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Perceived Risks and the Demand for Index-Based Insurance: Evidence from Shrimp Farmers in the Mekong Delta

Vo Hong Tu , ***Nguyen Thuy Trang*** *

Department of Rural Socio-Economics, College of Rural Development, Can Tho University, Can Tho 94000, Vietnam

ABSTRACT

This study investigates the demand for index-based insurance among shrimp farmers in the Mekong Delta, a region increasingly vulnerable to climate-related risks and environmental uncertainties. The study aims to identify the major factors influencing farmers' willingness to adopt such insurance schemes and how these preferences are shaped by both economic and ecological conditions. Drawing on survey data collected from 500 shrimp farmers, the study employs a multinomial logit regression model to analyze the complex interplay between perceived risks, socio-demographic characteristics, and the likelihood of purchasing insurance products. The findings reveal that water pollution, climate variability, and frequent disease outbreaks remain the most pressing concerns for shrimp farmers. Interestingly, semi-intensive farmers, particularly those without plastic-lined ponds, exhibit a stronger inclination toward purchasing insurance. However, paradoxically, farmers facing higher levels of production risks tend to be more reluctant, largely due to distrust in compensation mechanisms, limited understanding of insurance operations, and negative past experiences with support programs. By contrast, when farmers perceive greater environmental, market, and financial risks, their willingness to engage with index-based insurance increases significantly. Overall, the study underscores the importance of designing tailored insurance products linked to market and environmental indices. Such approaches would not only enhance adoption rates but also strengthen the resilience and long-term sustainability of shrimp farming communities in the Mekong Delta.

Keywords: Adoption; Insurance Demand; Index-based Insurance; Shrimp Farming; Risk Management

*CORRESPONDING AUTHOR:
Nguyen Thuy Trang, Department of Rural Socio-Economics, College of Rural Development, Can Tho University, Can Tho 94000, Vietnam; Email: nttrang@ctu.edu.vn

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1. Introduction

1.1. Rationale

The Mekong Delta, renowned for its agricultural production and its pivotal role in ensuring food security, not only in Vietnam but also globally, is confronted with numerous challenges that pose a threat to the livelihoods of its farmers [1,2]. Among these, shrimp farming stands out as a vital sector contributing significantly to Vietnam's seafood exports. However, shrimp farmers in the region are confronted with various risks, including climate change impacts, disease outbreaks, and market instability [3–5]. The shrimp farming sector, which is increasingly central to the economy of the Mekong Delta, faces additional challenges due to structural transformations in agricultural practices. The shift from traditional rice farming to intensive and semi-intensive shrimp farming in coastal areas has left many farmers, particularly new entrants to shrimp farming, vulnerable to production risks. These new shrimp farmers often lack the experience and technical knowledge necessary to navigate the complexities of shrimp farming and to manage risks effectively, which further heightens their vulnerability [3,6]. Consequently, farmers in the region are exposed to a variety of threats to their income, and there is an urgent need to identify effective risk management strategies to safeguard their livelihoods and ensure the sustainability of the sector.

Previous studies indicate that most farmers are inherently risk-averse and adopt a range of strategies across production and distribution to manage uncertainties [7,8]. Agricultural insurance emerges as a notable tool in mitigating these risks, as emphasized by the previous study of Huirne, et al. [9]. Despite recognizing the potential benefits of innovation in enhancing productivity and household income, farmers, as observed by Liu [10]; Liu and Huang [11], often hesitate to embrace new technologies. Establishing a supportive environment characterized by certainty can foster farmers' confidence, thereby promoting investment and bolstering production efficiency. In underdeveloped market conditions, particularly prevalent in developing countries, participation in agricultural insurance encounters challenges due to information asymmetry between policyholders (farmers) and insurers (insurance companies), as highlighted by Khoi and Hiep [12]. This information gap gives rise to obstacles such as insurability and moral hazard [13].

Traditional forms of agricultural insurance have been promoted as effective risk mitigation tools but have faced challenges in the context of shrimp farming in the Mekong Delta, with issues such as insurability and moral hazard hindering their adoption [3,6]. Initially, a damage-based insurance model was piloted under Decision No. 315/QĐ-TTg, dated March 1, 2011, by directive of the Prime Minister. The program targeted implementation in 20 provinces, including Ca Mau, Bac Lieu, Tra Vinh, Soc Trang, and Ben Tre in the Mekong Delta, with the aim of providing timely protection for farmers. However, during its trial phase, the insurance model faced significant challenges, mainly due to conflicts of interest between farmers and insurance providers-particularly in relation to damage assessment. As a result, the government has issued various policies to continue the implementation of agricultural insurance and provide additional support. Nevertheless, to ensure the program's effectiveness, it is essential to study farmers' demand for insurance and understand the practical reasons behind their reluctance to participate, thereby informing the development of more targeted and feasible policy solutions.

Unlike traditional agricultural insurance, which compensates farmers based on measured individual losses in the field—often involving costly assessments, delayed payouts, and potential disputes—index-based insurance triggers payouts automatically when a predetermined indicator (such as rainfall or temperature) crosses a threshold, thereby reducing transaction costs and accelerating compensation, as outlined by Bobojonov et al. [14,15]. While precipitation serves as the primary index, other metrics such as temperature and humidity have also been considered [16,17]. In this study, we focused on two primary indices: precipitation and temperature. These factors are becoming increasingly important in the Mekong Delta, as heavy rainfall and rising temperatures significantly affect salinity levels and the growth of shrimp. Excessive rainfall can dilute pond salinity, while elevated temperatures may lead to hypersalinity and increased disease prevalence, both of which hinder optimal shrimp development [18,19].

By exploring the demand for index-based agricultural insurance among shrimp farmers, we aim to provide insights into the factors influencing insurance uptake and the potential effectiveness of index-based insurance as a risk management tool in this context. This research is motivated by the desire to contribute to the development of tailored risk management strategies that can better meet the needs of shrimp farmers in the Mekong Delta, ultimately fostering sustainable agricultural practices and ensuring food security in the region.

