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Perception and management of risks in the shrimp sector, empirical results of producers in the province of El Oro, Ecuador.

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Percepción y manejo de los riesgos en el sector camaronero, resultados empíricos de los productores de El Oro, Ecuador.

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Abstract

This study was conducted to explore shrimp farmers' perceptions of risk and risk management. The data used originated from a field survey in the southern coasts of Ecuador, El Oro. There are many studies dedicated to the study of aquaculture´s risks, but there is a need to know about the shrimp farmers' perception of risks and the strategies they used to mitigate them. Therefore, this document explores: (a) farmers 'perceptions of risks and their management responses and (b) farmers' socio-economic characteristics in terms of their risk perceptions and risk management strategies. Farm-level data were collected through a sample recognition survey of 79 shrimp farms. The exploratory factor analysis showed that the risks in shrimp farming are derived from five factors: Policy and finance; Market and costs; Weather and environment; Lack of technical knowledge; and Production management. The results also revealed that the risk perception of shrimp farmers could significantly influence their risk management behavior. In addition, seven factors were identified for risk management strategies, including government support and risk sharing; education and technology improvement; implementation of good production practices; corrective management; disease prevention; contract external assistance; and marketing.

Keywords: Risk, risk management, shrimp farming, factor analysis, Ecuador.

Resumen

Este estudio se realizó para explorar las percepciones de los productores de camarón sobre el riesgo y la gestión del riesgo. Los datos utilizados provienen de un estudio de campo en El Oro, una provincia ubicada en la costa sur de Ecuador. Hay muchos estudios dedicados al estudio de los riesgos de la acuicultura, pero es necesario conocer la percepción de los riesgos por parte de los camaroneros y las estrategias que utilizaron para mitigarlos. Por lo tanto, este documento explora: (a) las percepciones de los agricultores sobre los riesgos y sus respuestas de gestión y (b) las características socioeconómicas de los agricultores en términos de sus percepciones de riesgos y estrategias de gestión de riesgos. Los datos a nivel de granja se recopilaron a través de una encuesta de reconocimiento de muestras de 79 granjas camaroneras. El análisis factorial exploratorio mostró que los riesgos en el cultivo de camarón se derivan de cinco factores: políticas y finanzas; Mercado y costos; Clima y medio ambiente; Falta de conocimiento técnico; y Gestión de producción. Los resultados también revelaron que la percepción de riesgo de los productores de camarón podría influir significativamente en su comportamiento de gestión de riesgos. Además, se identificaron siete factores para las estrategias de gestión de riesgos, incluido el apoyo del gobierno y el riesgo compartido; mejora de la educación y la tecnología; implementación de buenas prácticas productivas; manejo correctivo; la prevención de enfermedades; contratar asistencia externa; y marketing.

Palabras clave: Riesgos, evaluación de riesgos, cultivo de camarón, análisis factorial, Ecuador.

Introduction

In Ecuador, the shrimp sector is one of the main productive areas that employ more than 200,000 direct jobs. This study focuses on understanding the behavior and perception of shrimp farmers in the face of risk and on the strategies they use to mitigate them, with the objective of having a broader panorama of the sector and observe critical points of improvement. The UN's Food and Agriculture Organization defines aquaculture as the "farming of aquatic organisms including fish, mollusks, crustaceans, and aquatic plants. Farming implies some intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators, etc." (Food and Agriculture Organization of the United Nations [FAO], 2003). As with any livestock industry, several risks can impact the viability of aquaculture initiatives (Agence Française de Développement [AFD], 2017). However, the dangers in aquaculture may differ between the systems and practices depending on environmental conditions, and the type of species to be produced.

Agro-business is risky compare to businesses in other sectors, and producers usually are risk-averse and sacrifice some income to reduce the chances of economic losses (Kahan, 2013). The FAO and Network of Aquaculture Centers in Asia and the Pacific have identified seven "risk categories" in previous expert discussions. These categories were pathogen risks, food safety and public health risks, ecological (pests and invasive) risks, genetic risks, environmental risks, financial risks, and social risks. In, this paper, I focus on the risks that production-related, including financial risks. (Arthur et al., 2009).

In aquaculture, financial risks refer primarily to investment risk associated with individual farms or facilities. Yu et al. (2008) suggest that financial risks are divided into market threats and production threats. Market threats include price fluctuations and the impacts of the regulatory environment. Competition, either domestically or internationally, will add to the volatility of market prices and hence to profit margins. In contrast, the regulatory environment may create additional cost burdens at the national level that are equally shared across the industry (AFD, 2017). On the other hand, production threats result in financial loss due to reduced yield. These threats may come from

adverse environmental conditions, equipment failure, inadequate quality stock, disease or pest infestation, and others; poor quality of labor or unskilled labor can have a negative impact on these external factors; therefore, employee management can lead to severe failures in production (AFD, 2017).

Additionally, diseases in production have also become one of the major sources of risk in the last several years (Lestariadi & Yamao, 2018). According to a recent assessment conducted by (The World Bank, 2013) disease outbreaks have reportedly cost the aquaculture industry tens of billions of dollars in the last 20 years. According to the Food and Agriculture Organization (FAO, 2016), disease outbreaks cost the global aquaculture industry some US$6 billion per year and represent a significant farm-level risk. The shrimp industry alone has suffered losses of approximately US$10 billion since 1990, and new diseases are appearing every year. Vietnam independently reports losing an average of US$1 billion per year due to diseases. As an example, the Chilean salmon farming industry is in the process of recovering from a severe outbreak of infectious salmon anemia virus (ISAV) which cost 350,000 to 400,000 tons of fish and 20,000 jobs (The World Bank, 2014).

