

**Coping up with the Risks; Increasing Sustainability:  
Strategies for Small-scale Shrimp Farming in Indonesia**

Riski A. Lestariadi\*, Masahiro Yamao

Graduate School of Biosphere Science, Hiroshima University, Japan

\*Corresponding author: d150559@hiroshima-u.ac.jp

**Abstract**

Small-scale shrimp farmers have contributed significantly to the increasing of shrimp production in Indonesia. In line with increasing production, they have also faced with various risks, thus resulting in high fluctuation of their income. Risk management strategies are needed to cope the risks and to increase their sustainability in shrimp farming. The research analyzed the various factors of risks and possibilities ex-ante and ex-post coping strategies for small-scale shrimp farmers in Indonesia. A field survey of 166 shrimp farmers was conducted in the North and South coastal zone of East Java, Indonesia. The result revealed that the top three important factors of risk that influenced in shrimp farming were shrimp price volatility, high mortality due to diseases, and increasing formulated feed price. Related to ex-ante strategies, strictly manage water quality, feeding management, and applying better management practices is the best strategies to mitigate the impact of risk into shrimp farmers' income. Regarding ex-post strategies, the small-scale shrimp farmers tended to engage informal loan resulting to loss of savings, and family labor to streamline their consumption and asset.

**Keywords:** Aquaculture risk, shrimp farming, sustainability, risk management strategies, Indonesia

**1. Introduction**

Indonesian aquaculture has grown at a significant rate and contributes to creating jobs opportunity for more than a million household during the last decade (MMAF, 2015). In terms of production, aquaculture production continues a positive trend, which has grown at 36.6% during the past 15 years. Thus, Indonesia has become the second ranked of the biggest aquaculture producers in the world at 2016. (FAO, 2016). The total production of Indonesian aquaculture was reported to reach 4.253 thousand metric tons, and contributed 5.77 % of total world production. Moreover, seaweed, milkfish, and shrimp were the major commodities in Indonesia during from 2000 to 2015 (FAO, 2016). Furthermore, shrimp was the leading Indonesian fisheries exports in terms of value for the couple of years (MMAF, 2015).

Such a fast growth of shrimp production has caused many challenges, like increasing foreign exchange, improving shrimp farmers' income, and increasing risk. However, the business environment of shrimp farms has changed due to the above-mentioned conditions. Kilawati et al. (2015) revealed that the spread of shrimp diseases such as White Spot Syndrome Virus (WSSV) and White Faces Disease (WFD) are the main problems at several provinces in Indonesia. Moreover, environmental degradation, shrimp price fluctuation, and product rejection from importing countries were some of the few issues that affected Indonesian shrimp production in the last several years (Sustainable Fisheries Partnership, 2013; Undercurrent News, 2014).

However, market demand has influenced farmers' decisions in their shrimp farming. Applying a new technology in shrimp farming, such as intensive system is the shrimp farmer's response at on-farm level. This system allows them to cultivate shrimp with higher stocking density and thus increasing their productivity. But, it also brings more risks to the shrimp farms, for example, production risk, marketing risk, personal risk, and institutional risk. Therefore, a risk management system is increasingly needed to enhance the ability of shrimp farmers to deal with risk as well as maintaining the sustainability of their livelihood.

The primary objective of this paper was to explore risk management strategies for small-scale shrimp farmers in East Java, Indonesia. Specifically, this paper examined the sources of risk in shrimp farms, then investigated the ex-ante and ex-post risk management strategies for small-scale shrimp farming.

## **2. Risk Management Strategies**

A critical issue in developing countries (e.g. Indonesia), where the economic environment is riskier, is to understand the way in which risk affects the household choices to deal with risk (Murdoch, 1994; Dercon, 2005). There are two components of risk that are related to the different aspects of shrimp farmers' decisions. The first is the possibility of unforeseeable future events. This component led the shrimp farmers to try and reduce future risk and its consequences (ex-ante). Then, the second is the actual occurrence of shocks. This component pushes the shrimp farmers to cope with the effects of shock when it occurs (ex-post).

