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FACTORS DRIVING THE ADOPTION OF COPING STRATEGIES TO MARKET RISKS OF SHRIMP FARMERS: A CASE STUDY IN A COASTAL PROVINCE OF VIETNAM

Nguyen Thai Phan[a,b] †
Isabelita M. Pabuayon[b]
Nguyen Duc Kien[a]
Truong Quang Dung[a]
Le Thanh An[a]
Nguyen Cong Dinh[a]

[a]*University of Economics, Hue University, Vietnam.*
[b]*University of the Philippines Los Banos, Laguna, Philippines.*

† ✉ *ntphan@hueuni.edu.vn (Corresponding author)*

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ABSTRACT
Shrimp farmers in Vietnam respond passively to market risks, such as input and output price shocks. This study provides a better understanding of market risks, risk management strategies adopted by shrimp farmers, the factors driving their choice of strategies, and how such strategies affect farm performance. Random sampling was used to collect information from a sample of 246 shrimp farmers. Several analytical methods were combined, including descriptive analysis, coefficient of variance estimation for market risks, and a logistic regression model to uncover factors behind farmers' decisions to adopt risk management strategies. To cope with market risks, shrimp farmers frequently adopt two risk management strategies: changes in farming technology and practices, and agricultural input contracts. Overall, 54.9% of shrimp farmers only used a single strategy, whereas the others used combined risk management strategies. Age, farm size, membership in a farmers association, participation in training, gender, price of output, price of seed, price of fertilizer, distance from farm to the market center, and shrimp type were identified as factors driving the probability of using combined risk management strategies.

Contribution/Originality: This study provides apart of existing literature for the market risk faced by the shrimp farmers and their strategies for market risk management. The findings could possibly contribute valuable insights on the factors affecting the choice of market risk management strategies and the impact on the productivity and income of shrimp farmers in Vietnam.

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1. INTRODUCTION
In Vietnam, agriculture is essential for economic development and is the dominant source of income because most of the population lives in rural areas. Moreover, agricultural production provides food, fuel and raw materials for the

processing industries. In 2017, Vietnam's gross domestic product (GDP) increased by 6.81%, and aquaculture production contributed significantly to economic growth with an increase of 5.54% (GSO - General Statistics Office of Vietnam, 2017). In 2017, the total output of aquaculture production in Vietnam was estimated to be 3,858,000 tons, which was 5.5% higher than in 2016. Shrimp production reached 683,400 tons in 2017, which was 4% higher than that in 2016 (GSO - General Statistics Office of Vietnam, 2017). In 2017, black tiger shrimp production in Vietnam reached 256,400 tons, a decrease of 2.8%, whereas white shrimp production rose to 427,000 tons, 8.5% higher than in 2016. Thus, there have been significant achievements in the development of aquaculture production, especially shrimp farming, to help improve socioeconomic conditions by reducing the unemployment rate and providing a better livelihood in the coastal provinces of Vietnam. However, the aquaculture sector is still at high risk in production and faces challenges from recent changes in production.

Risk management is critical for minimizing the consequences of shrimp production risks, particularly for shrimp farmers in coastal provinces (Girdžiūtė, 2012). Understanding the risks in shrimp farming is necessary to help farmers develop appropriate coping strategies to mitigate the damage caused by adverse events and circumvent extreme outcomes such as bankruptcy in their farming operations (Joy, Richard, Keith, Janet, & Agapi, 1999; Kien, Ancev, & Randall, 2019). There are five distinct risk factors in agriculture: production, market, credit, personal, and environmental (Herath & Thirumarpan, 2017; Mitra & Sharmin, 2019). Market risk can broadly impact production (Bernard, De Janvry, Mbaye, & Sadoulet, 2017), income (Foster & Rausser, 1991; Paul & Vogl, 2013), agricultural operations (Drollette, 2009) and total supply (Keefe & Jolly, 2001). Market risks refer to those associated with changes in the prices of outputs and inputs (Ahsan, 2011; Farzaneh, Allahyari, Damalas, & Seidavi, 2017; Greiner, Patterson, & Miller, 2009; Knutson, Smith, Anderson, & Richardson, 1998; Mahaliyanaarachchi, 2016), which may occur after the commitment to production begins (Joy et al., 1999). Price shocks in the output and input markets could lead to lower incomes for shrimp producers and lower productivity in aquaculture production.