Although previous studies have explored agricultural insurance demand in various settings, there has been limited focus on shrimp farming in the Mekong Delta, especially concerning index-based insurance that includes precipitation and temperature [6,20]. This study contributes to the existing literature by filling this gap and offering a comprehensive analysis of the factors driving insurance demand among shrimp farmers in the region. Overall, the novelty of this study lies in its focus on a specific shrimp farming sector within a geographically constrained region and its exploration of an innovative insurance mechanism tailored to the needs of shrimp farmers.

In summary, the main objectives of this study are (1) to explore the perceptions of shrimp farmers regarding risks and their socio-demographic characteristics, and (2) to identify the factors influencing the adoption of index-based insurance among shrimp farmers, with the goal of proposing effective solutions for the implementation of insurance in shrimp farming.

1.2. Literature Review

1.2.1. Agricultural Insurance in Vietnam

In Vietnam, agricultural insurance was piloted in 20 provinces starting from 2011 under Decision 315/QĐ-TTg. To ensure the continuity of this initiative, the government enacted Decree No. 58/2018/NĐ-CP specifically addressing agricultural insurance. Furthermore, Decision No. 22/2019/QĐ-TTg was introduced to bolster agricultural insurance, aiming to alleviate financial losses stemming from natural disasters and epidemics. Despite its beneficial effects on farm household incomes and the heightened awareness of risk management mechanisms, the level of participation in agricultural insurance remains constrained [3,21]. Challenges include inappropriate insurance packages, contentious damage assessment processes, and complex compensation procedures [20].

1.2.2. Factors Affecting the Adoption of Agricultural Insurance

Based on the literature review of previous studies, independent variables commonly employed to assess the demand for insurance uptake are affordability, membership in cooperatives, risk perception, access to credit, information and education, government incentives, farm size and gender of policy holders.

First, higher income levels have been associated with increased adoption of index-based insurance as individuals with greater financial resources are more likely to afford insurance premiums [22,23].

Second, several studies have explored the relationship between cooperative membership and the adoption of agricultural insurance. Zhang, et al. [24] found that cooperative members were more likely to uptake agricultural insurance due to the collective bargaining power and support provided by cooperatives in navigating the complexities of insurance policies. Similarly, a study conducted by Devkota, et al. [25] indicated that cooperative membership positively influenced the adoption of agricultural insurance among smallholder farmers, as cooperatives often facilitate access to information, training, and financial resources necessary for insurance uptake. Additionally, Lawangen [26] demonstrated that cooperative members tend to have better risk management practices, including the uptake of agricultural insurance, compared to non-members, as cooperatives offer risk-sharing mechanisms and promote a culture of collective decision-making and risk mitigation strategies.

Third, the perceived risk of weather-related events such as droughts, floods, or hurricanes plays a significant role in the adoption of index-based insurance. Farmers who perceive higher risks are more inclined to adopt insurance as a risk management tool [15,27].

Fourth, access to credit facilitates the adoption of insurance as it enables farmers to afford insurance premiums and invest in agricultural inputs [12,28]. Fifth, awareness and understanding of index-based insurance

products are essential for adoption. Farmers who receive adequate information about insurance products are more likely to adopt them [12,29].

Sixth, supportive policy frameworks and regulatory environments can encourage the adoption of insurance by providing incentives, subsidies, or risk-sharing mechanisms [30,31]. Seventh, the size of the farm can influence insurance uptake. Larger farms may have more resources to allocate towards insurance premiums, making them more likely to adopt insurance compared to smaller farms [12,32].

Finally, male members predominantly made decisions regarding farm management and operations while working full time on their shrimp farms [33,34]. Thus, it is hypothesized that male respondents are more likely to adopt the insurance.

1.2.3. Risk Perception in Agricultural Production

Risk perception has been widely recognized as a central determinant of farmers' decision-making, influencing both production choices and the adoption of risk management strategies, including insurance. For instance, Just and Pope [35] emphasized that farmers' perceptions of yield variability directly shape their willingness to invest in protective measures, while Mamun, et al. [36] showed that smallholder farmers often view climate variability as the greatest production risk, thereby increasing demand for weather-related insurance schemes. In aquaculture, Joffre, et al. [37] highlighted that shrimp farmers perceive disease outbreaks (e.g., white spot syndrome, early mortality syndrome) and water quality fluctuations as the most critical threats to production, which strongly affect their interest in adopting financial or technical risk management tools. Anand, et al. [38], via a survey of 604 shrimp farmers across coastal India, identified 27 distinct production risks ranging from very low to catastrophic in likelihood, all impacting production and income, underscoring the complexity of risk perception in shrimp farming. More generally, a global review covering 197 studies revealed that weather-related risks (55%), biosecurity threats (48%), and human-related risks (35%) are the most significant sources of risk perceived by farmers, though only a small fraction of studies examined how socioeconomic factors influence risk perception or the choice of risk management strategies [39]. Together, these studies reinforce the importance of integrating farmers' risk perceptions—particularly regarding disease and market risks—into analyses of their willingness to adopt index-based insurance.

2. Materials and Methods

2.1. Data Collection

2.1.1. Sampling Method and Sample Size

This study investigated the demand or intention to purchase the index-based insurance among shrimp farmers in the Mekong Delta by interviewing 500 households across the four main provinces namely Ca Mau, Bac Lieu, Soc Trang, and Kien Giang. These provinces constitute over 88% of the Mekong Delta's total shrimp production area, with Ca Mau leading in 2023 with 278,789 hectares, followed by Kien Giang with 143,352 hectares, Bac Lieu with 141,241 hectares, and Soc Trang with 54,660 hectares. The sample was distributed as follows: 200 households in Ca Mau, 159 in Bac Lieu, and 81 and 61 in Soc Trang and Kien Giang, respectively. This multi-province sampling strategy ensured a diverse and representative dataset, enhancing insights into regional shrimp farming dynamics. To ensure a broad representation, the sampling method stratified the participants based on cooperative membership. The initial phase involved interviewing cooperative members, but reaching super-intensive shrimp farmers was challenging. To overcome this, the research team worked with provincial cooperative managers for introductions. Despite invitations, only a few members agreed to participate. Interviewed farmers were then asked to refer neighbors, helping ensure a sample with similar natural and socioeconomic conditions. This approach aimed to provide a representative view of shrimp farming in the Mekong Delta (**Figure 1**).