Nonetheless, ¿Why should attention be paid to the risks inherent in aquaculture production? The answer lies in what this activity means to the world. Whereas aquaculture provided just 7% of fish for human consumption in 1974, this share had increased to 26% in 1994 and 39% in 2004 (FAO, 2016). Species such as salmon and shrimp have come from intensive farming; much of this expansion has been due to smallholders' wide-scale adoption of aquaculture. FAO estimates that fish farmers increased from 6.1 million in 2000 to 18.7 million (FAO, 2016). Aquaculture operates at various scales, and it can vary from subsistence-level 'backyard' fish farming to the industrial scale. In September 2015, many countries adopted 17 Sustainable Development Goals (SDGs) with specific targets to be achieved until 2030. Whether it be the primary production stage or any related level on the supply chain, the aquaculture value chain can achieve SDGs at national and regional levels (AFD, 2017). However, the goals that might be achieved will depend on the business model. Subsistence

aquaculture may not directly reduce poverty but greatly help reduce hunger, as it can provide a constant supply of high-protein food and generate additional income if it is sold. Small-scale commercial aquaculture has a more significant opportunity to contribute to family income directly and addressing poverty issues (AFD, 2017). Small and medium-sized enterprises (SMEs) contribute the most to SDG 8, decent work and economic growth, and SDG 1, No Poverty. However, expansion and development may not benefit all, and increasing intensification can create environmental and socio-economic problems. Finally, industrial aquaculture can be an essential element of economic growth, mainly if it generates foreign revenues from exports. It can also produce job opportunities, but these tend to be most skilled, and jobs per unit production are low. (AFD, 2017).

The aquaculture industry represents a solution to many of the food security issues facing the growing human population. Aquaculture is not just a matter of producing fish; it is part of a complex value chain influenced by a range of environmental, social, and governmental factors (AFD, 2017). The purpose of this paper is to provide an overview of how risk can manifest in aquaculture operations and management. Decision-makers frequently use risk analysis to understand events that potentially have large consequences and have large uncertainty (Bodemer & Gaissmaier, 2015). More generally, risk is defined as a combination of the likelihood of an occurrence of a hazardous event or exposure(s) and the severity of losses that can be caused by the event or exposure (Choudhary et al., 2016). Risk is about a future event, and future events can be imagined or construed, not sensed, and risk perception is all about thoughts, beliefs, and constructs, towards hazards and their benefits (Sjöberg, 1980). In this study, we adhere to the definition of risk perception that conceptually explain risk perception as a "subjective assessment of the probability of a specified type of accident happening and how concerned we are with the consequences" (Sjöberg, 2000).

In exploring the risk environment, there are several types of analyses of risk sources and the levels of their impact on farming activities; one of these types is factor analysis. Factor analysis aims to reduce many individual items into fewer dimensions (Lestariadi & Yamao, 2018). Exploratory factor

analysis (EFA) is used when researchers have little idea about the underlying mechanisms of the target phenomena. Therefore, they are unsure of how variables would operate vis-à-vis one another (Matsunaga, 2010). For example, a recent study by the University of Japan (Lestariadi & Yamao, 2018) found out that on the northern coasts of East Java, Indonesia, 32 risk sources were present on shrimp production activities. The shrimp price volatility and high mortality due to shrimp diseases are the most important ones. The exploratory factor analysis showed that the risks derived from eight factors as input and pond preparation, finance and credit access, production, personal aspects, harvesting and marketing, weather and environment, policy and institutional aspects and business environment. Furthermore, nine factors were identified for risk management strategies, including disease prevention, education, and technology improvement; production inputs; farm management; government support; risk sharing and insurance; financial aspects; household adjustment; and alternative income sources. Additionally, (Ahsan, 2011) carried out related research in shrimp farms in Bangladesh. The study found 23 risk sources. Factor analysis reduce these sources of risk into seven factors: institutional, demand, marketing, business insecurity, input price, political affairs, and credit. On the other hand, the prevention of diseases is considered among the best strategies to manage the risks in the shrimp farming business. (Bergfjord, 2009), surveyed Norwegian aquaculture and found 39 risk sources. For the risk sources, the future salmon price was the most critical risk. On top of that, the exploratory factor analysis was applied to reduce the number of strategies into nine factors and found the most important was the marketing factor.

The facts mentioned earlier revealed that aquaculture (e.g., shrimp farming) has a hazardous nature, making the farmers face multidimensional risks. Therefore, the understanding of small-scale shrimp farmers' risk management strategies is essential for formulating the proper policy to develop and preserve the sustainability of the shrimp industry and the farmers' livelihood (Krause, 2014). However, the literature in risk management of small-scale shrimp farming, particularly in developing countries (e.g., Ecuador), is scarce. The purpose of this study is to investigate the risk behavior of

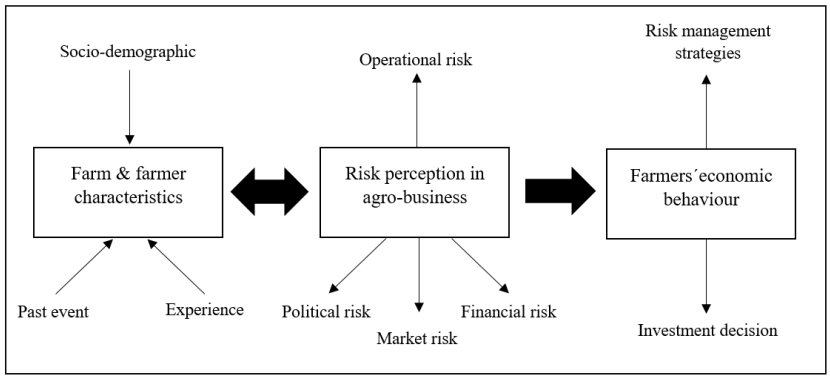
small-scale shrimp farmers in Ecuador, keeping in mind the importance of risk management strategies in small-scale shrimp farming. Therefore, this research had two objectives: (1) to indentify the sources of risk in small-scale shrimp farming and the use of risk management strategies at farm level; (2) to analyze the major risk factors and risk management strategies in the study area. This study also provides some information on farmers' motivations, goals, and plans for the future. This paper is organized as follows: the second section provides a brief description of shrimp aquaculture in Ecuador; the third section explains the methodology; the fourth section discusses the results, and the last section concludes.

Conceptual Framework.