Shrimp farming in Thua Thien Hue province faces significant market risks from changing market conditions. Shocks from input and output prices have had adverse impacts, such as lower incomes and productivity for farmers engaged in shrimp production. Generally, farmers respond passively to input and output price risks; they use traditional strategies to reduce input prices, and they agree to any price that has been set by middlemen for their output. In the short run, these practices can reduce the damage of market risks experienced by farmers. However, they are not encouraged to increase farm investments in the long term. Understanding management strategies for addressing market risks is vital to ensuring effective shrimp production and increasing farmers' income. Until now, there is no study conducted in Vietnam that comprehensively examines the farmers' shrimp production management strategies and their impacts on farm productivity and income. Some studies have been conducted on the strategies used in risk management of diseases and climate. However, they do not refer the level of fluctuation of input and output prices in shrimp industry. Therefore, this study focuses on market risk, which is one of the five sources of risk in shrimp production in the study area. This study examines fluctuations in prices in the shrimp output and input markets and identifies how farmers manage market risks to lessen their adverse impacts.

2. LITERATURE REVIEW

A change in technology involving shrimp seeds (Paul & Vogl, 2013), feeding, and fertilizer for onion production (Bernard et al., 2017) can reduce the impact of market or price variability by decreasing production costs or increasing productivity (Brennan, Clayton, & Be, 2000; Renkow, 1993). In addition, improvements in the use of onion seeds increased their weight, leading to bargaining power to increase the price of onions for farmers (Bernard et al., 2017). Notably, technology can affect the magnitude of output and input prices (Miller & Tolley, 1989). This new technology can improve the quality of products and the use of production inputs (Ha & Bac, 2021). Adopting improved agricultural technologies is crucial for economic development and rural income growth (Barrett & Carter, 2010; Takahashi & Barrett, 2014). Essentially, a change in technology can increase labor availability, but can decrease the time for other productive activities, social network experience, yield, income (Raju, 1976) and risk aversion (Takahashi & Barrett, 2014). Any change in technology can reduce production costs and can reduce the farmers' dependence on the quantity of inputs. Consequently, the input price risks can affect farmers' production processes.

An agricultural contract specifies the quantity and quality of a designated crop to be transacted on a future date. It sets either a predetermined price for the crop or a formula for pricing based on the future market price. Consequently, in marketing contracts, intermediaries sometimes share price risks with farmers. In addition to ensuring prices in production contracts, intermediaries may provide inputs and guide the production process (Du, Ifft, Lu, & Zilberman, 2015). In fact, contractual farmers appear to have been largely successful in improving their incomes (Ahsan, 2011; Wang, Wang, & Delgado, 2014) and productivity levels (Assefa, Meuwissen, & Oude, 2017; Eidman, 1990; Goodhue, 1999; Hueth & Ligon, 1999; Kutawa, 2016). The significance of a contract is revealed in a study by Jang & Olson (2010), who specified that the desired quality attributes and related production systems begin before production if necessary. This enables the buyer to reduce the risk and associated costs of the producer not accessing the appropriate quantity of the desired inputs or having to accept attribute bundles that reduce the output value. Similarly, agricultural contracts also consider transaction costs and risks (Al Ruqishi, Gibreel, Akaichi, Zaibet, & Zekri, 2020; Eidman, 1990; Fukunaga & Huffman, 2009). Several socioeconomic variables, including education, age, family size, training status, and experience, among others, significantly influence risk perception and management strategies (Ahsan, 2011; Farzaneh et al., 2017; Nganje, Kaitibie, & Taban, 2005).