2.1.2. Introduction to the Context of Index-Based Agricultural Insurance

Index-based agricultural insurance is a relatively new concept in Vietnam, with pilot programs so far primarily applied to coffee cultivation. To ensure shrimp

farmers fully understand this insurance model, interviewers will dedicate 3–4 minutes to explaining its core principles—specifically focusing on two key indices: precipitation and temperature, as well as the process for making claims in the event of losses. The explanation provided to farmers includes:

Index-based insurance operates by determining compensation based on predefined indices or benchmarks—typically related to weather conditions—rather than assessing individual losses or damages. In the context of shrimp farming, the focus is primarily on two key factors: temperature and rainfall. When these indices exceed or fall below established thresholds, compensation is triggered. This method reduces risk for insurers while providing a more flexible and efficient solution for farmers.

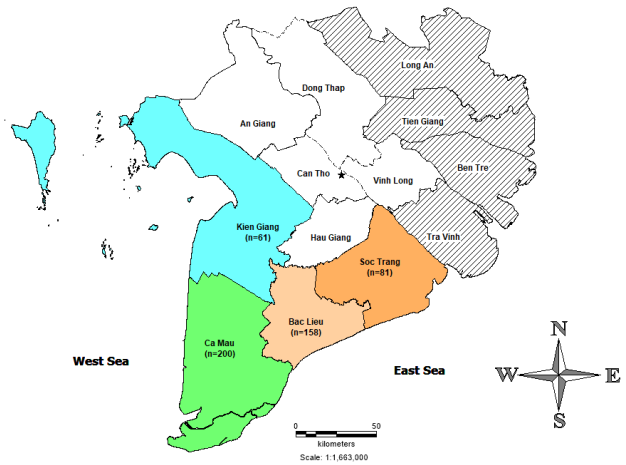

Figure 1. The map of the Mekong Delta and study sites.
Note: Study sites are marked in colors, with provinces shaded in stripes being coastal ones.

To reveal demand or intention to purchase the index-based insurance, questions such as "In order to contribute to the development of index-based insurance packages for shrimp farmers, could you kindly indicate your willingness to purchase such insurance?" were asked during the interview. It's also essential to understand that compensation values will be determined based on fluctuations in the insured index, following established regulations. For example, in temperature-based insurance: if temperatures rise within the range of 2–4 °C compared to the region's 20-year average, compensation level "a" will be applied; if temperatures exceed 4 °C, compensation level "b" will be applied (where b > a). Specific compensation amounts will be determined by experts, scientists, and government officials in each region to accurately address the losses incurred by shrimp farmers.

Finally, the interviewer will ask, "Are you willing to purchase index-based weather insurance for your shrimp farming?" The responses from farmers can be coded as follows: some are willing to purchase insurance (coded as 1), some have no intention to purchase (coded as 0), and others are unwilling to purchase due to a lack of belief in insurance (coded as 2).

2.2. Analytical Model

Given that the dependent variable in this study is categorical with three mutually exclusive and unordered outcomes-namely, (0) no intention to purchase index-based insurance, (1) willingness to purchase index-based insurance, and (2) lack of belief in insurance leading to unwillingness to purchase—an appropriate modeling approach is required to capture the discrete nature of these choices. The Multinomial Logit (MNL) model is particularly well-suited for this context. This model allows for the estimation of the probability of each outcome as a function of various explanatory variables, without imposing any inherent ordering among the response categories. Moreover, the MNL framework is designed to handle situations where individuals face a set of discrete, non-overlapping alternatives, making it ideal for modeling respondents' intentions and perceptions toward index-based insurance in this study.

Let $Y_i \in \{0, 1, 1\}$ be the outcome for respondent i, and X_i be a vector of independent variables.

We model the probability that individual i chooses alternative j as:

$$P\left(Y_i = j\right) = \frac{\exp\left(X_i' \beta_j\right)}{\sum_{k=0}^{2} \exp\left(X_i' \beta_k\right)}$$

To identify the model, we normalize one category (usually the base) to zero. Let's use category 0 as the base: $\beta_0 = 0$

Then, for categories $j = 1, 2$, the probabilities become:

$$P\left(Y_i = 1\right) = \frac{\exp\left(X_i' \beta_1\right)}{1 + \exp\left(X_i' \beta_1\right) + \exp\left(X_i' \beta_2\right)}$$

$$P\left(Y_i = 2\right) = \frac{\exp\left(X_i^{'}\beta_2\right)}{1 + \exp\left(X_i^{'}\beta_1\right) + \exp\left(X_i^{'}\beta_2\right)}$$

$$P\left(Y_i = 0\right) = \frac{1}{1 + \exp\left(X_i^{'}\beta_1\right) + \exp\left(X_i^{'}\beta_2\right)}$$

Each set of coefficients β_j reflects the log-odds of choosing alternative j relative to the base (alternative 0). Specifically:

$$\log\left(\frac{P\left(Y_i = 1\right)}{P\left(Y_i = 0\right)}\right) = X_i^{'}\beta_1$$

$$\log\left(\frac{P\left(Y_i = 2\right)}{P\left(Y_i = 0\right)}\right) = X_i^{'}\beta_2$$

Each $\beta_{j,k}$ is the marginal effect of predictor X_k on the log-odds of choosing outcome j versus base outcome 0.

The marginal effect of variable X_k on the probability of choosing outcome j is:

$$\frac{\partial P_{ij}}{\partial X_{ik}} = P_{ij}\left(\beta_{jk} - \sum_{l=0}^{2} P_{il}\beta_{lk}\right)\partial Xik$$

Drawing on the literature review and the current context of shrimp farming in the Mekong Delta, this study identifies the independent variables presented in **Table 1** as determinants of farmers' intentions to purchase index-based insurance.

Table 1. The independent variables affecting the demand of index-based insurance.