Ex-ante risk management and ex-post risk coping strategies could be defined as measures taken before and after experiencing shock, respectively (Lekprichakul, 2009). In addition, a shock is an unpredicted or unfavorable event that effect fluctuation in shrimp farmers' income. The ex-ante risk management strategies that are undertaken before a shock occurs include risk avoidance, risk reduction and risk transfer (Chuku, 2009). These strategies are taken to minimize the impact of a shock when it occurs. Moreover, Makoka (2008) revealed that the purpose of ex-ante risk management strategies is to reduce fluctuation in farmers' income.

Furthermore, if the shrimp farmers fail to manage the shock through ex-ante, they develop strategies to cope with the shock through ex-post. The purposes of ex-post coping strategies are reducing fluctuation in consumption and assets (Kummer et al., 2012).

## **3. Materials and Methods**

This paper uses data from small-scale shrimp farms in East Java, Indonesia. Surveys were conducted in both the south and north coastal areas. Two regencies were selected: 1) Banyuwangi Regency in the south coastal area, and 2) Lamongan Regency in the north coastal area. Those regencies are selected purposively because they are the main shrimp producing areas in East Java. The sample included 79 and 87 shrimp farms in south and north coastal area, respectively.

Before designing the survey, in-depth interviews with experts in shrimp farming were conducted to collect opinion and suggestion related to sources of risk and risk management strategies. In the total, 33 sources of risk and 34 risk management strategies were presented to the respondents. Five points Likert scale was employed to measure sources of risk and risk management strategies. Then, risks and risk management strategies were ranked by their means in descending order to evaluate the level of risk and the effectiveness of risk management strategies. The descriptive analysis was used to interpret the results analysis.

#### 4. Results and Discussions

##### 4.1 Sources of Risk in Small-scale Shrimp Farming

To explore the potential impact of the sources of risk on small-scale shrimp farmers' income, this research used the concept of level of risk. The level of risk is defined as the output of the consequences and likelihood. The second column in Table 2 is presented the level of 32 sources of risk in small-scale shrimp farming. For the reference, the consequences and likelihood are presented in the third and fourth columns, respectively.

The result revealed that two sources of risk such as *shrimp price volatility* and *high mortality due to diseases* were classified as very high level with the potential of having the most severe impact on shrimp farmers' income. In the second level consists of two sources (*increasing formulated feed price* and *water pollution due to excessive formulated feed*) of risk that were classified into a high level with average scores varying from 15.0 to 19.9. The remaining 28 sources of risk were rated between 10.0 to 14.9 and belonged to the moderate level of risk. These are indicators that need serious attention for risk management for small-scale shrimp farming in Indonesia.

For the top five most significant sources of risk, *shrimp price volatility* was the top source of risk in the research areas. This source illustrates that the majority of farmers have been cultivating shrimp without any marketing contract or insurance. Also, the shrimp price fluctuation has been triggered by the spread of shrimp diseases, such as Infectious Mionecrosis Virus (IMNV), White Spot Syndrome Virus (WSSV), and White Feces Disease (WFD) in the last several years. Therefore, it is not surprising that *high mortality due to diseases* was the second ranked source of risk.

*Increasing formulated feed price* becomes the third rank and classified at the high level of risk. This finding shows that formulated feed price can have a major impact on shrimp farms' income. The reason comes from applying the intensive system in shrimp farming. Regarding production cost, Hung and Quy (2013), revealed that formulated feed costs comprised 66 to 68 percent of the total production costs in intensive shrimp farming system. The fourth rank of the source of risk was *water pollution due to excessive formulated feed* and classified into a moderate level of risk. This source of risk is closely related to the lack of knowledge of shrimp farming technique that has been practiced by shrimp farmers. The shrimp farmers used feeding trays to monitor consumption level and to adjust the next feeding ration. This method highly depended on the shrimp farmers experience to estimate the amount of formulated feed for the next feeding ration. As the result, if the shrimp farmers failed to determine the

amount of feed, the shrimp pond suffered from overfeeding. Overfeeding can reduce the quality of brackish water and produces toxic substances as a result of uneaten feed.