3. MATERIALS AND METHODS

3.1. Market or Price Risk Analysis

Market risk is usually referred to as price risk (Drollette, 2009). Market risk tends to be high because the industry depends on demand in the global market, such as shrimp raising (Ahsan, 2011; Mahul, 2003). Van Schalkwyk & Groenewald (1994) pointed out that price risk is measured by investigating the combined effects of the aggregated output and input price ratio and the price stability of the output and input price ratio over time. In this study, price ratios, standard deviations, and coefficients of variation were used to compare the variability in prices of whiteleg and black tiger shrimp to estimate the level of price variations.

1) Price variability or risk can be measured by the ratio of successive prices (P_t / P_{t-1}) instead of differences (P_t – P_{t-1}) (Joy et al., 1999). The average prices for whiteleg and black tiger shrimp in a year or seasonal period were calculated, and the study used the percentage of the ratio of successive prices. The higher the percentage ratios of successive prices, the higher the risk. The formula for the percentage ratio of successive prices is as follows:

$$PR = \frac{\left|\overline{P_t} - \overline{P_{t-1}}\right|}{\overline{P_{t-1}}} * 100$$

Where:

PR = Percentage of the ratio of successive prices.

$\overline{P_t}$ = Mean price of shrimp in the t^{th} year.

$\overline{P_{t-1}}$ = Mean price of shrimp in $t\text{-}1^{th}$ year.

2) Standard deviation analysis: When price data for whiteleg and black tiger shrimp had the same mean value, the study considered the standard deviation. The greater the standard deviation, the more variable the prices. Higher variability indicates a higher risk. The standard deviation formula is as follows:

$$\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(P_i - \overline{P})^2}$$

Where:

σ = Standard deviation.

N = Number of years.

P_i = Price in the i^{th} year (i = 1, 2, 3, ….).

i = The i^{th} year.

$\overline{P}$ = Mean price in the specified period (at least five years).

3) Coefficient of variation analysis: When price data sets are different, a comparison of their standard deviations is not meaningful. Therefore, this study used the coefficient of variation analysis. A greater coefficient of variation indicates higher risk. The formula for the coefficient of variation is as follows:

$$CV = \frac{\sigma}{\overline{P}} * 100$$

Where:

CV = Coefficient of variation.

σ = Standard deviation.

$\overline{P}$ = Mean price in the specified period (at least five years).

3.2. Selecting Risk Management Strategies

First, focus group discussions were organized with local communities to provide an overview of the market risks and coping strategies. Participants were asked to rank the severity level of the risk and the popularity of the coping strategies used by local farmers. The most significant risks and strategies were selected for further investigation. Primary data were collected through face-to-face interviews with respondents using pre-tested questionnaires focusing on changes in production technologies or practices used by farmers. The analysis was performed for the two types of shrimp and classified according to the type of risk management strategy adopted.

3.3. Factors Affecting the Choice of Risk Management Strategy

Previous studies have analyzed the factors behind risk perception and management strategies using economic random effects models, such as the logit model (Farzaneh et al., 2017; Jordaan & Grové, 2008; Nganje et al., 2005) and probit model (Coble, Knight, Pope, & Williams, 1996). These models are useful for analyzing risk perceptions and management strategies. Coble et al. (1996) showed that the rate of insurance return impacts farmers' choices of risk mitigation strategies. Farzaneh et al. (2017) pointed out that insurance adoption depends on the income of silk farmers and other sources. In this study, a logit model was used to analyze the factors that impact the choice of risk management strategies and were classified according to a single or combined strategy.

The formula of the empirical model is as follows:

Management strategy adopted (j) = $\beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X_8 + \beta_9X_9 + \beta_{10}X_{10} + \beta_{11}X_{11} + \beta_{12}X_{12} + \beta_{13}D_1 + \beta_{14}D_2 + \varepsilon$.