The best way to describe decision-making behavior is to understand the individual's frame of reference for evaluating choices with uncertain outcomes. The decision maker's perceptual world is that person's reality and forms the basis for her or his intentions (Flaten et al., 2005). Therefore, this paper will use (van Raaij, 1981) decision-making model to explain the interdependence between farm and personal characteristics, risk awareness, and management responses. The van-Raaij descriptive model, Figure 3, is a framework for research on economic behavior, where the perceived economic environment determines the individual's economic decisions.

Figure 1

Model for economic behavior of van-Raaij´s model modified by D.A Ashan (2009).



According to this model, both the farms and farmers' elements (e.g., farm size, education, income level) influence farmers' risk perceptions (Flaten et al., 2005). Several recent studies used this model to explain farmers' risk perceptions and management responses regarding those risks and obtained interesting results (Ahsan, 2011; Lestariadi & Yamao, 2018). The present study also used van-Raaij's model to explain the risk perception and risk management responses of the coastal shrimp farmers of El Oro.

Background About Shrimp Aquaculture of Ecuador.

Ecuador is located on the Pacific coast, northwest of South America. It has an area of 256,370 km^2. More than 95 percent of Ecuadorian aquaculture corresponds to the cultivation of marine shrimp (Litopenaeus spp), followed by the cultivation of Tilapia (FAO, 2004). The generation of foreign exchange is the most important aspect of aquaculture activity in the Ecuadorian economy, although the generation of jobs directly benefits the population. Consequently, around 200 thousand families depend on shrimp production in Ecuador, corresponding to larval laboratories, balanced processors, packing plants, logistics and transportation, and other related services. According to sources from the National Chamber of Aquaculture of Ecuador, Ecuadorian shrimp exports reached 11,400 tons in 1998. Ecuador currently exports around 679 985 tons of shrimp each year (Poveda & Piedrahita, 2020).

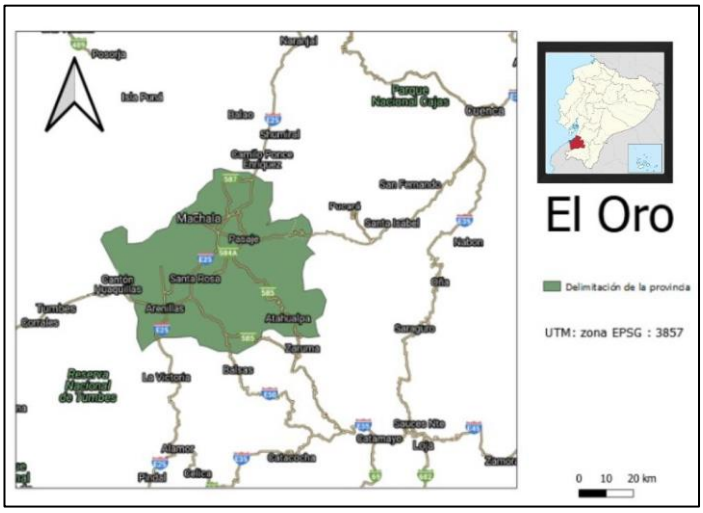
Nowadays, Ecuador has 1532 registered shrimp farmers within 240,000 hectares in production, distributed in the provinces of Guayas, El Oro, Manabí, and Esmeraldas, being the province of Guayas and El Oro the largest, with an economic contribution of 169,124 (USD Millions) and 147,977 (USD Millions) respectively (Peña, 2017). The production share of shrimp in the Province of El Oro currently represents approximate 38% of the country's non-oil exportable supply. Unfortunately, the price of shrimp has dropped drastically since May 2014, where it reached the highest pound price of $ 3.50 / lb; now the price of shrimp fluctuates around $ 2.20 / lb.

Methodology

The study was carried out in El Oro, a province on the south coast of Ecuador (Fig. 2). El Oro is vital production area for aquaculture. The area comprises estuaries and mangroves whose natural diversity of the soil and mineral wealth provide nutrients to its waters, facilitating the cultivation, fishing, and commercialization of shrimp (Ordonez, 2015). It is the second-largest producer in Ecuador, and has the most significant number of shrimp farms in terms of producers. In addition, most small and medium producers are in this area, making the research sample more significant.

Figure 2

Map of Ecuador showing the province of El Oro.



The shrimp producers in the following study were classified according to the shrimp farm´s operational system and the number of hectares used to produce. Shrimp farms can be divided according to the system with which they are managed. These are extensive, semi-intensive, and intensive; around 90% of the shrimp farms in El Oro produce extensively. Extensive production refers to all shrimp farms that sow less than 15 larvae per square meter, and the semi-intensive one goes between a range of 15 to 50 animals per square meter. Finally, the intensive production sows more than 50 larvae per square meter. After this comes the classification by extension, dividing them in the following way. Type A shrimp farms have an extension of up to 20 ha, type B shrimp farms have an

extension between 20 to 79 ha, type C shrimp farms have a range between 80 to 150 ha, and finally, type D shrimp farms have a land area of 150 ha or more. All the data mentioned above were discussed with experts in personal interviews; they adapted the parameters to the reality and situation of the province of El Oro.

Survey.