No.	Notation	Variables	Description/Unit	Expected Sign	Sources/Note
1	X_1	*GEN*	Sex of the respondent, dummy variable, 1 = male and 0 = female	+	Pongthanapanich, et al. [33]
2	X_2	*AGE*	Years	–	Ankrah, et al. [29]
3	X_3	*FAMSIZE*	Members	+	Nguyen, et al. [3]; Jatto [40]
4	X_4	*EDU*	Year of schooling	+	Khoi and Hiep [12]; Ankrah, et al. [29]
5	X_5	*EXP*	Years of experience	–	Nguyen, et al. [3]; Ashfaq, et al. [41]
6	X_6	*COOP*	Dummy, 1 = coop member and 0 = others	+	Devkota, et al. [25]; Lawangen [26]
7	X_7	*EXTEN*	Dummy, 1 = extensive farming, 0 = others	+	Proposed in this study.
8	X_8	*INTEN*	Dummy, 1 = intensive farming, 0 = others	+/–	Semi-intensive farming is considered as base.
9	X_9	*TRAIN*	Dummy, 1 = attended training, 0 = no	+	Janzen and Carter [42]; Vasilaky, et al. [43]
10	X_{10}	*CREDIT*	Dummy, 1 = access to credit, 0 = no	+	Khoi and Hiep [12]; Ahmed, et al. [28]
11	X_{11}	*POND*	Number of shrimp pond	+	Bekkerman, et al. [44]; Sharma and Walters [45]
12	X_{12}	*LOSS*	Times of losses	+	Janzen and Carter [42]; Dougherty, et al. [46]
13	X_{13}	*WATER*	Water pollution, Likert from 1 to 5	+	Proposed in this study
14	X_{14}	*CROP*	Number of crops per year	+	Proposed in this study
15	X_{15}	*PRORISK*	Production risk	+	Jensen, et al. [47]
16	X_{16}	*ENRISK*	Environmental risk	+	
17	X_{17}	*MARISK*	Market and financial risk	+	

Note: Extensive shrimp farming primarily depends on the natural feed available in the pond. It features a low stocking density, minimal intervention, and does not require advanced technology or large investments [48,49].
Semi-intensive shrimp farming uses moderate stocking densities, supplemented feeding, and partial pond control, requiring moderate investment and management [48].
Intensive shrimp farming uses high stocking densities, controlled feeding, and advanced technology, requiring substantial investment. In this study, intensive and super-intensive farming are combined due to their similarities and limited data on super-intensive farmers [48,50].

The current study employed Stata 13 to conduct data analysis, including descriptive statistics and logit regression. Before estimating the multinomial logit model, multicollinearity was assessed through a correlation matrix.

3. Results

3.1. Socio-Demographic Characteristics of Shrimp Farmers

The survey results in **Table 2** clearly show that the majority of individuals involved in shrimp farming activities within their households are males, comprising an average of 82–94% of the total observations. This observation is consistent with the existing norms in shrimp farming, which reflect biases concerning gender and spiritual beliefs. There's a prevailing notion in the study sites that increased involvement of women in shrimp farming could potentially lead to decreased productivity.

Table 2. Socio-demographic characteristics of shrimp farmers.

No.	Variables	All	Ca Mau	Bac Lieu	Soc Trang	Kien Giang
1	*GEN*	0.84	0.83^{a}	0.82^{a}	0.94^{a}	0.82^{a}
		(0.36)	(0.38)	(0.38)	(0.24)	(0.39)
2	*AGE*	52.76	52.47^{ab}	55.71^{a}	50.05^{b}	49.72^{b}
		(11.13)	(10.73)	(10.97)	(10.66)	(11.81)
3	*FAMSIZE*	4.22	4.33^{a}	4.23^{ab}	3.86^{b}	4.34^{ab}
		(1.43)	(1.53)	(1.51)	(1.08)	(1.26)
4	*EDU*	7.28	7.57^{a}	6.77^{a}	7.09^{a}	7.95^{a}
		(3.34)	(2.91)	(3.60)	(3.42)	(3.71)
5	*EXP*	15.98	18.31^{a}	18.05^{a}	9.98^{b}	11.02^{b}
		(7.49)	(6.16)	(8.46)	(4.52)	(4.80)
6	*COOP*	0.29	0.20^{b}	0.41^{a}	0.20^{b}	0.41^{a}
		(0.47)	(0.43)	(0.49)	(0.40)	(0.50)
7	*EXTEN*	0.65	0.74^{b}	0.74^{b}	0.00^{a}	0.95^{c}
		(0.48)	(0.44)	(0.4)	(0.00)	(0.21)
8	*INTEN*	0.32	0.24^{c}	0.22^{b}	1.00^{a}	0.02^{c}
		(0.47)	(0.43)	(0.41)	(0.00)	(0.13)
9	*TRAIN*	0.23	0.23^{b}	0.34^{a}	0.14^{bc}	0.10^{b}
		(0.42)	(0.42)	(0.47)	(0.34)	(0.30)
10	*CREDIT*	0.17	0.18^{b}	0.13^{b}	0.29^{a}	0.08^{b}
		(0.39)	(0.38)	(0.34)	(0.53)	(0.27)
11	*POND*	1.97	1.51^{b}	2.81^{a}	1.96^{b}	1.32^{c}
		(2.14)	(1.96)	(2.76)	(1.24)	(0.65)
12	*LOSS*	2.00	2.00^{ab}	1.97^{b}	2.58^{a}	1.31^{bc}
		(1.87)	(2.01)	(1.51)	(1.91)	(1.68)
13	*WATER*	3.45	3.42^{a}	3.97^{b}	2.90^{c}	2.97^{c}
		(0.99)	(0.90)	(1.07)	(0.77)	(0.68)
14	*CROP*	5.25	7.34^{a}	4.55^{b}	2.60^{c}	3.73^{b}
		(4.51)	(4.59)	(4.42)	(0.70)	(4.48)
15	*PRORISK*	13.60	13.39^{a}	13.83^{a}	14.00^{a}	13.13^{a}
		(3.37)	(3.11)	(3.47)	(3.81)	(3.11)
16	*ENRISK*	16.62	16.27^{b}	18.06^{a}	15.22^{b}	15.90^{b}
		(4.06)	(2.98)	(4.31)	(5.55)	(2.98)
17	*MARISK*	11.69	11.38^{b}	11.93^{b}	13.42^{a}	9.77^{c}
		(3.02)	(2.71)	(3.17)	(2.65)	(2.71)

Source: Estimated from the surveyed data in 2024, n = 500.
Note: The letters a, b, c in the same row, differing from each other, indicate significant differences among provinces in the study area.
ENRISK is determined by the cumulative score of 5 criteria, as illustrated in **Figure 2**, with each criterion rated on a Likert scale from 1 to 5.
MARISK is derived from the cumulative score of 4 criteria, as depicted in **Figure 3**, with each criterion assessed on a Likert scale from 1 to 5.
PRORISK is computed based on the total score of criteria outlined in **Figure 4**, with each criterion evaluated on a Likert scale from 1 to 5.