Where j is the dependent variable recorded as a binary variable; 0 represents shrimp farmers who have used a single strategy; 1 represents shrimp farmers who have used a combined strategy to minimize market risks; α is constant; β_i represents the parameters of the explanatory variables to be estimated; X_i is the explanatory variable: age of farmer (years), size of shrimp farm (hectares), educational level of the farmer (years in school), membership in a farmers association (1 = yes, 0 = no), gender of the farmer (1 = male, 0 = female), participation in training (1 = yes, 0 = no), price of output (1000 VND/kg), price of seed (VND/per shrimp seed), price of feed (1000 VND/kg), price of fertilizer (1000 VND/kg), distance from farm to market center (kilometers), type of shrimp (1 = whiteleg shrimp, 0 = black tiger shrimp); and D_i represents the dummy variables. The selection of explanatory variables was based on a review of the literature by Coble et al. (1996); Farzaneh et al. (2017); Jordaan & Grové (2008); Nganje et al. (2005).

3.4. The Impact of Market Risks Management Strategies

The impact of management strategies adopted by shrimp farmers was estimated by comparing the average net income (VND/hectare) and productivity (tons/hectare) of the two groups using a single risk management strategy and a combination of risk management strategies. At a 10% significance level, the mean values of the two groups were compared using a t-test. The formulation of the average farmers' income in each group of risk management strategies is as follows:

$$\overline{I_k} = \frac{\sum_{i=1}^{n} \frac{I_{ik}}{H_{ik}} * 1000}{N_k}$$

Where:

$\overline{I_k}$	=	Mean of income in the kth group (VND/1,000 m^2).
I_{ik}	=	Income of the ith farm in the kth group (VND).
H_{ik}	=	Area of the ith farm in the kth group (m^2).
k = 1	=	Group of farmers using a single strategy.
k = 2	=	Group of farmers using a combination of strategies.

The formulation of the mean farm productivity for each group of risk management strategies is as follows:

$$\overline{Q_k} = \frac{\sum_{i=1}^{n} \frac{Q_{ik}}{H_{ik}} * 1000}{N_k}$$

Where:

$\overline{Q_k}$	=	Mean of productivity in kth group (kg/1,000 m^2).
Q_{ik}	=	Production of the ith farm in kth group (kg).
H_{ik}	=	Area of shrimp of the ith farm in the kth group (m^2).
k = 1	=	Group of farmers using a single strategy.
k = 2	=	Group of farmers using a combination of strategies.
N	=	Number of farms in the kth group.

4. RESULTS AND DISCUSSION

4.1. Market or Price Risks in Shrimp Production

The percentage of the ratio of successive prices (PR) was used to estimate price changes from 2012 to 2017. The higher the percentage ratio of successive prices, the higher the risks. This study used PR and the coefficient of variation (CV) to compare the risk level of price between the two types of shrimp in Thua Thien Hue province.

Table 1 shows the estimates of the market risk involved in shrimp production, including output, seed, and feed prices. The PR of black tiger (BT) shrimp for output during the 2012–2017 period is lower than that of whiteleg (WL) shrimp. This means that the level of output price change in BT shrimp is lower than that of WL shrimp price. Therefore, BT shrimp farmers experience less output price risk than WL shrimp farmers did, specifically from 2012 to 2017. Thus, the price of WL shrimp fluctuated more widely during these years than the price of BT shrimp during the same period.

Table 1 shows that the average prices of output, seed, and feed for the two types of shrimp are different. Therefore, this study uses the coefficient of variation (CV) of the prices from 2012 to 2017 to compare the market risk levels of the two types of shrimp. The coefficient of variation of the BT shrimp price is lower than that of WL shrimp, by 12.14% and 16.36%, respectively. Therefore, WL shrimp farmers faced more output price risk than BT shrimp farmers did from 2012 to 2017. In general, the amount of competition in the world market causes considerable variation in the price of WL shrimp.

Table 1. Estimates of market risks in shrimp production.