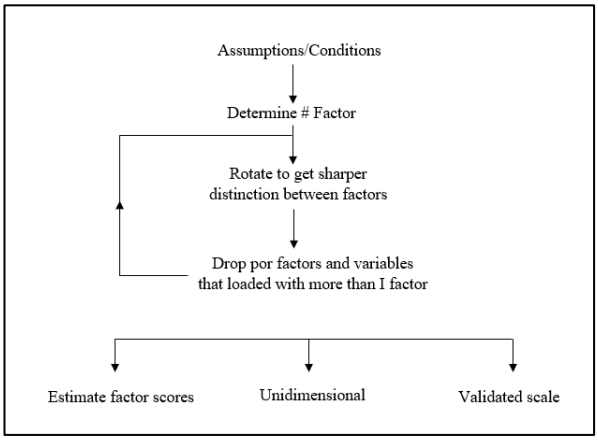
The sample included 79 shrimp farms. The questionnarie included questions related to general characteristics of shrimp farm, such as area or number of workers, as well as costs and harvests carried out-farm. Farms were divided according to these aspects. In order to complete the survey, in depth consultation with professionals in shrimp farming with 15 years of experience was conducted to avoid omitting any crucial information related to risk sources or management strategies. As a result, the researchers developed a questionnaire covering risk sources and risk-management strategies presented to the respondents. Each shrimp farmer was given a questionnaire with a list of 25 sources of risk and 28 strategies to mitigate those risks. Next, the respondent should answer on a likert scale (from 1 to 5) the probability that this risk will materialize in the shrimp farm, and they should also answer again on a likert scale (1 to 5) the impact that this risk would have if it will happen. In this research, a five-point Likert scale was used to measure the consequences (from 1= insignificant to 5= critical) and the likelihood (from 1 = almost impossible to 5 = almost certain occurrence) of risk sources. In addition, the concept of risk levels was used to measure the potential impact of risk sources. The level of risk is defined as the result of the multiplication between consequence and likelihood of risk. Afterward, the risk level score (ranging from 1 = least significant to 5 = most significant) is used for the analysis. The effectiveness of risk management strategies was also measured with a five-point Likert scale, ranging from 1 (= not effective at all) to 5 (= very effective).

Statistical Analysis

The statistical analysis was made using the IBM SPSS version 28.0 software. Before performing the EFA, all variables were checked through a KMO correlation coefficient matrix and, the Bartlett's test of sphericity, both of them measures the degree of intercorrelations among the variables and the appropriateness of factor analysis. After this, the exploratory factor analysis was carried out, which examinates the correlations between the observed variables and goups them in latent variables or factors. In figure 3, a flow chart of the steps carry out to perfom an exploratory factor analysis is shown. Highly correlated variables were put in the same groups, which are also called "factors". Additioanly, the factor loading score is the correlation coefficient for the variable and factor. Facotr loading shows the variance explained by the variable on that particular factor. In this study, the variables consisted of information related to sources of risk and management strategies. It can be understood as the purpose of factor analysis, as a method that tries to group extensive information data and create latent variables that group these smaller ones and explain the movement of those variables in the form of "factors." Moreover, the eigenvalues express the degree of variation among variables in each factor. The eigenvalue score major than 1 was used to determine the number of factors to be extracted (Hair, 2013)

Figure 3

*Flow chart of steps to perform an exploratory factor analysis***.**



Results y Discussion

This section presents the result of the factor analysis of risk sources and risk management strategies for shrimp farming in El Oro, Ecuador. First of all, a descriptive analysis of the sample is shown in Table 1. Then the exploratory factor analysis was applied to reduce a large number of risk sources and risk management strategies into several factors. The factors extracted and obtained from the study are presented in Table 2 and Table 3, respectively.

Table 1

Descriptive characteristic of farms shrimp in El Oro, Ecuador.

Characteristic	XLF (n=22)	LF (n=11)	MF (n= 34)	SF (n= 8)	IF (n = 4)
Mean farm size (ha)	352.9	97.5	49.4	14.3	10
Mean density (animals/m2)	12.8	11.16	10.5	11	19.0
Mean production per ha (lb)	4073	2819	2905	3085	5072
Mean farming experience of head (years)	27	13	14	9	20
Mean needed workers/10 ha	3	2	3	3	4
Mean number of animals harvested/kilo	30	35	37	36	39
Mean total direct costs (US$)/ha (inputs)	2886	1948	1997	2794	2990
Mean total indirect costs (US$)/ha (operative)	1533	1048	1075	1504	1610
Mean total costs (US$) per ha	4419	2996	3072	4299	4600
Owners that administrated their own farm (%)	35%	60%	67%	75%	75%
Owners that do not have other sources of income (%)	29%	10%	36%	50%	25%
Shrimp farms that are on land (%)	70%	60%	63%	63%	100%
Shrimp farms that are on islands (%)	29%	40%	37%	38%	0%

Note. The shrimp farms were categorize by territorial extension as 4 main categories; Extra large Farms, Large Farms, Medium Farms, Small Farms. Additionally Intensive Farms were also included as a different category.

Table 1 presents the essential characteristics that can be obtained from the descriptive part of the survey. The shrimp farms were divided into five groups according to the production area. These areas were small, medium, large, giant, and intensive farms. The mean of the shrimp farms was 14.3 ha, 49.3 ha, 97.5 ha, 352.9 ha, and 10 ha, respectively. This division was adapted to the reality of the

province of El Oro through interviews with experts. Additionally, it was possible to obtain the average number of workers for every 10 hectares employed and an average of pounds harvested per hectare and costs associated with production.

Sources of Risk in Shrimp Farms in the Province of El Oro.

In this study, the concept of risk levels is used to measure the possible impact of each variable. The level of risk is defined as the result of multiplying the possible consequence of a risk by the likelihood of occurrence. A total of 25 sources of risk were identified. The risk source with the most significant impact was the volatility of the price of shrimp; this was the most significant with a score of 16.22, being the only one at the first level (see Table 1, column 2). The second level of risk, that includes variables with a score between 12 and 15, are the future price of inputs on the rise (14.98) and the oversupply of shrimp in the market (14.59) as the main ones. The following five sources of risk were scored between 9 and 11, it constituted the third (moderately significant) level of risk. Finally, the rest of the sources were classified at the fourth (slightly significant) level. No risk was categorized at an insignificant level.

Most significant risks in the shrimp sector are related to the price of shrimp and the inputs necessary to produce. Similar findings as with the Greek farmers were also reported by Theodorou and Tzovenis (2021). Kabir et al. (2020) showed that price variability in Bangladesh were the greatest concern of shrimp producers, while in Norway the futures price were found by Bergfjord (2009) as the major concern of salmon producers. The international market influences the price of shrimp, and the government of Ecuador does not have measures that help producers, which creates more uncertainty within the activity. Additionally, the increasing prices of larvae and inputs such as balanced food tend to be widely perceived by producers.

