males and females respectively (GSS, 2012). The region shares boundaries with Greater Accra region on the south, on the East, the Volta region, on the north Ashanti region, and the west is the Central region. The ambiance of the region supports inland water transportation and inland fishing. Aquaculture is the major livelihood; however, agriculture and allied trades dominate as well (Amoah, 2019). Below is a table of aquaculture farm distribution in Ghana:

Generally, the Upper West and East regions are perceived to be more suitable for culture-based fisheries (CBF) due to the sizeable number of artificial water bodies and low records of rainfall (Kapetsky *et al.*, 1991). Also, the adverse weather conditions, dryness, and less rainfall had incapacitated farmers in the Northern region to actively participate in aquaculture. Over three consecutive years, the Eastern region had been the major region known for aquaculture production (Firmus). Besides, Lake Volta is found in the Eastern region and is the center for most aquaculture activities in Ghana. Worthy of notice is that, after production in the Eastern region, the Greater Accra region stands as the commercial hub due to the substantial number of consumers. For example, Tropo Farms Ltd has marketing outlets in Kasoa and Tema, in the Greater Accra region (Firmus, not dated). Figure 1 presents further details of the study area.

3.3 Sampling and data

The multistage sampling procedure was used in this study. This approach was considered because the farmers (aquaculturists) were geographically dispersed. In the first stage, the Eastern region of Ghana was pre-defined because it had the majority of the aquaculturist. In the second stage, despite the numerous zones in the region, four zones, namely, Asuogyaman, Kwahu South, Kwaebibirem, and New-Juaben were purposively selected due to the pre-eminence of aquaculturist. In the third stage, given the number 140 aquaculturist sample size, a random sampling was done to select the interview farmers. Following the empirical works of Xiu *et al.* (2012) and Adeyonu *et al.* (2016) who used a sample size of 127 and 136 respectively, the study employed a sample size of 140. Moreover, scientifically justifying the sample size, the central limit theorem (CLT) indicates that a sample size ≥ 30 is suitable for statistical analysis (Mensah *et al.*, 2020) because the distribution of the sample means is fairly



Source(s): Authors Construct, 2020

Figure 1.
Map of the study area

normally distributed. This indicates that the sample size is appropriate for the study. Strengthening the sampling of the key informants (Fish farmers), focused group discussions (FGDs) were conducted to establish the perceptions on the prospects of aquaculture insurance. The goal of the research was explained to the fish farmers before the start of the FGDs. The FGDs began with four field assistants, each assigned to the given study zones (Refer to Figure 1 for details). "Perceptions on the prospects of aquaculture insurance" were given to each field assistant as a theme to be discussed with the group. A period of one hour was used to discuss the said theme.

Data collection was done from March 10th to 20th May 2020. Upon administering the final questionnaire, pre-testing was conducted. Responses from the pre-testing were used to fine-tune the final survey instrument. The semi-structured questionnaire used for the study had the following modules: personal characteristics, farm-level parameters, prospects of aquaculture, key on-shore and off-shore perils, factors influencing aquaculture insurance participation and amount intensity, aquaculture insurance preference, profitability analysis, insurance claims payment procedure, and aquaculturist perceived challenges of aquaculture insurance.

3.4 Method of data analysis

3.4.1 Thematic analysis. The thematic analysis was deployed to examine the contents of the focus groups on the perceptions of the prospects of aquaculture insurance. The recorded information (audio) was transcribed into English by the field assistants. Upon transcribing the data, authors first familiarize the data by reading through the text and taking initial notes. Coding surfaced as the second phase; thus, we highlighted sections of the text and came up with shorthand labels or "codes" to describe the content. Patterns were identified within the codes and converted into themes. These themes were achieved by combining several codes. In deepening the analysis, the authors reviewed the themes generated by comparing them against the dataset. The generated themes were present in the data, which validates the themes' admissibility. However, the authors further iteratively compared the interview with the dataset until no new codes and themes were found.