Item		Unit	Black Tiger Shrimp	Whiteleg Shrimp
Price of Output	Percentage of the ratio of successive prices (2012–2017)	Percent	5.54	7.49
	Average price (2012–2017)	VND/kg	138,321	116,489
	Standard deviation		16,787	19,057
	Coefficient of variation	Percent	12.14	16.36
Price of Seed	Percentage of the ratio of successive prices (2007–2017)	Percent	13.53	8.28
	Average price (2007–2017)	VND/kg	75	84
	Standard deviation (2007–2017)		39	24
	Coefficient of variation (2007–2017)	Percent	51.38	28.59
Price of Feed	Percentage of the ratio of successive prices (2007–2017)	Percent	3.37	1.48
	Average price (2007–2017)	VND/kg	32,545	29,091
	Standard deviation		5,306	1,832
	Coefficient of variation (2007–2017)	Percent	16.30	6.30

In contrast, it was found that the CV of BT shrimp seed and feed prices is higher than that of WL shrimp seeds and feed. This means that the fluctuation level of the shrimp seed price of BT is higher than that of WL. Thus, BT shrimp farmers suffer more price risks for seeds than the WL shrimp farmers from 2007 to 2017. In general, the number of black tiger shrimp seed and feed suppliers is low. This causes BT shrimp farmers to face more price risks from seed and feed suppliers. Meanwhile, more WL shrimp seed and feed suppliers (such as private companies and state seed centers) reduce the price risk for WL shrimp seed and feed. Similarly, the PR for the 2007–2017 BT shrimp seed and feed period is higher than that of the PR of WL shrimp seed and feed. Therefore, WL shrimp farmers experienced less market risk for feeds than BT shrimp farmers from 2007 to 2017.

Overall, the results show that WL shrimp farmers suffered more output price risks than BT shrimp farmers. However, BT shrimp farmers experience a higher input price risk than WL shrimp farmers. In addition, the price risk for seeds for both types of shrimp farmers is relatively high. This risk can cause difficulties as the farmers can incur high costs for seeds during the new growing season.

Table 2. Descriptive statistics of the sample.

Item	Black Tiger Shrimp		Whiteleg Shrimp		Average	
	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev
Age (years)	53	11.75	41	7.79	49	11.92
Average annual household income (million VND)	8,935	15,452	16,973	22,251	11,484	18,276
Average of farming area (m^2)	11,275	11,988	11,677	13,549	11,402	12,505
Gender						
• Male	144	85.71	72	92.31	216	87.80
• Female	24	14.29	6	7.69	30	12.20
Educational Level						
• Elementary school	120	71.43	33	42.31	153	62.20
• High school	33	19.64	18	23.08	51	20.73
• College	15	8.93	27	34.62	42	17.07
Membership in a farmers' association						
• Yes	141	83.93	30	38.46	171	69.51
• No	27	16.07	48	61.54	75	30.49
Membership in cooperative association						
• Yes	27	16.07	9	11.54	36	14.63
• No	141	83.93	39	88.46	210	85.37
Membership in a women's association						
• Yes	6	3.57	0	0.00	6	2.44
• No	162	96.43	78	100.00	240	97.56
Attendance in training						
• Yes	147	87.50	72	92.31	219	89.02
• No	21	12.50	6	7.69	27	10.98

4.2. Household and Farm Characteristics

The average age of shrimp farmers is high, at 49 years of age (see Table 2). The average age of WL shrimp farmers is lower than that of BT shrimp farmers because WL shrimp production has only become popular in recent years. In addition, due to the tremendous financial requirements needed to produce whiteleg shrimp, the majority of the whiteleg shrimp farmers have a stable source of income to support production. Therefore, the annual income of households of WL shrimp is higher than that of BT, at VND 16,973,077 per household and VND 8,935,714 per household, respectively. There is no significant gap in the mean farm area between the two types of shrimp because the local government still supports developing both types of shrimp in Thua Thien Hue province. In Thua Thien Hue province, BT shrimp farmers produce shrimp based on the experiences shared by other shrimp farmers. Hence, they do not consider pursuing higher education. As a result, more than 70% of BT farmers have only completed elementary level. In contrast, WL shrimp production requires farmers to have basic knowledge of white shrimp culture and ways to prevent disease to ensure high productivity. Completing high school and college education helps farmers better understand WL shrimp production. Therefore, about 60% of WL shrimp farmers have completed high school and college education. A farmers association is an organization consisting of local farmers in a particular area. Members often share their experience in agricultural production and provide technical support to other members. BT shrimp farmers placed more importance on the farmers association than the WL shrimp farmers did. More than 83% of BT shrimp farmers are members of a farmers association. In contrast, only about 40% of white shrimp farmers are members of a farmers association. WL shrimp farmers often do not want to share their experience with other farmers, so they do not join a farmers association.