Furthermore, the total of 25 risk sources were reduced using the Varimax rotation common factor analysis. Prior analysis, the assumptions of factor analysis were verified using the Kaiser-Meyer-Olkin (KMO) test and Bartlett test. As shown by the results, the KMO was 0.874, and the Bartlett test

was statistically significant at 0.01. Referring to Hair (2013) these results mean the data was satisfactory for factor analysis. Based on this justification, the 25 risk sources were reduced into five factors. The factors grouped the risks that had a higher correlation coefficient, thus, observing the description of each risk, a name was determined to each factor that would better explain the characteristics of these risks. The factor are (1) politics and finances, (2) markets and costs, (3) environment and climate, (4) technical training and, (5) production management. These five factors explain 65.96% of the total variance (in social science this is considered satisfactory; (Hair, 2013). The factor loading, total variance and extracted factors are shown in the fourth, fifth and sixth columns in Table 2, respectively.

Table 2

Risk sources in shrimp farming of El Oro, Ecuador.

Risk sources	Risk level score*	Rank	Factor loading score	Total variance explained (%)	Factor extracted
Taxes and new contributions to the state	12.59	11	0.849	24.01%	Policy and Finance
Political instability of the country	13.25	5	0.795		
Uncertainty about market access	13.34	4	0.784		
Inadequate access to bank credit	12.03	12	0.777		
Rising interest rates	12.67	10	0.767		
Shrimp oversupply in the market	14.59	3	0.698		
Insufficient capital to operate.	12.71	9	0.653		
New licenses and regulations to produce	10.77	16	0.590		
Insecurity (assault / robbery)	12.97	8	0.565		
Future price of inputs will increase	14.98	2	0.777	14.63%	Market and Costs
Larva price on the rise	13.15	6	0.708		
Increasing equipment / machinery price	13.01	7	0.674		

Risk sources	Risk level score*	Rank	Factor loading score	Total variance explained (%)	Factor extracted
Problems with logistics and transportation	10.87	15	0.594		
Poor budget and cost planning.	7.24	25	0.563		
Shrimp price volatility.	17.2	1	0.514		
Floods	10.4	18	0.829	11.01%	Weather and environment
Biophysical shocks (storms, sudden changes in light, temperature, etc.)	9.67	19	0.793		
Water sources with excess organic matter.	10.43	17	0.539		
Illnesses / health problems for employees.	8.81	22	0.500		
Lack of knowledge to prepare pools before planting	7.25	24	0.771	9.07%	Lack of technical knowledge
Not giving the amount of food necessary for the number of animals.	8.07	23	0.715		
Unskilled or untrained labor	8.82	21	0.557		
Shrimp death caused by disease	11.96	13	0.742	7.24%	Production management
Pool water contamination due to excess balancing	9.49	20	0.552		
Poor quality of the larvae.	11.65	14	0.470		

Note. Risk level score: 1–4 = insignificant; 5–8 = slightly significant; 9–11= moderately significant; 12–15 = significant; 16–20= most significant. Source: own research.

The first factor extracted is "policy and finance," which explained around 24.01% of the total variation. Various risks such as taxes and new contributions to the State, political instability in the country, uncertainty in new markets, and inadequate access to bank credit had a high factor loading within the risks in this group. These results are related to the current situation in the country. It can be seen that the help from the State is almost non-existent to improve production within this sector and offer greater security of relations with other countries in order to improve international trade.

Ecuador, since 2008 had many problems in relations with countries that were potential markets due to the lack of free trade agreements, unlike other shrimp-producing countries. The second factor is named “Market and Costs” which explains 14.63% variation and tries to group the risks related to the price of the inputs used in production. Costs such as feed, larva price, and the price paid per pound of shrimp have the highest loading factor in an economy of scale such as shrimp production, every penny costs. In this activity, the costs are divided as follows, around 50% to 60% of the total production costs come from high-quality formulated feed, then 5% in salaries, and finally, the remaining 35% is divided between operating expenses and operational (Sánchez et al., 2020).

Extreme changes in climate such as biophysical shocks, temperature changes, floods, and water sources with excess organic matter, make up the principal authors of factor number three. This factor was named "climate and environment." This factor explains about 11.01% of the next observed. The problems in the environment and the climate variability are inherent problems within any production, but they have significant weight within Aquaculture since shrimp behave differently according to the weather or the season (winter or summer). Climate dramatically influences shrimp health and how it will perform in the production cycle. In winter, where more rains fall and the climate is colder, shrimp tend to grow more slowly and have a more significant number of diseases and increase the use of inputs such as probiotics or antibiotics. Compared to the summer, when there is more sun, the shrimp grows faster and consumes more food that, in the same way, transforms it faster, and the diseases are not as recurrent. Fortunately, in the El Oro sector, the climate is favorable to Shrimp production.

Shrimp farmers were also affected by risks associated with "lack of technical knowlegde" or "personal aspects," a factor that explained around 9.07%. Delving into this factor, the lack of knowledge to prepare the pools before being seeded, not giving adequate food, and untrained or inefficient workers were the highest loading factor. Most of the surveyed shrimp producers had an average experience of approximately 15 years, which is why most of these risks listed last. In the

interviews with experts, a common characteristic appeared. Many producers are stubborn when it comes to production and technical knowledge, they believe they know everything about shirmps and their production management is perfect, and any error is not attributed to the owner/administrator, but to external factors such as the government or the market.

As a last factor, we have "production management." It explains around 7.24% of the variation, mainly associated with deaths caused by diseases, contamination of swimming pools, and deficient quality larvae. These risks are likely related to producers who do not have much experience or are just starting in the shrimp business. However, this technical failure when buying the larvae and when feeding can be solved by implementing good manufacturing and production practices. The oxygen levels, the pH levels, and the levels of organic matter in the water are the main determining factors to avoid the death of animals caused by diseases or intoxication.

Risk Management Strategies in Shrimp Farms of El Oro, Ecuador.

In the research work, 27 risk management strategies were presented to the respondents. These strategies were ranked on a five-point Likert scale regarding their effectiveness in mitigating the impact of sources of risk. The average scores with their respective ranking can be viewed in table three's second and third columns of Table 3. In the results, it can be observed that around 14 risk management strategies are classified as highly effective in reducing the risks associated with shrimp production, with an average ranging from 4.1 to 5. Buying quality seed, buying formulated feed from reliable brands, strict feed management, hiring qualified technical assistance, and producing at the lowest possible cost are the five strategies with the highest score on the list.