Table 1. Consequences, Likelihoods, and Levels of Risk

Code	Sources of Risk	Consequence (Mean*)	Likelihood (Mean**)	Risk Level	Rank
HM01	Shrimp price volatility	4.921	4.450	21.897	1
PR01	High mortality due to diseases	4.926	4.434	21.841	2
FC01	Increasing formulated feed price	4.643	4.035	18.734	3
PR02	Water pollution due to excessive formulated feed	4.561	3.492	15.924	4
PR03	Low quality of shrimp fries	4.921	3.040	14.957	5
PE01	Not enough formulated feed supply	3.899	3.527	13.752	6
PE02	Shrimp farmers do not have brackish water treatment facility	4.843	2.839	13.750	7
FC02	Not enough capital for operating shrimp farms	4.091	3.306	13.528	8
PR04	Low quality of formulated shrimp feed	4.899	2.712	13.286	9
PR05	Feeding management failure	4.503	2.929	13.186	10
PE03	Lack of knowledge to prevent shrimp diseases	3.889	3.257	12.665	11
PE04	Polluted brackish water sources	4.651	2.709	12.597	12
PR06	Excessive stocking density	3.593	3.399	12.213	13
PI01	Changed government policy and regulation	4.254	2.861	12.170	14
PR07	Lack of information about the origin of shrimp fries	3.958	2.902	11.486	15
PE05	Lack of knowledge of pond preparation	4.216	2.682	11.307	16
PR08	Inappropriate pond location	4.249	2.648	11.251	17
PR09	Do not conduct treatment before stocking shrimp fries	3.714	2.971	11.035	18
FC03	Lack collateral for loan	3.762	2.890	10.874	19
PE06	Lack of labor knowledge	3.978	2.698	10.733	20
HM02	Shrimp size variability	3.376	3.130	10.565	21
PR10	Inappropriate pond design	3.423	3.077	10.532	22
PR11	Brackish water quality	3.016	3.393	10.234	23
HM03	Inappropriate harvesting method	3.524	2.749	9.686	24
HM04	Harvesting without grading	3.545	2.696	9.556	25
PE07	Asymmetric information between buyer and farmers	3.478	2.690	9.359	26
PR12	Inappropriate shrimp fries size	3.143	2.902	9.121	27
FC04	High interest rate for loan	3.392	2.638	8.948	28
PE08	Not enough labor supply	3.184	2.628	8.368	29
PE09	Flood	3.026	2.575	7.793	30
FC05	High wages of hired labor	3.039	2.553	7.760	31
PI02	Low level of awareness among shrimp farmers	2.724	2.693	7.335	32

Source: Author's Survey Data 2016

\*Likert-type scale is used from 1 (minor impact) to 5 (severe impact)

\*\*Likert-type scale is used from 1 (rare incidence) to 5(almost certain occurrence)

Based on the rank of sources of risk above, the small-scale shrimp farmers in East Java ranked the risks rather differently compared to farmers in other countries. For example, marketing risk was perceived as the most important source of risk by a group of Dutch farmers (Meuwissen, 2001) and New Zealand farmers (Martin, 1996), while production risk was the top-rated sources of risk in America (Knutson et al., 1998, Harwood et al., 1999, Hall et al., 2003). Socio-economic characteristic of shrimp farmers is expected to improve their perceptions of the sources of risk in shrimp farming.

#### 4.2 Risk Management Strategies in Small-scale Shrimp Farming

The risk management strategies were measured by shrimp farmers based on the efficacy for mitigating each source of risks in shrimp farms. Five points Likert scale was employed to measure the risk management strategies, with 1 representing negligible effect, while 5 as the most significant effect. The average score of the efficacy of the risk management strategies are presented in Table 2 and 3, respectively.