4.3. Market Risk Management Strategies

Shrimp farmers in Thua Thien Hue are affected by changes in input and output prices in the domestic shrimp market. Price changes are considered market risks for farmers. Also, shrimp farmers depend on the middlemen's output prices because there are very few middlemen in the area. Due to market risks, shrimp farmers apply new technology and use agricultural contracts as solutions to reduce the impact of market risk on income and shrimp production.

Technological changes refers to changes in the type of shrimp seed, feed, fertilizer, suppliers, or the production process. The change in shrimp seed type refers to the change in the size of shrimp seed from post 12 to post 15. Post 12 and post 5 refer to the number of age days of shrimp seed in Vietnam. The post 15 type of shrimp seed is more significant and better in disease prevention. The change in feed type refers to the change from homemade feed to industrial or commercial feed. The industrial feed has nutritional value and provides better development for shrimp. The change in fertilizer refers to the change from natural or homemade fertilizers to industrial chemicals. Industrial fertilizers are more effective for the treatment of shrimp diseases. Shrimp farmers in Thua Thien Hue change from using input suppliers from other provinces to suppliers in their local areas to reduce transportation costs. The change in the production process refers to the shift from the traditional or non-use of machinery in shrimp production to using machines for growing and harvesting to increase productivity.

Table 3. Distribution of market risk management strategies used by farmers.

Item	Black Tiger		Whiteleg		Average	
	No.	Percent	No.	Percent	No.	Percent
Change of farming technology/practices	168	100	78	100	246	100
Seed type	51	30.36	42	25.00	93	37.80
Feed type	75	44.64	12	7.14	87	35.37
Fertilizer type	9	5.36	45	26.79	54	21.95
Seed supplier	135	80.36	36	21.43	171	69.51
Feed supplier	60	35.71	15	8.93	75	30.49
Fertilizer supplier	24	14.29	33	19.64	57	23.17
Production process	108	64.29	36	21.43	54	21.95
Adoption of agricultural input contracts	39	100.00	73	100	112	45.53
Seed supplier	39	100.00	54	73.97	93	83.04
Feed supplier	3	7.69	73	100	76	81.72
Using a single strategy	126	75.00	9	11.54	135	54.88
Using combined risk management strategies	42	25.00	69	88.46	111	45.12

All agricultural contracts focus on the use of inputs in Thua Thien Hue province. These contracts provide inputs for the production processes of the two types of shrimp. Suppliers transport inputs to each farmer's shrimp farm. There is no cost for these contracts because suppliers also need to sell inputs to increase their income. In addition, farmers can pay the expenses for inputs after harvesting and selling their output. However, the supplier can decide to implement the contract based on the information of shrimp farmers, who need to demonstrate their repayment capacity. For a technological change in shrimp production, 69.51% of the households interviewed changed seed. Most households changed seed suppliers due to poor quality in comparison to previous years. Overall, findings show that 54.88% of households only use one strategy to minimize market risk, and 45.12% of shrimp farmers apply a combination of coping strategies (see Table 3).

4.4. Factors Affecting the Choice of Risk Management Strategy

The results of the logit model are shown in Table 4. In a binary choice model, the sign of the estimated coefficients is critical to understanding the relationship between the variables and the adoption of management strategies. Combined strategies are more likely to be adopted if the coefficient has a positive sign (Kien, Ancev, & Randall, 2021).

Among the socioeconomic factors, age has a marginal negative effect coefficient (-0.003) and has a p-value of 0.091. This means that as young shrimp farmers become older, the probability that they will use a combination of risk management strategies decreases. Younger shrimp farmers may better understand the shrimp industry and the market risks involved; hence, they adopt multiple strategies. Likewise, the size of the area is statistically significant with a p-value of 0.002 and a marginal effect value of 0.001. This indicates that as the production area increases, shrimp farmers tend to adopt a combination of strategies to ensure profitable harvests from their significant investments. Thus, they want to mitigate the impact of market risk during their production process. The results of this research is in line with previous research; a key factor that affects risk management strategy adoption is age and farm size (Adnan et al., 2020).