The age distribution of shrimp farmers, mainly between 49 to 55 years old, suggests an experienced workforce. This finding is in line with previous studies of Nguyen, et al.[3]; Long and Hien[51]. However, the prevalence of older individuals also raises concerns about succession planning and the need to attract younger farmers to ensure the industry's sustainability[52]. The reported family size of shrimp farmers ranging from 3.86 to 4.34 persons indicates a relatively small household size within this agricultural context. This finding is slightly lower compared to the previous studies of Nguyen, et al.[3]; Ha, et al.[53]. The notable finding that Soc Trang province has the lowest family size among shrimp farmers prompts further discussion. It may reflect specific socio-economic dynamics within the region, such as migration patterns and urbanization regarding family structure[54]. The reported educational level of shrimp farmers averaged around 7.28, indicating attainment typically at the secondary school level, which is consistent with the previous studies of Khoi and Hiep[12]. The average experience is approximately 16 years, with shrimp farmers in Cu Lao Dung district, Soc Trang province, having the least experience. This is attributed to the recent conversion of the production model in the area, particularly transitioning from sugarcane cultivation to intensive shrimp farming[5,55]. Con-

sequently, the average experience of shrimp farmers in Soc Trang province is around 10 years.

The study also shows that, on average, 29% of shrimp households are affiliated with cooperatives. Notably, Bac Lieu and Kien Giang emerge as the two provinces boasting the highest membership rates within cooperatives. Overall, the study reveals that about 23% of the surveyed households participated in technical training courses related to shrimp farming, while 17% accessed credit facilities to bolster their shrimp farming endeavors. Concerning shrimp farmers' perception of water quality, it is deemed relatively contaminated. Farmers in Bac Lieu province perceive the pollution level to be the most severe, followed by Ca Mau. Meanwhile, farmers in Soc Trang and Kien Giang provinces perceive the pollution level to be moderate. The survey results also indicate that, on average, shrimp farmers experience losses twice since they started shrimp farming, with farmers in Soc Trang province facing higher levels of risk. As for the number of crops, on average, there are about 5 crops per year depending on the study site, with Ca Mau province having the highest number of crops per year, while Soc Trang province has the lowest, averaging around 2.6 crops per year.

3.2. Shrimp Farmers' Perception of Risks

3.2.1. Perception about Environmental Risks

Agriculture is inherently reliant on natural conditions, making the influence of the environment on farmers' production processes paramount.

Regarding water pollution, **Figure 2** shows that respondents willing to purchase index-based insurance consistently perceive climate-related risks more strongly than those unwilling or unwilling due to a lack of belief. For example, concerns about changes in rainfall patterns, monsoon season schedules, and increased temperatures are rated highest by the willing group, indicating a clear link between risk awareness and willingness to adopt insurance solutions. This suggests that those who recognize the severity of climate impacts are more open to risk management tools like index-based insurance.

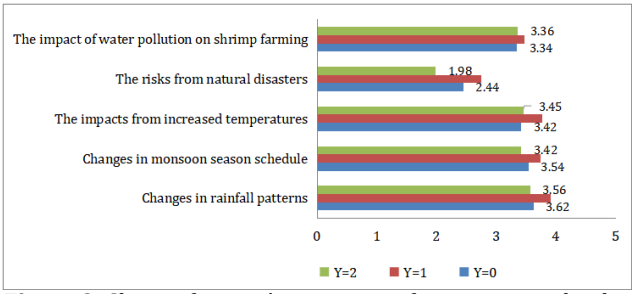

Figure 2. Shrimp farmers' perception of environmental risks.
Source: 2023 survey results, n = 500.

In contrast, the group unwilling to purchase insurance because of a lack of belief tends to score lower across most risk factors, especially for natural disasters. Their notably low concern for natural disaster risks points to a deeper skepticism, not only about the insurance product itself but potentially about the risks' relevance or insurability. This skepticism could be a major barrier to insurance uptake, highlighting the importance of building trust and credibility among this segment. Interestingly, the impact of water pollution on shrimp farming is perceived relatively equally across all groups, with minimal differences in concern levels. This indicates that water pollution is a widely recognized issue but does not significantly influence the decision to purchase index-based insurance. Therefore, while environmental concerns are high overall, not all risks have the same weight when it comes to influencing insurance adoption decisions.

Overall, the findings suggest that increasing willingness to purchase index-based insurance requires targeted efforts to improve understanding and trust, especially among those skeptical of the product. Educational campaigns that clarify how index-based insurance can effectively mitigate specific risks like rainfall variability and temperature changes may help reduce disbelief. Building confidence in the insurance mechanism is crucial to expanding adoption and improving resilience to climate risks.

3.2.2. Perception about Market and Financial Risks

Fluctuations in market demand and prices pose significant risks to shrimp producers. Shrimp production demands substantial initial investment in infrastructure, equipment, and inputs, particularly for intensive and

semi-intensive farming [37]. Financial risks arise from uncertainties in input costs, such as feed, labor, and energy, as well as access to credit.

The findings in **Figure 3** reveal that The results indicate that concerns about market fluctuations are relatively high and quite consistent across all groups, regardless of their willingness to purchase index-based insurance. Scores hover around 3.4 to 3.5, suggesting that fluctuations in market prices or demand are broadly recognized as a significant risk factor by farmers or producers. This shared awareness implies that market instability is a common challenge that affects production decisions and overall business confidence, irrespective of attitudes toward insurance products. Similarly, increased input costs are perceived as a notable risk, with all groups reporting scores slightly above 3.2. This highlights the widespread impact that rising prices for seeds, feed, labor, or other production inputs have on agricultural operations. The close scores among the groups suggest that concerns over input costs are not a primary factor driving differences in willingness to purchase index-based insurance, but rather a general economic pressure felt across the board.