Heckman's two-stage model was used to determine the factors influencing participation for aquaculture insurance and amount intensity. The study hypothesised the adoption of aquaculture insurance as a two-stage decision. Thus, in the first stage, the decision to adopt aquaculture insurance and the premium allocated for aquaculture insurance in the second stage. However, according to Oppong-Kyeremeh and Bannor (2020), the said two-staged decisions can be determined jointly or differently. In the case of a joint determination, the Tobit model is preferred. Notwithstanding, in our case, the decision for a one-stage process or a two-stage process is contingent on the separability or Tobit test via the likelihood ratio test statistic, λ which is estimated as:

$$\lambda = 2(LL_{Probit} + LL_{Truncated} - LL_{Tobit}) \tag{2}$$

Upon completion of the analysis, the test statistic, λ was greater than the critical value of Chi-square $(x^2_{0.1})$ (Oppong-Kyeremeh and Bannor, 2020). Therefore, the use of the two-stage process. Further, a selectivity bias test was done on the decision of Cragg's Double hurdle model or the Heckman selection model. A significant inverse mills ratio signifies the use of Heckman's two-stage model (Amfo and Ali, 2020) due to the presence of sample selection bias. From Table 1 the inverse mills ratio was significant. As a result, Heckman's two-stage model was adopted. In the first stage, the Probit model is used in estimating the decision of aquaculturists to participate in aquaculture insurance or otherwise. This decision is affected by some factors. The use of the ordinary least squares (OLS) regression model is used for the

No.	Name of company	Location	Production	Type of company	Product
1	Ainoo- Ansah Limited	Central Region	30,000 fingerlings a month	Hatchery	Fingerlings
2	Raanan Feeds	Pram Pram	25,000 t	Feed Mill/ Factory	Fish Feed
3	Tropo Farms	Eastern Region	2,000 t	Cage Culture Farm	Tilapia, White, Catfish, Tilapia Fingerlings
4	West African Fish Ltd	Eastern Region	2,000 t	Cage Culture Farm	Tilapia
5	Sunwoo Culturing Systems	–	500 tonnes	Cage Farm	Tilapia
6	Safeway Agro	Volta Region	200 tonnes	Cage Farm	Tilapia
7	Lee's Farm Ltd	Eastern Region	200–300 tonnes	Cage Farm	Cage Farm
8	Maleka Farms	Eastern Region	250–300 tonnes	Cage Farm	Cage Farm
9	Delta Fisheries	Eastern Region	200–300 tonnes	Hatchery and Cage Farm	Fingerlings and Cage Farm

Source(s): Adopted from Firmus (not dated)

Table 1.
Aquaculture farm distribution in Ghana

second stage to account for the amount intensity. The issue of selection bias in OLS is addressed with Inverse Mills Ratio (IMR) estimated from the selection equation (Probit model) and incorporated in the OLS equation.

Therefore, the Heckman two-stage model is specified as follows:

Selection equation,

$$Z^* = A_1 + A_2 W_i + u_i;\ i = 1,\ 2,\ \ldots,\ N \tag{3}$$

Where W is the factors affecting participation in insurance or not.

Z_i^* = Latent variable;

A_1 = Constant term;

A_2 = Vector of coefficients;

u_i = Stochastic error.

But the latent variable Z^*, is not observed. The observed binary variable is Z_i such that:

$$\begin{aligned} Z_i &= 1,\ \text{if}\ Z_i^* > 0 \\ &= 0,\ \text{otherwise} \end{aligned} \tag{4}$$

That is, an aquaculturist will participate in insurance if, $Z_i = 1$ and otherwise, the aquaculturist fails to participate in aquaculture insurance.

The marginal effect for the coefficients estimated is expressed as:

$$\frac{\partial \rho r(y_i = 1 | x_{i;}\beta)}{\partial x_{ij}} = \frac{e^{xi\beta}}{[1 + e^{xi\beta}]^2} . \beta_j \tag{5}$$

In the second stage of the Heckit model ordinary least squares, regression model (OLS) was used in estimating the factors affecting the amount intensity by the aquaculturist which is expressed as:

$$Y_i = B_1 + B_2 X_i + e_i \tag{6}$$

Where Y_i is the dependent variable amount (premium).

B_1 = Constant term;

B_2 = Vector of coefficients;

X_i = Regressors;

e_i = Error term.