Similarly, gender is statistically significant with a p-value of 0.000 and a marginal effect coefficient of 0.639. This implies that male farmers use a combination of risk management strategies. This result is consistent with the outcome achieved by Vigani & Kathage (2019).

Table 4. Results of logit regression on the factors affecting the choice of coping strategies.

Variable	Coefficient	P-Value	Marginal Effect (dy/dx)	P-Value
Age	-0.017*	0.084	-0.003*	0.091
Farm size	0.003***	0.002	0.001***	0.002
Level of education	-0.057	0.149	-0.011	0.154
Membership in a farmers association	0.948**	0.044	0.183**	0.037
Gender	3.319***	0.000	0.639***	0.000
Participation in training	1.294**	0.013	0.249**	0.013
Price of output	0.005*	0.059	0.001*	0.057
Price of seed	0.003***	0.000	0.001***	0.000
Price of feed	0.015	0.397	0.003	0.383
Price of fertilizer	-0.050***	0.005	-0.010***	0.003
Distance from farm to market center	-0.003**	0.039	-0.001**	0.035
Type of shrimp	2.898***	0.009	0.558**	0.013
Location 1 (1 = Quang Cong, 0 = otherwise)	-0.245	0.315	-0.047	0.306
Location 2 (1 = Dien Hai, 0 = otherwise)	-0.437	0.340	-0.084	0.356

Note: * denotes significance at the 90% level (α = 10%); ** denotes significance at the 95% level (α = 5%); *** denotes significance at the 99% level (α = 1%).

Participation in training is statistically significant, with a p-value of 0.013 and a marginal effect coefficient of 0.249. Furthermore, membership in a farmers association positively influences the decision to use a combination of risk management strategies, with a p-value of 0.037 and a marginal effect coefficient value of 0.183. In the study by Mairura et al. (2021), it was determined that group membership and training in agriculture affected a farmer's perception of uncertainty in the production process. These factors could affect a farmer's decision to use risk management in agricultural fields. Generally, participation in training and membership in a farmers association helps farmers to understand the role of using a combination of risk management strategies. Officers from the government, and other farmers in farmers association, will share the benefits of using a combination of risk management strategies. As a result, shrimp farmers tend to use a combination of risk management strategies to mitigate market risks.

The marginal effect coefficients of the seed price and output price are 0.001, significant at p-values of 0.000 and 0.057, respectively. This shows that as prices of seed and shrimp increase, farmers are more likely to adopt a combination of risk management strategies. The increasing price of output implies increasing profit, all other things being equal. By using a combination of risk management strategies, farmers may protect the expected high profit. On the other hand, the rising seed price (input) means more expense for the farmers. Therefore, they will tend to adopt a combination of strategies to ensure that they can recover their costs. However, increasing fertilizer output decreases the probability of using a combination of risk management strategies, with a p-value of 0.003 and a marginal effect coefficient of -0.010. An increase in fertilizer price can reduce farmers' investment in shrimp farming inputs. Therefore, shrimp farmers may be less likely to choose a combination of strategies to reduce risk when they have reduced investment in production. In addition, an increase of 1% in the distance from the farm to the market center reduces the probability of using a combination strategy by 0.1%. Farmers will have difficulty accessing inputs and output markets if shrimp ponds are located far from the market area. Therefore, it is difficult for shrimp farmers to use multiple strategies to minimize market risks in shrimp farming. During the production process of whiteleg shrimp, farmers tend to use various strategies to mitigate price risk. Whiteleg shrimp production requires a substantial financial investment and farmers always adopt production technologies to achieve high yields and minimize risks. In addition, they work together with input suppliers to reduce transportation costs and the impact of price fluctuations on inputs.