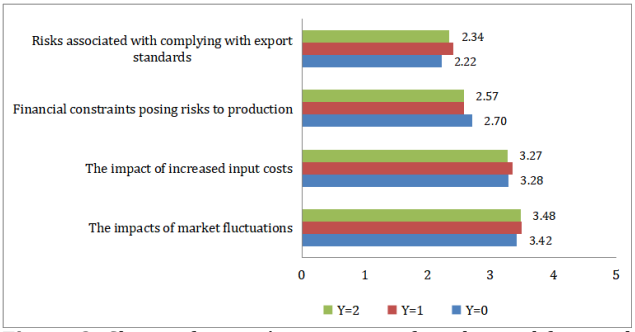

Figure 3. Shrimp farmers' perception of market and financial risks.

Source: 2023 survey results, n = 500.

Financial constraints, however, are seen somewhat differently. Scores for this risk factor are lower than those for market fluctuations and input costs, particularly for the groups willing or unwilling to purchase insurance (around 2.6 to 2.7). This lower concern might reflect either a lack of awareness about the full extent of financial risk or a perception that such constraints are less immediate or less controllable through insurance solutions. It could also indicate that financial barriers are a subtle but persistent challenge that does not strongly differentiate attitudes toward insurance.

Finally, the risks related to complying with export standards receive the lowest concern scores across all groups, around 2.2 to 2.4. This suggests that compliance risks may be seen as less pressing or less relevant to the majority of producers surveyed, possibly because not all are involved in export activities. The relatively low awareness or concern may also point to gaps in understanding about how export requirements could impact market access and production viability, which could be an area for further education or support.

3.2.3. Perception about Production Risks

Furthermore, amidst the challenges posed by natural conditions and external factors, farmers themselves encounter numerous risks throughout the production process [3,4].

The findings reveal that among the various operational and production-related risks, disease outbreaks are perceived as the most critical issue across all groups, with scores ranging from 3.30 to 3.46 (**Figure 4**). Respondents willing to purchase index-based insurance rate this risk the highest, suggesting that those more open to insurance are also more aware of the serious consequences of disease outbreaks on productivity and income. Even among those unwilling or skeptical due to disbelief, concern remains relatively high, indicating widespread recognition of this threat in agricultural and aquaculture activities. Post-harvest losses and risks in production techniques, by contrast, receive moderate concern, with scores generally ranging between 2.3 and 2.8. Post-harvest losses show a slightly declining trend from the unwilling to the skeptical group, possibly implying that those who lack belief in insurance may also underappreciate the economic losses that occur after harvesting. In the case of production techniques, all groups show similar scores, suggesting a shared view of this risk as moderately relevant. The slightly higher score in the disbelief group (2.81) may point to a perceived gap in technical knowledge or confidence in production methods. Operational risks linked to limited capabilities, such as technical skills, access to technology, or labor constraints, also rank moderately across the board. Interestingly, the unwilling group rates this risk slightly higher (2.79) than the willing group (2.59), which may reflect

a feeling of vulnerability or self-reported lack of capacity that contributes to their hesitation in adopting new risk management tools like index insurance. This perception may present an opportunity to improve insurance adoption by coupling it with technical support or capacity-building programs.

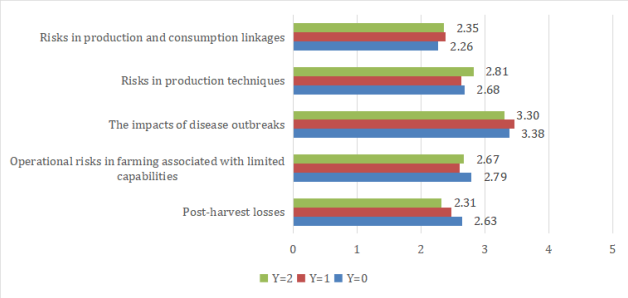

Figure 4. Shrimp farmers' perception of production risks.

Source: 2023 survey results, n = 500.

Lastly, risks in production and consumption linkages receive the lowest concern across all groups, with scores ranging from 2.26 to 2.38. This suggests that farmers or producers may not fully recognize the implications of weak value chain connections, such as unstable market access, poor distribution networks, or inconsistent consumer demand. This low awareness could indicate a need for broader education on how stronger production-consumption linkages can stabilize income and reduce risk exposure, particularly in developing rural or agricultural economies.

3.3. The Demand for Index-Based Agricultural Insurance among Shrimp Farmers

The multinomial logit results on the factors influencing the intention to purchase index-based insurance are presented in **Table 3**. The overall model is statistically significant, with an L.R. $\chi 2$ value of 112.06, which is much greater than the critical value, indicating that the independent variables collectively provide a good fit for explaining the demand for index-based insurance.

Table 3. Estimates of factors affecting the uptake of index-based insurance.

Variable	Y = 1 versus Y = 0		Y = 2 versus Y = 0		Marginal Effect
	Coef.	SE	Coef.	SE	
Soc Trang	−0.64	0.57	−0.75	0.60	0.16
Ca Mau	−0.65	0.44	−0.11	0.45	0.09
Bac Lieu	−0.83*	0.46	−2.11***	0.54	0.31
GEN	0.32	0.33	−0.10	0.34	−0.03
AGE	0.00	0.01	0.00	0.01	0.00
FAMSIZE	0.02	0.08	0.12	0.09	−0.01
EDU	0.00	0.04	0.01	0.04	0.00
EXP	0.00	0.02	−0.03	0.02	0.00
COOP	0.04	0.26	0.27	0.29	−0.03
EXTEN	−0.92	0.74	0.34	1.23	0.08
INTEN	−0.94	0.75	0.76	1.23	0.04
TRAIN	0.68**	0.28	0.16	0.34	−0.10
CREDIT	0.71**	0.31	0.07	0.36	−0.10
POND	0.07	0.06	−0.03	0.10	−0.01
LOSS	−0.07	0.06	−0.09	0.07	0.02
WATER	0.37***	0.13	0.34**	0.15	−0.08
CROP	0.001	0.03	0.04	0.03	0.00
PRORISK	−0.10**	0.04	−0.05	0.05	0.02
ENRISK	0.07**	0.03	−0.02	0.03	−0.01
MARISK	0.10**	0.05	0.07	0.06	−0.02
Constant	−1.86	1.42	−1.44	1.83	0.16
Log-likelihood		−480.470			
Observations		500.000			
L.R. χ^2		112.060			
Prob> χ^2		0.000			
Pseudo R^2		0.104			
Correct prediction		52%			

Source: Based on the surveyed data in 2024, n = 500

Note: *, **, *** indicates the 10%, 5%, 1% significance levels, respectively.