In general, risk management strategies such as *strictly managing water quality, strict feeding management, following better management practices, only buy fries from reliable place, used shrimp fries that have SPF certificate, production contract, contract for shrimp farms input, partial harvesting, attending workshop in shrimp farming, and sharecropping* were top ten strategies and the most significant tools to manage risk for small-scale shrimp farms in the research areas.

##### 4.2.1 Ex-ante Risk Management Strategies

Regarding on-farm ex-ante strategies in Table 2, most farmers used the risk reduction and risk transfer to manage their risk in shrimp farming, which are characterized by diversification of their income sources and choice of production strategy. Among strategies ex-ante risk management strategies, *strictly manage water quality* was regarded as the most effective strategy, followed by *strictly feeding management*, and *applying better management practices* in aquaculture for the second and third ranks, respectively. The average score of these strategies is classified into the most effective ones in mitigating shrimp farming risks, such as high mortality due to diseases and water pollution due to excessive formulated feed.

However, it was a surprise that *reduces stocking density* strategy was the ninth rank. Instead of avoiding profit loss by reducing stocking density, the farmers had been maintaining their shrimp farms at a higher stocking density level to get more profit. This result implied that the shrimp farmers were risk takers. Risk Reduction Strategies

Risk reduction strategies was the most common strategies in research areas. Shown in Table 3, there are eight risk management strategies to mitigate impact of risk into shrimp farmers' income. The top three of the most effective strategies in this group was *strictly manage water quality* (5.00), *strictly feeding management* (4.99), and *applying better management practices* (4.91). All of these strategies was closely related to the second sources of risk in Table 2, which is high mortality due to diseases. In a couple of years, shrimp diseases were problems that had arisen continuously in Indonesia. During the period from 2008 to 2009, shrimp farming suffered from *Infectious Mionecrosis Virus* (Sustainable

Fisheries Partnership, 2013). Soon after recovery from *Mionecrosis Virus*, the problem due to disease continued into mid-2011 and was caused by *White Spot Syndrome Virus* (Kilawati et al., 2015). Then, Indonesian shrimp production dropped in 2014 after *White Feces Disease* appeared in East Java and Lampung.

Table 2. Ex-Ante Risk Management Strategies

		Strategies
Ex-Ante	<b>Risk Reduction</b>	<ol style="list-style-type: none"> <li>1. Strictly manage water quality (5.00)</li> <li>2. Strictly feeding management (4.99)</li> <li>3. Applying better management practices (4.91)</li> <li>4. Partial harvested (4.67)</li> <li>5. Attending workshop in shrimp farming (4.55)</li> <li>6. Prevent shrimp diseases by regular checking (4.14)</li> <li>7. Request government support for technical assistant (4.14)</li> <li>8. Develop brackish water treatment (3.54)</li> <li>9. Hire technical assistant (3.44)</li> <li>10. Apply new technology in shrimp production (2.38)</li> <li>11. Farm diversification (3.29)</li> <li>12. Off-farm work (1.20)</li> </ol>
	<b>Risk Avoidance</b>	<ol style="list-style-type: none"> <li>1. Only buy shrimp fries from reliable place (4.79)</li> <li>2. Only buy shrimp fries that have SPF certificate (4.78)</li> <li>3. Reduce brackish water pond size (4.40)</li> <li>4. Reduce stocking density (4.22)</li> <li>5. Reallocated shrimp pond to designed area (4.11)</li> <li>6. Buying formulated feed from reliable brands (3.50)</li> <li>7. Make credit arrangement before production cycle (3.45)</li> <li>8. Enforcing the shrimp pond dyke (3.43)</li> <li>9. Buying shrimp fries from public hatchery (3.02)</li> <li>10. Use large size shrimp fries (2.76)</li> <li>11. Follow the government policy and regulation (1.22)</li> </ol>
	<b>Risk Transfer</b>	<ol style="list-style-type: none"> <li>1. Production contract (4.78)</li> <li>2. Sharecropping (4.52)</li> <li>3. Informal marketing contact with wholesaler (2.52)</li> <li>4. Contract for shrimp farms inputs (4.69)</li> <li>5. Vertical integration (4.21)</li> <li>6. Marketing contract with processor (3.78)</li> <li>7. Sharing machinery and paddle wheels (1.96)</li> </ol>