4.5. Changes in Productivity of Shrimp Farms

The average farm area of the group using a single strategy is 8,950 m^2, and the average farm area of a group using combined strategies is 13,978 m^2. Additionally, the output of the group using a single strategy is lower than the output of the group using combined strategies (1,823 kg and 9,465 kg, respectively).

As a result, the average farm productivity of the group using a combination of risk management strategies is higher than that of the group using a single strategy, at 677 kg/1,000 m² and 204 kg/1,000 m², respectively (see Table 5). The difference in productivity between the two groups is 474 kg/1,000 m² with a p-value of 0.0782. Agricultural contracts are an important strategy which ensures that shrimp farmers have good quality inputs for shrimp production. Thus, those using a combination of strategies are likely to perform better than those who use only one strategy.

Table 5. Test difference in the average productivity of shrimp farms.

Item	Unit	Single Strategy (A)	Combined Strategies (B)	Difference (B-A)
Area	m²	8,950	13,978	5,028
Output	Kg	1,823	9,465	7,642
Productivity	Kg/1,000 m²	204	677	474*
P-value				0.078

Note: * denotes significance at the 90% level (α = 10%).

4.6. Net Income from Shrimp Production

The average net income of the group using a combination of risk management strategies is higher than that of the group using a single strategy, at 131,160,898 VND/1,000 m² and 3,553,781VND/1,000 m², respectively (see Table 6). The difference between the net incomes of the two groups is 127,607,116 VND/1,000 m² with a p-value of 0.0981. A combination of risk management strategies ensures that shrimp farmers have good quality inputs for shrimp production. This pushes farmers to use a combination of risk management strategies to have more good quality outputs and higher selling prices than farms using a single strategy.

Table 6. Average costs and returns of shrimp farms by type of risk management.

Item	Unit	Single Strategy (A)	Combined Strategies (B)	Difference (B-A)
Revenue	(VND/1,000 m²)	34,459,680	186,114,747	151,655,067
Average price	(VND/kg)	168,920	274,911	105,991
Average quantity	(Kg/1,000 m²)	204	677	474
Costs	(VND/1,000 m²)	30,905,899	54,953,849	24,047,951
Seed cost	(VND/1,000 m²)	3,858,042	10,541,204	6,683,163
Feed cost	(VND/1,000 m²)	12,505,264	30,882,012	18,376,748
Fertilizer cost	(VND/1,000 m²)	3,867	4,442,802	4,438,934
Energy costs	(VND/1,000 m²)	2,200,585	3,566,536	1,365,950
Family labor cost	(VND/1,000 m²)	2,044,959	2,955,254	910,295
Other costs	(VND/1,000 m²)	10,293,181	2,566,041	-7,727,140
Net income	(VND/1,000 m²)	3,553,781	131,160,898	127,607,116*
P-value				0.098

Note: * denotes significance at the 90% level (α = 10%).

5. CONCLUSIONS AND POLICY RECOMMENDATIONS

The market risks of output for whiteleg (WL) shrimp were higher than that of black tiger (BT) shrimp. However, BT shrimp farmers experienced more input price risk than WL shrimp farmers. To cope with the risks, shrimp farmers adopted two types of risk management strategies: change of farming technology/practice and adoption of agricultural input contracts. Overall, 54.9% of shrimp farmers used a single strategy (adopting farming technology or adopting agricultural input contracts), while the others used combined risk management strategies. We found that farm size, membership in the farmers' association, participation in training, gender, price of output, price of seed, age, price of fertilizer, distance from the farm to the market center, and type of shrimp are the main drivers of the probability of applying combined risk management strategies. The study compared the farm productivity and net incomes of shrimp farmers by the risk management strategy adopted. The results showed that the farm productivity and net incomes of the group using a single strategy were lower than those of the group using a combination of strategies. Also, the adoption of agricultural contracts was found to be an important strategy for obtaining good quality inputs and improving the overall farm performance. The study also shows that a larger scale of shrimp production is associated with a higher probability of farmers using combined risk management strategies. Overall, it is necessary to promote combined risk management strategies, contract farming, and large-scale shrimp production in the area to better cope with market risks.

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