Considering the errors u_i and e_i, an assumption is made that either of them has a bivariate normal distribution.

$$\begin{bmatrix} e_i \\ u_i \end{bmatrix} \sim N \begin{pmatrix} \sigma^2 & \rho\sigma \\ \rho\sigma & 1 \end{pmatrix} \tag{7}$$

Where the correlation coefficient between the two error terms is denoted as ρ. For technical reasons, the variance of the stochastic error u_i is set to be 1.

Estimating equation (6) will result in selectivity bias if, $Z_i = 1$ and error terms u_i and e_i, are correlated. Therefore, to achieve consistent estimates of B_1 and B_2, the following equation is estimated:

$$E\left[Y_i | Z_i^* > 0\right] = B_1 + B_2X_i + B_3\lambda_i;\ i = 1,\ 2,\ \ldots,\ n \tag{8}$$

Where the Inverse Mills Ratio (IMR) λ_i is now incorporated as a new variable and is equal to:

$$\lambda_i = \frac{f(A_1 + A_2Wi)}{F(A_1 + A_2Wi)} \tag{9}$$

Where f and F denote standard normal density function and standard normal cumulative distribution function, respectively.

In estimating λ_i, A_1, and A_2 from the probit model based on the binary outcome Z_i is estimated as follows:

$$\lambda_i^\wedge = \frac{f(a_1 + a_2Wi)}{F(a_1 + a_2Wi)} \tag{10}$$

Where the lower-case alphabets (a_1 and a_2) are the parameters estimated for Eq. (3).

Therefore, the final model is specified as:

$$Yi = B_1 + B_2X_i + B_3\lambda_i^\wedge + V_i \tag{11}$$

Respective specification of the Probit and OLS empirical model:

$$\begin{aligned} Aqua_{Part} = {} & \beta_0 + \ \beta_1Aware + \beta_2Income + \beta_3Age + \beta_4Farmexp + \beta_5Hsize + \beta_6Edu \\ & + +\beta_7Exten + \beta_8Stocks + \beta_9Rears + \beta_{10}Gender + \beta_{11}CreditA + +\beta_{12}FBO \\ & + \beta_{13}Religion + e_i \end{aligned} \tag{12}$$

$$\begin{aligned} AmtWTP = {} & \beta_0 + \beta_1Income + \beta_2Age + \beta_3Farmexp + \beta_4Hsize + \beta_5Edu + +\beta_6Exten \\ & + \beta_7Stocks + \beta_8CreditA + +\beta_9FBO + +\beta_{10}\lambda\hat{\ }\mathrm{i} + v_i \end{aligned} \tag{13}$$

Table 2 shows the variables used in the Heckman two-stage model. The researchers hypothesised different variables under two-main sub-headings: Demographic and institutional factors. Demographic factors included age, gender, education, household size, farm experience, farm income, and religion. However, the institutional characteristics are aquaculture insurance awareness, extension service access, credit access, rearing system, stock size, and farmer-based organisation membership.

The regressands were participates in aquaculture insurance and the amount paid. The rest were the regressors employed as the determinants affecting the regressands. Table 3 under model 1, age, gender, education, farm experience, farm income, aquaculturist religion, aquaculture insurance awareness, and farmer-based organisation membership were hypothesised to positively influence participation in aquaculture insurance. In contrast, household size, extension service access, credit access, rearing system, and stock size were hypothesised to negatively influence the decision to participate in aquaculture insurance. Under model 2 in Table 3, age, education, farm experience, farm income, extension service access, credit access, stock-size, and farmer-based organisation membership were hypothesised to affect the premium (amount) contribution to aquaculture insurance positively. However, household size was hypothesised to negatively influence the premium (amount) contribution to aquaculture insurance. It is worth noting that, all the variables and the expected sign used in the model were sourced from literature, as shown in the literature review section.