The Pseudo R2 value of 0.104 shows that about 10.4% of the variance in the intention to purchase insurance is explained by the model, which is reasonable for a logistic regression [56], though additional factors may still influence the willingness to purchase. Additionally, the model's correct prediction rate of 52% demonstrates its ability to accurately classify the willingness to purchase the insurance for nearly 52% of the observations, reflecting a fairly medium predictive ability [57].

The correlation matrix indicated that multicollinearity was not present. Based on the results of the multinomial logit regression, a comparison between farmers who are willing to purchase insurance and those who are not reveals that several variables significantly influence the willingness to adopt index-based agricultural insurance. These factors include participation in training programs (TRAIN), access to credit (CREDIT), perception of water pollution, and perceived levels of production risk, environmental risk, and market and financial risk. Among these, perceived production risk is negatively associated with willingness to purchase, whereas the remaining variables exhibit positive associations.

In the subgroup of farmers who are unwilling to purchase insurance due to a lack of trust or belief in the product, perception of water pollution continues to show a positive relationship with their responses. This suggests that even among farmers who currently lack trust in insurance, those who perceive high levels of water pollution may be willing to purchase insurance-provided that the policies and compensation mechanisms are clear and transparent. A particularly notable finding is that, in both comparison groups, farmers in Bac Lieu province exhibit lower probabilities of being willing to purchase insurance and higher probabilities of lacking trust in the product. This difference is statistically significant when compared to farmers in Kien Giang province. The finding also indicates that, at a significance level of 21%, shrimp farmers operating under intensive and extensive farming systems are less likely to be willing to purchase agricultural insurance compared to those practicing semi-intensive farming. Although the result is not statistically significant at conventional levels (e.g., 5% or 10%), it still suggests a potentially meaningful trend worth considering.

Table 3 also shows that the model's overall prediction accuracy is relatively modest-approximately 52%—suggesting considerable variation and divergence in farmers' perceptions and willingness to adopt this new insurance mechanism. Based on the predicted probabilities from the multinomial logit model, each household can be classified into one of the three groups—willing to purchase, unwilling to purchase, and unwilling due to lack of belief—according to the category with the highest predicted probability. The results show that among the 216 farmers identified as unwilling to purchase insurance, the model correctly predicted the group membership for 155 farmers, yielding the highest prediction accuracy among the three groups. However, the model also misclassified 26 farmers as likely to be willing to purchase insurance and 25 farmers as belonging to the "lack of belief" group, based on the shrimp farmers' characteristics. Similarly, among the 160 farmers who actually expressed willingness to purchase insurance, only 63 were correctly predicted by the model, resulting in a prediction accuracy of 39.38%. The misclassifications in this group were due to 72 farmers sharing similar characteristics with the "unwilling to purchase" group and 25 farmers being predicted as lacking belief in agricultural insurance. For the 124 farmers who indicated a lack of belief in agricultural insurance, the prediction accuracy was the lowest, with only 42 farmers correctly classified into this group.

These results highlight the considerable heterogeneity among farmers in terms of awareness, knowledge, access to information, and most notably, trust in the compensation mechanisms of agricultural insurance schemes. The substantial overlap in characteristics across the groups suggests that socio-economic variables alone may not fully capture the complexity of farmers' decision-making processes regarding insurance purchasing intention. Additional factors such as past experience, peer influence, and institutional trust may play important roles and warrant further investigation. The results shown in **Figure 5** indicate that only 17 out of 124 farmers (13.7%) would consider shifting to the willing-to-purchase insurance group if the claims procedures, compensation, and mechanisms were made clear and

transparent.

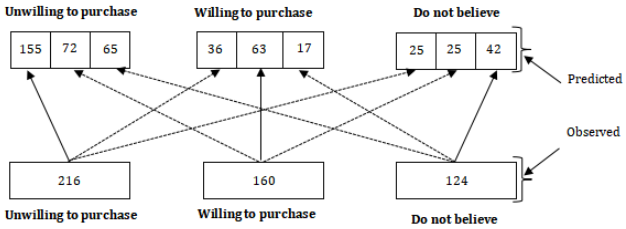

Figure 5. Observed and predicted probabilities to purchase insurance.

Note: The numbers in rectangles indicate number of farmers
→ indicates correct predictions ⇢ indicates incorrect predictions
The calculations in rectangles are based on the highest probabilities among categories
Source: Based on the surveyed data in 2024, n = 500.

4. Discussion

4.1. Discussions

Table 3 shows that shrimp farmers engaged in intensive and extensive farming systems have a lower probability of being willing to purchase insurance compared to those practicing semi-intensive farming. These results highlight that semi-intensive farmers exhibit the highest likelihood of adopting index-based insurance. This outcome may be explained by the greater inherent risks associated with the semi-intensive model—particularly among farmers who do not use plastic lining at the bottom of their ponds. Without this protective layer, they face significant challenges in managing water quality and controlling disease outbreaks, making them more vulnerable to production losses and therefore more inclined to seek insurance as a risk mitigation tool. In intensive farming, the high initial investment [4,51] and the professionalism of shrimp farmers, coupled with management skills, result in a low inclination to participate in agricultural insurance. Conversely, for extensive shrimp farmers—who are often households with limited financial resources—the additional cost of insurance premiums represents a significant barrier to adoption, as highlighted in previous studies [33,58].

Furthermore, the study reveals a negative relationship between perceived production risks and the willingness to purchase insurance. In other words, as farmers perceive higher production risks, their likelihood of purchasing insurance decreases. This inverse relationship can be explained by the additional costs associated with purchasing insurance, combined with concerns about compensation for losses—concerns that are shaped by experiences with traditional insurance practices, as noted in the study by Khoi and Thao [6]. In addition, farmers may undervalue the probability of weather shocks, leading to reduced demand for insurance [46]. Underestimating the probabilities of multiple shocks and insurance failures, such as basis risk, fosters compound risk aversion among farmers, significantly impacting demand [59]. This inverse relationship may also stem partly from shrimp farmers' confidence in their ability to manage production risks. Over time, their extensive farming experience, coupled with continuous training in new scientific and technical knowledge offered by academic institutions and industry management agencies, as well as technical advice from shrimp seed and feed companies, has to some extent empowered farmers to mitigate risks throughout the production process.