Source: Author's Survey Data 2016

a) Risk Avoidance Strategies

The purpose of risk avoidance is eliminating activities that can negatively affect a shrimp farms income. Due to limited capital, the small-scale farmers used several strategies to avoid the risks in their shrimp farms, such as *only buy shrimp fries from reliable place* (4.79) and *only buy shrimp fries that have SPF certificate* (4.78). The average score of these strategies was classified into the most effective strategies in mitigating shrimp farming risks. Spreading the shrimp diseases in recent years has forced farmers to pay more attention to managing risk in their shrimp farms at low level. However, risk avoidance strategy such as *reduce brackish water pond size* (4.41) this strategy has a strong correlation with the eighth rank source of risk in Table 1, which is *not enough capital to operate shrimp farms*. The

shrimp farmers used this strategy to reduce production cost in their shrimp farms and maintain their production at the lowest possible cost.

b) Risk Transfer Strategies

In terms of risk transfer strategies, the results found that *sharecropping* was the main strategy. Increasing uncertainty in shrimp farming due to diseases in the last several years pushed the farmers to share the risk through lease out the brackish water pond to their neighbor or others shrimp farmers. The tenant will share their output to the landlord based on an agreement between them. Moreover, three strategies were classified as the most effective strategies with average scores of efficacy between 4.00 to 5.00. These strategies are *production contract* (4.767), *contract for farms inputs* (4.691), and *vertical integration* (4.212). The result implied that the shrimp farmers have tried to reduce their risks by delivering to the third parties. *Production contract* strategy was the most effective to mitigate the shrimp farms risk related to the output side, while the *contract for shrimp farm inputs* was to alleviate the risk associated to input sides, such as formulated feed, machinery and paddle wheel.

4.2.2 Ex-post Risk Coping Strategies

In terms of ex-post risk coping strategies, the average score of efficacy from each strategy are presented in Table 3. The purpose of ex-post strategies was to reduce fluctuation in consumption and assets of shrimp farmers’ household.

Table 3. Ex-Post Risk Coping Strategies

		Strategies
<b>Ex-Post</b>	<b>Risk Coping</b>	<ul style="list-style-type: none"> <li>• Use informal loan (3.72)</li> <li>• Request social assistance after natural disaster (3.28)</li> <li>• Change consumption patterns (2.76)</li> <li>• Use family labor (2.11)</li> <li>• Dissaving (2.09)</li> </ul>

Source: Author’s Survey Data 2016

The result found that five ex-post strategies had been used by the shrimp farmers to cope with the risks in their shrimp farming. Due to lack of collateral and high interest rate for loan, the small-scale shrimp farmers tend to used *informal loan* and *dissaving* as ex-post risk coping strategies. However, only *use informal loan strategies* (3.716) were an average effective, while the three remaining strategies were classified as little effective in mitigating welfare impact of risk. Moreover, to reduce expenditure in shrimp production, the shrimp farmers used *family labor* (2.11). This strategy was effective to cope the external factors risk, such as increasing wages of hired labor and not enough labor supply