In the second group, 11 strategies were found with an average value between 3.1 and 4.0. Finally, only two strategies fell into being moderately effective: informal loans and requesting technical assistance from the government. No strategy categorized as ineffective or not effective at all was recorded. Although shrimp price volatility was perceived as the most significant source of risk,

the strategies that could have controlled this risk (such as a contract or insurance) were ranked as one of the last. This may be explained because in El Oro, producers do not receive any stimulus from the government or financial entities, which is why the production contract system is not expected within this sector.

The research found that shrimp producers prefer to invest in activities that stimulate the health and quality of their production, such as the purchase of certified quality larvae and a balanced high protein percentage and correct food handling to ensure shrimp health. What comes to be contradictory with strategy number 5, producing at the lowest possible cost, since implementing balanced quality and technical support can become very expensive. Finally, factor analysis with a Varimax rotation reduced the strategies in seven factors: (1) government support, (2) implementation of good production practices, (3) technology improvement, (4) disease prevention, (5) corrective activities, (6) hiring of external technical services, and (7) marketing improvement. Together they explained about 57.7% of the accumulated variance.

Table 3

Risk management strategies in El Oro, Ecuador.

Risk management strategies	Mean*	Rank	Highest loading factor	Total variance explained (%)	Factor extracted
Vertical integration (control / cooperation with other links in the value chain).	3.75	19	0.714	15.24%	Government support and risk sharing
Contracting insurance for shrimp damage / loss.	3.48	24	0.688		
Request technical assistance from the government.	2.92	26	0.678		
Make credit arrangements before the production cycle begins.	3.68	21	0.675		
Production contract.	3.58	22	0.668		
Monitor the market price.	4.10	11	0.641		

Risk management strategies	Mean*	Rank	Highest loading factor	Total variance explained (%)	Factor extracted
Contact the authorities to request support in prices and regulations that promote development.	3.58	23	0.618		
Strict food management.	4.46	3	0.830	12.99%	Implement good production practices
Buy "seed" from reliable and qualified suppliers.	4.57	1	0.698		
Provide technical training to staff.	4.25	7	0.690		
Implement actions that motivate staff.	4.24	8	0.611		
Plan the supply of feed.	4.28	6	0.517		
Purchase of balanced formulations from reliable brands.	4.47	2	0.486		
Produce at the lowest possible cost.	4.29	5	0.441		
Implement environmental certifications (ACS).	4.05	14	0.681	8.35%	Education and Technology improvement
Attend shrimp production workshops.	4.13	10	0.635		
Invest in technology to feed better	4.15	9	0.594		
Strict management of water quality.	4.09	12	0.780	5.34%	Disease prevention
Implement a water treatment system.	3.75	19	0.602		
Perform thinning in the middle of production.	3.78	18	0.571	5.21%	Corrective management
Sow at lower densities	3.33	25	0.524		
Deploy more guards.	2.47	27	0.493		
Hiring of financial advisory services	3.87	17	0.582	5.07%	Contract external technical Assistance
Prevention, periodic veterinary / medical advice for shrimp.	3.95	15	0.475		
Hire qualified technical assistance.	4.38	4	0.410		
Remove the influence of the intermediary.	3.89	16	0.637	4.07%	Marketing improvement
Promote products internationally.	4.09	12	0.409		

Note. Mean of risk management strategies: 0.0–1.0 = not effective at all; 1.1–2.0 = poorly effective; 2.1–3.0 = medium effective; 3.1–4.0 = effective; 4.1–5.0 = very effective. Source: Own research

Factor number 1 is referred to as "government support and risk sharing," it explained about 15.24% of the observed variance. Implementing environmental certifications, contracting insurance

for the loss or damage of shrimp production, and receiving technical assistance from the government are the three strategies with the highest loading scores of 0.71, 0.68, and 0.67, respectively. On the other hand, these strategies were among the strategies less popular. It may be because the Ecuadorian shrimp farmer does not trust the government to ask for help, and no production insurance is attractive to the guild.

Factor 2 is labeled with the name "implementing good production practices," explaining 12.99% of the observed sentence. The most correlated strategies to this factor are strict feed management, buying quality larvae from certified suppliers, and training standard personnel in technical knowledge of shrimp farming. These strategies are also among the five best strategies proposed by shrimp farmers, emphasizing the purchase of certified and viable larvae. In shrimp farms, production has a 50% probability of doing well if its larvae are of quality and present the best conditions. Factor number 3 “Improving production technology” and it includes the risks associated with improving processes in implementing new technology such as feeders and serving shrimp production workshops. Factor number 4 comprises disease prevention, strict water quality management, and implementing new treatment systems.

The strategies of sowing at lower densities, thinning, and hiring more security, were grouped as “Corrective management” in Factor 5 (5.21% of the observed variation). Moreover, Factor 6 “Contract external assistance” group the following strategies hiring financial assistance, periodic review of a veterinarian, and hiring quality technical service; this factor explained a 5.07% variability. Finally, the last Factor focuses on marketing and explains 4% of the variance. The strategies in this factor are removing the influence of the intermediary and promoting the products internationally. From a primary production point of view, the first strategy has the objective of selling directly to the retailer, bypassing the intermediary, and thus being able to have a better price. The second strategy aims to find better markets or new markets to diversify buyers and not depend only on China or the United States.

Conclusions

In El Oro, most of the shrimp farms continue to produce extensively, where the XL farms with the highest costs per hectare. Likewise, the extra large ones are the ones that harvest the largest shrimp. As a result, around 25 sources of risk were found. The volatility of the price of shrimp and the increase in inputs were the most critical risks for the Shrimp sector in the province of El Oro, Ecuador. The price of shrimp has been fluctuating over time, but since May 2014, the price reached its maximum point, and after that date, it has been decreasing until reaching worst prices than in 2008.