Variable	Description	Measurement	Model 1	Model 2	Supporting literature
Aqua$_{Part}$	Participates in aquaculture insurance	Discrete decision (1 = Yes, 0 = No)			
Amt	Amount WTP	Amount in Ghana Cedis (GH¢)			
Demographic factors					
Age	Number of years from birth	Continuous (In years)	+	-	Xiu *et al.* (2012), Bishu *et al.* (2018)
Gender	Aquaculturist gender	Dummy (1 = Male 0 = Female)	+	n/a	Oppong Mensah (2017), Mensah *et al.* (2021)
Edu	Had formal education	Continuous (In years)	+	+	Akter *et al.* (2011), Zheng *et al.* (2018)
Hsize	Household size	Continuous (In numbers)	−	+	Okoffo *et al.* (2016)
Farmexp	Farm Experience	Continuous (In years)	+	+	Akintunde (2015)
Income	Farm income	Continuous (In Gh cedis)	+	+	Akter *et al.* (2008), Bishu *et al.* (2018)
Religion	Aquaculturist religion	Dummy (1 = Christian 0 = Muslim)	−	n/a	Sihem (2019)
Institutional factors					
Aware	Aquaculture insurance awareness	Dummy (1 = Yes 0 = No)	+	n/a	Mohammed and Ortmann (2005), Zheng *et al.* (2018)
Exten	Extension service access	Dummy (1 = Yes 0 = No)	−	+	Akintunde (2015)
CreditA	Credit access	Dummy (1 = Yes 0 = No)	−	+	Akter *et al.* (2008)
Rears	Rearing system	Dummy (1 = Earthen pond 0 = Otherwise)	+	n/a	Akintunde (2015)
Stocks	Stock size	Continuous (In numbers)	+	+	Akintunde (2015)
FBO	Farmer-based organisation membership	Dummy (1 = Member 0 = Otherwise)	+	−	Adeyonu *et al.* (2016)

Source(s): Authors' compilation based on field data and literature review, 2020. Model 1 is the participation in aquaculture insurance. Model 2 is the aquaculture amount intensity; n.a. denotes not applicable

Table 2. Description of regressors in the Heckman two-stage model

3.4.2 Profitability analysis. The profitability index (PI) and the return on investment (ROI) were employed as the profitability indicators of aquaculture. Following Mensah *et al.* (2013) and Aheto *et al.* (2019), profitability index (PI) and return on investment (ROI) is respectively estimated as:

$$\mathrm{PI} = \frac{\text{Value of fish}}{\text{Total cost of feed}} \tag{14}$$

$$\mathrm{ROI} = \frac{\text{Annual net profit}}{\text{Total capital investment}} \tag{15}$$

4. Results and discussion

The results from Table 1 show the summary statistics of variables. The mean participation in aquaculture insurance and amount WTP were 0.657 and GH¢ 241.667 (US$ 50.00)

Variable	Mean	Std. dev.	Minimum	Maximum
Participates in aquaculture insurance	0.657	0.476	0	1
Amount WTP	241.667	203.050	0	600
Awareness	0.686	0.466	0	1
FBO membership	0.357	0.481	0	1
Years in education	5.436	3.997	1	22
Extension service access	0.557	0.499	0	1
Age	43.586	8.108	26	59
Income	9490.036	26825.160	0	200,000
Household size	5.464	1.237	1	12
Years in farming	7.779	3.234	2	12
Religion	0.679	0.469	0	1
Credit access	0.400	0.492	0	1
Gender	0.671	0.471	0	1
Rearing system	0.636	0.483	0	1
Stock size	22386.430	60938.130	2,000	300,000

Source(s): Field data, 2020 NB: US$ 1 = GH¢ 5.9

Table 3.
Summary statistics of variables

respectively. In contrast, Zheng *et al.* (2018) revealed that the mean amount WTP for aquaculture insurance in China was US$ 90.05. A plausible reason could be that farmers in China had higher income levels relative to Ghanaian farmers. Hence, the significant difference. On awareness, the mean value was 0.686. This implies that 68.6% of fish farmers were aware of aquaculture insurance. However, aquaculture insurance was a mess in Vietnam because farmers were not adequately cognizant of the same (Nguyen and Jolly, 2019). Averagely, the mean respective FBO membership and years in education were 0.357 and 5.436. Signifying that, 35.7% of farmers were members of FBO and have attained the tertiary/vocational level of education. Likewise, women aquaculturists in Nigeria were highly educated (Oparinde, 2019). Concerning extension service access and age, the mean value was 0.557 and ~44. This indicates that 55.7% of fish farmers have extension service access. The result is no different from Hukom *et al.* (2020) and Alam and Guttormsen (2019) who found an average age of 44 and 43 years for aquaculture farmers in Indonesia and Bangladesh respectively. Yet at variance with Obiero *et al.* (2019) who revealed an approximate age of 51year for fish farmers in Kenya. More so, the average income was approximately GH¢ 9490.00 (US$ 1,608.00). Surprisingly, the farm income of fish farmers on average was US$ 222.40 in Tanzania (Mulokozi *et al.*, 2020). The result suggests that aquaculture is a lucrative enterprise in Ghana vis-à-vis Tanzania. The mean household size and years in farming were 5 and about 8 respectively. On household size, and years in farming, Ugwuja *et al.* (2017) and Ogunmefun and Achike (2017) respectively reported a similar outcome. The mean religion, credit access, gender, rearing system, and stock size were respectively 0.679, 0.400, 0.671, 0.636, and 22386.430. Implying that, 67.9% of the farmers were Christians, and the remainder being Muslims. On credit access, 40% of the farmers had credit access. Additionally, 67.1% of the farmers were males, and the remaining being females. Also, 63.6% of the farmers practised the semi-intensive system of aquaculture rearing.