Conversely, environmental, market, and financial risks show a positive relationship with the willingness to purchase insurance—meaning that as these perceived risks increase, farmers are more likely to consider insurance as a risk management tool. This suggests that shrimp farmers are more inclined to procure insurance when they perceive heightened risks related to the environment, market dynamics, and financial uncertainties. These risk factors lie largely beyond the control of farmers, potentially leading to an increased demand for index-based insurance—a finding that aligns with the previous study [30]. These findings suggest that insurance companies should prioritize indices related to market and environmental factors, which are beyond farmers' control, rather than disease indices, when designing products. Additionally, participation in training programs and access to credit are positively associated with a greater likelihood of adopting index-based agricultural insurance, consistent with findings from previous studies [30,33].

4.2. Policy Implications

Given that semi-intensive shrimp farmers are more likely to adopt index-based insurance, policies should target these farmers as the primary audience for new insurance schemes. Support could include informational

campaigns that highlight the benefits of risk coverage for their specific farming model, especially given the inherent risks such as water quality management challenges.

The results suggest that semi-intensive shrimp farmers, particularly those without plastic linings in their ponds, are the most likely to adopt index-based insurance due to their higher vulnerability to risks such as poor water quality and disease outbreaks. This highlights the need for targeted policy interventions that prioritize this group. Policymakers should focus on designing tailored insurance products that reflect their specific risk exposure, while also offering premium subsidies to improve affordability. Integrating insurance promotion with technical training on risk management, and leveraging local cooperatives to build trust and facilitate participation, can further enhance adoption. While intensive farmers currently show lower interest due to better risk control and higher professionalism, future insurance models could gradually expand to address their unique needs.

The results show that farmers are more inclined to adopt insurance when facing risks beyond their control, such as environmental, market, and financial risks. Thus, insurance products should prioritize market and environmental indices rather than disease-related indices, which farmers might feel they can manage through their own efforts. Insurance products could be designed to focus more on unpredictable risks, increasing the perceived value of coverage for farmers [60]. In addition, insurance companies should consider developing customized insurance products that offer flexibility based on farmers' needs and preferences. Given that farmers are more likely to adopt insurance for risks that are out of their control, insurers could provide options that cover market price fluctuations, climate events, or environmental risks, which may be more appealing to farmers facing uncertainties [60].

Participation in training programs significantly enhances the likelihood of purchasing insurance. Policies should therefore include increased funding for farmer training and awareness programs, particularly on risk management and the benefits of insurance. Collaborations between the government, insurance companies, and agricultural extension services could help ensure that training is accessible and relevant to farmers' needs [61]. Access to credit is associated with a higher likelihood of insurance adoption. Policies that facilitate better access to agricultural credit could also drive higher insurance uptake. Linking credit services with insurance coverage could encourage farmers' willingness to purchase insurance by providing them with the necessary financial resources to afford the premiums [62]. The inverse relationship between production risk and insurance adoption suggests that some farmers may underestimate the probability or impact of shocks. Policies should focus on enhancing risk awareness through educational initiatives that help farmers understand the benefits of managing production risks through insurance. Demonstration projects that showcase the benefits of insurance in mitigating losses from real-life scenarios could help build trust and overcome skepticism.

5. Conclusions

In conclusion, this study provides valuable insights into the perceptions of shrimp farmers regarding risks and the factors influencing their willingness to purchase index-based insurance in the Mekong Delta. The study highlights significant concerns about risks such as water pollution, increasing temperatures, rainfall fluctuations, and disease outbreaks. These factors are central to shrimp farmers' risk perceptions and their willingness to purchase insurance. Semi-intensive shrimp farming, which presents higher inherent risks—especially for farmers not using plastic liners—emerges as the most likely model for insurance adoption due to the challenges in managing water quality and disease control. The study confirms that risk perception plays a pivotal role in farmers' decisions to purchase insurance. While perceived production risks tend to discourage insurance uptake, risks related to the environment, market conditions, and financial uncertainty are associated with a greater willingness to purchase insurance, reflecting heightened awareness of these external vulnerabilities. Only a small proportion of farmers in the "do not believe" group would consider shifting to the "willing to purchase" group if information about the mechanisms, procedures, and compensation were made transparent.

Additionally, socio-demographic factors such as participation in training programs and access to credit significantly influence insurance adoption, underscoring the need for tailored strategies that address specific barriers and leverage opportunities within different farmer groups.

To increase the willingness to purchase index-based insurance among shrimp farmers, policies should focus on subsidizing premiums for both intensive and extensive farming models, thereby addressing financial barriers. Insurance products should be designed to cover uncontrollable risks, such as environmental and market fluctuations, rather than focusing on disease risks. Strengthening farmer training and awareness programs will increase understanding of the benefits of insurance, while improving access to credit will facilitate premium payments. By implementing these strategies, the study suggests that shrimp farmers' adoption of insurance can be significantly improved, providing better risk coverage and contributing to the sustainability of shrimp farming in the region.

Author Contributions

Conceptualization, V.H.T. and N.T.T.; methodology, V.H.T.; software, N.T.T.; validation, N.T.T. and V.H.T.; formal analysis, V.H.T.; investigation, N.T.T.; resources, N.T.T.; data curation, N.T.T.; writing—original draft preparation, V.H.T.; writing—review and editing, N.T.T.; visualization, V.H.T.; supervision, V.H.T.; project administration, V.H.T.; funding acquisition, N.T.T. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement

The research was reviewed and approved by the Research Ethics Committee for Social Sciences and Humanities at Can Tho University under application number: CTU-RECSH24007.

Informed Consent Statement

All procedures performed in studies involving human participants were in accordance with the ethical standards or comparable ethical standards.

Informed consent was obtained from all individual participants involved in the study.

Consent to Publish declaration: not applicable.

Data Availability Statement

Data is available upon request.

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Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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