It can be seen through the results, that the perceptions of shrimp farmers can be significantly influential towards risk management behavior. The five strategies with the highest scores were buying quality seed, buying food with quality formulation, strict food management, hiring qualified technical assistance, and producing at the lowest possible cost.

The exploratory analysis factor showed that risks in shrimp farms or shrimp farms could be derived from five factors which are politics and finance, cost market, climate and environment, technical training, and production management. All these factors explained about 66% of the observed variability (which means that not all the risk sources that have some effect in shirmp production are taken in consdirecion, thus approximatly 33% of variance is not explained in this paper. On the other hand, nine factors could also be identified that grouped the management of strategies for risk mitigation, which included government support, implementation of good production practices, technology improvement, disease prevention, corrective management alternatives, external contract technical assistance, and marketing.

Recommendations

This experience shows that there is a wide range of approaches to aquaculture development and risk management. However, it is very apparent that there is no single solution, and the approaches need carefull preparation and wide-ranging consultation to a successful intervention and a long-lasting impact.

Identifying these sources of risk and strategies for managing them can better understand the nature of the risk and the uncertainty in the shrimp farming activity. This research can have, in effect, a follow-up in the other provinces of Ecuador and in this way have a broader spectrum about the behavior of this country, which is one of the largest shrimp producers worldwide. These results can help or contribute to government and non goverment agents to design new policies and regulations that can provide long-term support and sustainability to the shrimp industry, especially to the producers who are primary sector.

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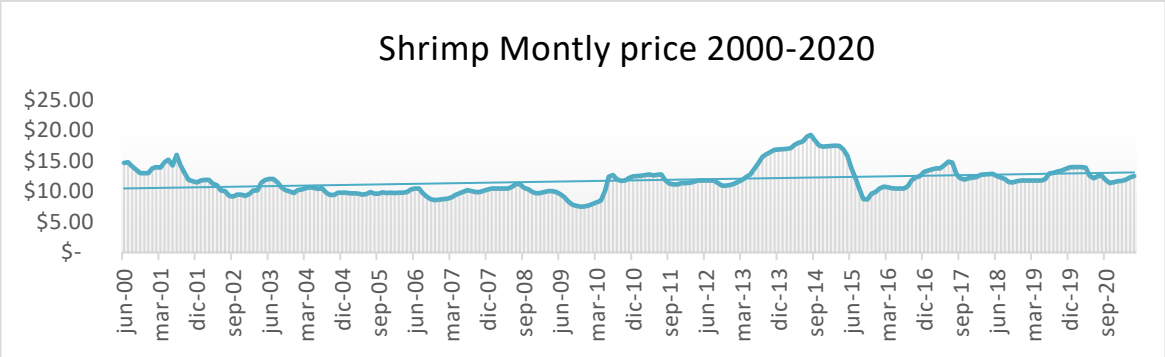
Appendixes

Appendix A

Price per pound of shrimp in US market from 2000 to 2020



Appendix B

KMO and Bartlett´s test of risk management strategies.

RISK MANAGEMENT STRATEGIES		
Prueba de KMO y Bartlett		
Medida Káiser-Meyer-Olkin de adecuación de muestreo		0.735
Prueba de esfericidad de Bartlett	Approx.. Chi-cuadrado	1037.245
	gl	351
	Sig.	0.000

Appendix C

KMO and Bartlett´s test of risk sources

Risk Sources		
Prueba de KMO y Bartlett		
Medida Káiser-Meyer-Olkin de adecuación de muestreo		0.874
Prueba de esfericidad de Bartlett	Approx.. Chi-cuadrado	1560.510
	gal	300
	Sig.	0.000

Appendix D

Survey to measure risk perception and risk management strategies

Encuesta para Proyecto Especial de Graduación, Zamorano 2021

Encuesta exploratoria con fines académicos enfocada en los camaroneros de El Oro sobre como perciben y manejan los riesgos de la actividad acuícola y el impacto que tiene en sus decisiones económicas.

Percepción y Manejo del Riesgo en el sector camaronero.

Sobre el productor

Nombre o razón social :	

1) Su objetivo principal en este momento es:

	a)Aumentar producción		c) Tener más hectáreas
	b) Aumentar tecnología (aeradores, alimentadores, etc.)		d) Reducir costos

2)	Años de experiencia en el sector:	años	
3)	Ser camaronero es mi única ocupación:	Si	No
4)	Soy el administrador de la camaronera:	Si	No

5) Con que frecuencia cambia de proveedor de insumos.

	a) Despues de cada corrida		c) Cada año
	b) Cada 6 meses		d) He seguido con los mismos provvedores por mas de 2 años

Sobre propiedad y producción

6)	Cuantos trabajores emplea por hectarea:	Trabajadores
7)	¿En que sector de El Oro se ubica la camaronera?	

9) Mi granja camaronera territorialmente se encuentra en:

	Isla		**Continente**

8) El area aproximada de la granja camaronera es de:

	a) < 20 ha		**c) Entre 80 - 150 Ha**
	b) Entre 20 - 79 Ha		**d) > 150 ha**

10) ¿A que densidad siembra normalmente por m2?

	a) 6 -7 animales/m2		c) 11-15 animales/m2
	b) 8 - 10 animales/m2		d) >15 animales/m2

11) ¿Qué talla usualmente cosecho mi piscina? (Camarón cola)

a) 51-60		c) 36 - 40		e) 26 -30		g) 16 -20		i) U-10	
b) 41 -50		d) 31-35		f) 21 .25		h) U -15		Otro	

12) ¿A quien le vende su camarón?			
	a) Intermediario		b) A una empacadora
	c) Exporta directo		**d)** Otro:

13) ¿ Cuantas veces alimenta al dia?			
	a) 2 veces		c) 4 veces
	b) 3 veces		d) Uso alimentadores automaticos

14) ¿ Cuantas libras cosecho normalmente ?			
	a) <2000 lb/ha		c) 3001-4000 lb/ha
	b) 2000-3000 lb/ha		d) >4000 lb/ha