4.1 Perceptions of aquaculture insurance prospects in Ghana

The thematic analysis categorised the perceptions into three themes: loss recovery, farm renovation, and promotes agriculture.

4.1.1 Loss recovery. The participants noticed that, as they continue to stay in business unforeseen circumstances (residual perils) such as adverse weather, viral, bacteria, parasitic and fungal diseases could diminish their production scales. As farmers stayed longer in business, they were beginning to be circumspect of the given residual perils since their financial capacity could not sufficiently redress the peril should it befall their farm. One of the participants in the focus group stated:

> As our production scales increase, the perils corresponding to our farm likewise increase. Meanwhile, should any of us encounter perils on our farm, the financial capacity to salvage the fishes from these perils are not readily available, because we have wives and children to fend as well. Therefore, having aquaculture insurance would erode the grave implications caused by these perils or precisely, recover our losses. (Focus group B)

Recovering from losses spurs the farmers to actively participate in aquaculture insurance. Therefore, the resultant perception of "Loss recover" for aquaculture insurance. Likewise, the result is consistent with Kwadzo *et al.* (2013) who indicated that the larger the loss of income and assets and fewer alternatives available to select to recover from such losses, the higher the tendency of selecting insurance.

4.1.2 Farm renovation. On many occasions' farmers revealed their stance on aquaculture insurance being the most financial source to utterly renovate their farm in the event of a residual peril. Also, the perception of aquaculture insurance as a farm renovation had augmented, because it appears to stand the test of time in the financial industry. The concept of farm renovation allowed them (farmers) to easily make frantic efforts to appreciate aquaculture insurance. One of the participants in the interview stated:

> As for me, anytime I hear of agricultural insurance I am quick to judge the positive outcome. The reason being that I ever eavesdropped on a conversation between an underwriter and a farmer, wherein the underwriter emphatically professed that your farm would be entirely renovated by us should the farm encounter a catastrophe. This inspired me to always be on the look for an insurance package for my farm. (Interviewee C)

Some of the farmers were not able to perceive aquaculture insurance as a farm renovation prospect. They had been much conscious of farmers whose farms were not renovated after being clients of an unknown insurance scheme. In consequence, the hesitant aura of recognising "farm renovation" as a perceived prospect of aquaculture insurance. However, Ajieh (2010) perceived that agricultural insurance could serve as compensation to farmers in the event of a natural disaster.

4.1.3 Promotes agriculture. Most likely, in Sub-Saharan countries agriculture is heavily dependent on rainfall. Failure of rainfall results in lower yields of agricultural produce, translating into poor commercialisation. Farmers (aquaculturists) had most often than not relied on rainfall to complement their artificial supply of water to the earthen pond. One of the interview participants stated:

> We cannot always buy water to revitalise the ponds. Seldomly, keeping our business moving we depend on heaven rain. Besides, if the rains do not meet our expectations index insurance would be available for us. Consequently, leveraging agriculture. (Interviewee A)

The participants revealed the ability of aquaculture insurance to promote agriculture. They believed that promoting their business, aquaculture insurance would be inevitable. The result validates with Ajieh (2010) who posits that agricultural insurance promotes agriculture by motivating the use of new and enhanced technologies and enabling higher investment in the agricultural industry. Again, it is somewhat related to the study of Danso-Abbeam *et al.* (2014) who contended that having farm insurance would remove the uncertainty of financial investment loss should flood, bush fire among other residual perils befalls the farm. This subsequently promotes agriculture as farmers would no longer be frightened of investment loss.

Table 4 shows the results of the factors influencing aquaculture insurance participation and amount intensity. The results showed that education had a positive and significant effect on the participation decision and amount intensity of aquaculture insurance in the study area.

Table 4.
Factors influencing aquaculture insurance participation and amount intensity

Variable	Participation decision	Heckman specification results Marginal effects	Amount intensity
Demographic factors			
Age	0.199 (0.277)	0.061	−0.010 (0.094)
Gender	0.007 (0.012)	0.003	–
Education	0.026 (0.013)**	0.026	0.038 (0.009)***
Household size	−0.800 (0.280)***	−0.047	0.100 (0.500)
Farm experience	0.052 (0.016)***	0.122	0.005 (0.122)***
Farm income	0.760 (0.270)***	0.299	−2.846 (0.490)***
Religion	0.028 (0.040)	0.011	–
Institutional factors			
Awareness	0.701 (0.230)***	0.274	–
Extension service	1.760 (0.470)***	0.607	0.100 (0.060)*
Credit access	0.193 (0.367)*	0.175	0.108 (0.520)**
Rearing system	−0.091 (0.306)	−0.091	–
Stock size	0.029 (0.020)	0.011	0.061 (0.034)*
FBO membership	1.850 (0.760)**	0.555	0.150 (0.070)**
Constant	−5.960 (1.318)***		2.819 (3.610)***
Mills ratio	2.099 (0.519)***		
Rho	0.234		
Sigma	0.157		
Wald chi-squared (13)	52.02		
Prob chi-squared	0.000***		
Number of observations	140		
Censored observations	35		
Uncensored observations	105		
LLProbit	−73.163		
LLTruncated	−527.365		
LLTobit	−617.785		

Source(s): Field data, 2020; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$ significance level; NB: Figures in parenthesis are standard errors

Thus, educated farmers are more likely (about 2.6%) to participate in aquaculture insurance than less educated farmers. This could be attributed to education increasing the cognisance of risk aversion (Ćurak *et al.*, 2013). Consequently, allowing farmers to comprehend the benefits of insurance (Treerattanapun, 2011). The result validates the finding of Sihem (2019) who found a positive relationship between education and agricultural insurance. Household size was found to have a negative and significant ($p < 0.01$) influence on the probability of aquaculture insurance participation, but no influence on the amount intensity. The result is not surprising, because farmers with higher household sizes have higher expenditures as they would have to fend for their wives and children. This translates into the tendency of decreasing participation in aquaculture insurance. The result is at variance with Zheng *et al.* (2018) who reported a positive relationship between household size and participation in aquaculture insurance. However, no different from Birinci and Tumer (2006) who revealed that bigger household size suggests a decrease in agricultural insurance purchase. Farm experience was found to be a positive and significant determinant of aquaculture insurance participation and amount intensity. A plausible reason could be that, although they (farmers) increase in experience, their proficiency on aquaculture insurance is not leveraged. Carrer *et al.* (2020) and Akinola (2014) indicated that farm experience decreases farmer's agricultural insurance participation. Farm income significantly affected aquaculture insurance participation positively, whereas negative effect on amount intensity. The result suggests that, as farmer's farm income increases, they are more likely to participate in aquaculture insurance by about 30%. However, decreases the amount intensity by GH¢ 2.846 (US$ 0.482). One possible reason could be that financial situations are getting better and could bear the brunt of the cost for any unforeseen circumstance. The result contradicts Zheng *et al.* (2018) who found a negative influence of income on aquaculture insurance participation. Nonetheless, in line with Sujarwo and Rukmi (2018).

On the institutional factors, awareness was found to have a positive and significant effect on the participation of aquaculture insurance. The result follows the findings of Akinola (2014) who indicated that awareness of agricultural insurance is a significant determinant of participating in agricultural insurance. Duhan and Dhingra (2018) also iterated that, farmers who are aware of agricultural insurance are more likely to participate in the same.