15) ¿Cómo se integra la empresa al resto de la cadena de valor? (Marque en las que participa la empresa)			
	Laboratorio		Exportador
	Venta de Insumos		Distribución
	Procesando		Empresa de asesoramiento tecnico

16) ¿Qué planes tiene la empresa para los próximos 5 años? Ponga una X en el cuadrado correcto - son posibles más marcas.			
	Sin cambios, sigue como hoy		Ampliar el área de producción
	Incrementar la producción		Adquisición / integración vertical
	Reducir la producción		Discontinuar
	Cambiar la gama de productos (nuevas especies, etc.)	Otro	
	Cambiar significativamente el método / tecnología de producción		

Actitud de riesgo y fuentes de riesgo

17) Evalúe las siguientes afirmaciones. **Ingrese la respuesta para cada línea en una escala del 1 al 5, 1 = totalmente en desacuerdo, 5 = totalmente de acuerdo**	
	En comparación con otras empresas piscícolas, nuestra empresa asume pocos riesgos.
	La agricultura es una industria con un gran riesgo financiero en comparación con otras industrias.
	Nuestra empresa está feliz de arriesgarse si creemos que podemos sacarle provecho.

18) ¿Cómo es la disposición de la empresa a asumir riesgos en 2021 en comparación con los últimos 3 años? Ingrese la respuesta en una escala del 1 al 5, 1 = mucho más pequeño, 5 = mucho más grande	
Respuesta:	

19) En una escala del 1 al 5, indique qué afirmación es mejor para su negocio:

1 = tomar un gran riesgo y aumentar la posibilidad de obtener mayores ganancias,

5 = tomar un pequeño riesgo y asegurar un ingreso estable pero quizás más bajo

Respuesta:	

20) Evalue en base a su experiencia, los RIESGOS que afectan las operaciones para producir camarón.

En una escala del 1- 5, siendo 1 el minimo y 5 el maximo

Impacto: 1) Despreciable - 2) Bajo - 3) Moderado - 4) Alto - 5) Crítico

Probabiliadad que ocurra: 1) Casi imposible que ocurra - 2) Poco probable - 3) Igualmente probable - 4) Muy Probable 5= Casi seguro que ocurra

Impacto 1-5	Riesgo en producción	Probabilidad 1-5
	Contaminación del agua de las piscinas por exceso de balanceado	
	Pobre calidad de la larva	
	Muerte del camaron provocado por enfermedades	
	Falta de conocimiento para preparar piscinas antes de sembrar	
	No dar la cantidad de alimento necesario para la cantidad de animales.	

Impacto 1-5	Riesgo clima y medio ambiente	Probabilidad 1-5
	Fuentes de agua con exceso de materia organica.	
	Choques biofisicos (tormentas, cambios bruscos de luz, temperatura, etc.)	
	Inundaciones	

Impacto 1-5	Riesgo humano	Probabilidad 1-5
	Enfermedades / problemas de salud para los empleados.	
	Asaltos/Robo armado	
	Mano de obra no entrenada o calificada	
	Fallo de bombas de agua, aireadores, motores, etc.	
	"Riesgo moral": mano de obra corrupta o poco fiable	

Impacto 1-5	Riesgo de mercado	Probabilidad 1-5
	Precio futuro de los insumos aumenten	
	Precio de la larva en aumento	
	Volatilidad del precio del camarón.	
	Precio del equipo/maquinaria en aumento	
	Problemas con logística y transporte	

Impacto 1-5	Riesgo político y social	Probabilidad 1-5
	Nuevas licencias y regulaciones para producir	
	Inestabilidad política del país	
	Incertidumbre sobre el acceso a los mercados / barreras comerciales	
	Impuestos y nuevas contribuciones al estado	
	Sobreoferta de camarón en el mercado	

Impacto 1-5	Riesgo financiero	Probabilidad 1-5
	Acceso inadecuado a créditos bancarios	
	Sin suficiente capital para operar las granjas camaronerass	
	Tasas de interés futuras en aumento	
	Pobre planificación presupuestaria y de costos.	
	Aumento de costos fijos	
	Cualquier otro (completar)	

Estrategias para gestionar el riesgo

21) El riesgo se puede mitigar de varias maneras,

Califique las siguientes estrategias según lo eficaz que son para mitigar el riesgo.

Donde 1= nada eficaz; 2= poco eficaz; 3 = eficacia media; 4= efectivo; 5 = muy eficaz.

a		Implementar un sistema de tratamiento de agua
b		Manejo estricto de la calidad del agua
c		Prevención, asesoría periodica veterinaria / médica para camarón
ch		Realizar raleos a la mitad de la producción.
d		Reducción de la densidad de población
e		Sembrar a menor densidad
f		Asistir a talleres de produccion de camarón.
g		Integración vertical (control / cooperación con otros eslabones de la cadena de valor)
h		Mayor inversión en tecnología de seguridad (sistemas de monitoreo, etc.)
i		Producir al menor costo posible
j		Proveer entremiento técnico al personal.
k		Compra de balanceado formulados de marcas fiables
l		Comprar "semilla" de proveedores confiables y calificados.

ll		Contratar asistencia técnica calificada.
m		Implementar acciones que motiven al personal.
n		Implementar más guardias
ñ		Manejo estricto de la alimentación
o		Planear con tiempo el abastecimiento de balanceado
p		Reducir tamaño de piscinas
q		Contactarse con las autoridades para pedir apoyo en precios y regulaciones que promuevan el desarrollo.
r		Implementar certificaciones abientales (ACS)
rr		Pedir asistencia técnica al gobierno.
s		Contratación de servicios de asesoría financiera
t		Contratación de un seguro por daños / pérdida de camarón
u		Contrato de producción.
v		Hacer arreglos del credito antes que incie el ciclo de producción .
w		Monitorear el precio del mercado
x		Promover productos internacionalmente
y		Remover la influencia del intermediario
z		Utilización de préstamos informales
		Otro (completar)

22) En orden de prioridad, enumere las tres estrategias que considere más importantes de la pregunta anterior? Ingrese la letra de línea.

	Más importante
	Segundo más importante
	Tercero más importante