The results from Table 4 further reveals that farmers who had extension service access have a direct and significant effect on both the probability and amount intensity of aquaculture insurance. Perhaps, farmers would be sufficiently educated on the benefits of aquaculture insurance by extension officers. Farayola *et al.* (2013) indicated that extension service access is essential in determining agricultural insurance participation because the education extended by extension agents is likely to influence participation on the same. The result is in agreement with Carrer *et al.* (2020) who reported a positive association between private technical assistance and agricultural insurance adoption. Credit access was positive and significantly different from zero on aquaculture insurance participation and amount intensity. The result is indicative that, the more credit access, farmers are more likely to participate in aquaculture insurance by about 18% and the corresponding amount intensity is increased by GH¢ 0.108 (US$ 0.018). The result is similar to these studies (Akter *et al.*, 2008; Adeyonu *et al.*, 2016) but at odds with Ntukamazina *et al.* (2017). Concerning amount intensity, the coefficient of stock size was positive and significantly different from zero ($p < 0.1$). This implies that increasing stock size increases amount intensity by GH¢ 0.061 (US$ 0.010). Akintunde (2015) observed a similar effect. FBO membership had a positive and significant influence on aquaculture insurance participation and amount intensity. Thus, FBO membership is likely to increase aquaculture insurance participation by approximately 56% and amount intensity by GH¢ 0.150 (US$ 0.025).

Table 5 shows the profitability indicators of aquaculture. The result is suggestive that, aquaculture is a profitable enterprise and presents an agripreneur opportunity to the economically active who are job displaced. In detail, the PI was greater than one and ROI positive. Generally, this indicates that aquaculture farms in the Eastern region of Ghana are in the medium term generally profitable. According to Asmah (2008), the profitability of Ghana's aquaculture is mainly bedeviled with constraints such as exorbitant feed price, low output levels, and low fish prices which could be upgraded through healthier farming practices. Increasing profitability suggest that farms should operate efficiently and produce quality fish for attractive market price. Undoubtedly, high profitability corresponds with a PI greater than 1 and a positive ROI (Aheto *et al.*, 2019). Besides, as Engle and Valderrama (2004) indicated, avoiding feed waste would save cost and contribute to farm profitability.

Profitability index (PI)	Return on investment (ROI)
Value of fish = GH¢ 1959620.00 (US$ 332138.98) Total cost of feed = GH¢ 948149.00 (US$ 160703.22) PI = 2.07	Annual net profit = GH¢ 1,030,500 (US$ 174661.00) Total capital investment = GH¢ 32,517,200 (US$ 5511389.83) ROI = 3.2%

Source(s): Field data, 2020 NB: US$ 1 = GH¢ 5.9

Table 5.
Profitability analysis

5. Conclusions and recommendations

The paper investigates the prospects, determinants, and profitability of aquaculture insurance among fish farmers in the Eastern Region of Ghana. Loss recovery, farm renovation, and promotes agriculture emanated as the themes on the perception of aquaculture insurance prospects. Different group of factors was found to influence aquaculture insurance participation and amount intensity. On demographic factors, the empirical results revealed a positive and significant relationship between aquaculture insurance and amount intensity and education and farm experience. In contrast, household size and farm income had a negative effect on aquaculture insurance participation and amount intensity respectively. Concerning institutional factors, awareness positively affected aquaculture insurance participation. Extension service, credit access, and FBO membership positively affected both aquaculture insurance participation and amount intensity. However, stock size influenced amount intensity negatively. Estimates on the profitability indicators (PI = 2.07; ROI = 3.2%) revealed that aquaculture is a profitable enterprise.

It is recommended that since education and awareness have a positive effect on aquaculture insurance participation and amount intensity and the former respectively, the Ministry of Fisheries and Aquaculture Development (MoFAD) should prioritise schedules like seminars to educate farmers on the benefits of aquaculture insurance. Consequently, increasing the awareness on the same. Additionally, based on the positive effect of stock size on amount intensity, it is recommended that insurance firms such as Ghana Agricultural Insurance Pool (GAIP) and World Cover on a pilot implementation of aquaculture insurance in the given study area should focus on farmers with higher stock size. Also, the government should provide employment opportunities through aquaculture to the teeming unemployed youths because the industry appears to be profitable. Concerning the methodology, future studies should employ similar estimation methods as it has proved to be robust in achieving the research objectives.

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