**5. Conclusions**

Regarding the sources of risk, shrimp price volatility and high mortality due to diseases were by far the most damaging sources of risk that were experienced by almost the majority of shrimp farmers in East Java. In terms of risk management strategies, the small-scale shrimp

farmers in East Java, Indonesia, like their peers overseas, e.g. Dutch farmers (Meuwissen, 2001), Australian farmers (Nguyen, et al. 2005), Georgian farmers (Lin, et al., 2008), and American farmers (Hucks, et al., 2012) developed several strategies to manage the various sources of risk that affect their farms. Concerning risk management strategies, the small-scale shrimp farmers developed several strategies to manage their risk before it occurred. Risk avoidance, risk reduction, and diversification of income sources are the common approaches for ex-ante risk management strategies. Regarding the ex-ante through risk sharing strategies, sharecropping, informal risk pooling, sharing equipment, insurance, and marketing contract were the main strategies to mitigate sources of risk in shrimp farming. In case any risk already occurred, the small-scale shrimp farmers tended to engage informal loan resulting to loss of savings, and family labor to streamline their consumption and asset as ex-post strategies. These strategies may reflect the inability of shrimp farmers to access formal loan from a financial institution.

## References

- Dercon, S. (2005). Risk, Poverty and Vulnerability in Africa. *Journal of African Economies Vol. 14*, 483-488.
- FAO. (2016). *The State of World Fisheries and Aquaculture: Opportunities and Challenges*. Rome: Food and Agriculture Organization of the United Nations.
- Gunning, J. (2012). *Risk Management and Coping Mechanisms in Developing Countries*. London: Government Office for Science.
- Hall, D. K. (2003). Analysis of Beef Producers Risk Management Perceptions and Desire for further Risk Management Education. *Review of Agricultural Economics Vol 25*, 430-448.
- Harwood, J. H. (1999). *Managing Risk in Farming: Concepts, Research and Analysis*. United States Department of Agriculture, USA: Agricultural Economic Report No 774.
- Hucks, N. T. (2012). Agricultural Risk Management in the Northern Coastal Plains of South Carolina. *Journal of Management and Marketing Research*, 1-9.
- Hung, L. (2013). On-farm Feeding and Feed Management in Whiteleg Shrimp (*Litopenaeus vannamei*) Farming in Vietnam. In M. N. M.R. Hasan, *On-farm Feeding and Feed Management in Aquaculture*. (pp. 337-357). Rome: FAO Fisheries and Aquaculture Technical Paper No. 583.
- Kilawati, Y. M. (2015). ICP11 as Biomarker for WSSV Disease in *Litopenaeus vannamei*. *Research Journal of Life Science Vol. 02 No. 03*, 183-188.
- Knutson, R. S. (1998). Southern Farmers' Income Risk. *Agricultural and Applied Economics Vol 30*, 35-46.
- Lin, S. J. (2008). Farm-Level Risk Management Using Irrigation and Weather Derivatives. *Journal of Agricultural and Applied Economics*, 485-492.

- Makoka, D. (2008). *Risk, Risk Management and Vulnerability to Poverty in Rural Malawi*. Cu villier Verlag Göttingen, ISBN-10: 386727746X; ISBN-13: 978-3867277464.
- Martin, S. (1996). Risk Management Strategies in New Zealand Agriculture and Horticulture. *Review of Marketing and Agricultural Economics*, 31-44.
- MMAF. (2015). [www.djpb.kkp.go.id/produksi](http://www.djpb.kkp.go.id/produksi). Retrieved January 05, 2016, from [www.djpb.kkp.go.id: ww.djpb.kkp.go.id/index.php/arsip/c/246/Udang-Vaname-dan-Udang-Windu-Masih-Andalan-Ekspor-Indonesia/?category\\_id=13](http://www.djpb.kkp.go.id:ww.djpb.kkp.go.id/index.php/arsip/c/246/Udang-Vaname-dan-Udang-Windu-Masih-Andalan-Ekspor-Indonesia/?category_id=13)
- Murdoch, J. (1994). Poverty and Vulnerability. *AEA Papers and Proceedings* 84, (pp. 221-225).
- Nguyen, N. W. (2005). Risk Management Strategies by Australian Farmers: Two Case Studies. *AFBM Journal Vol. 4 No. 1*, 23-30.
- Partnership, S. F. (2013). *Sustainable Shrimp Industry*. Surabaya: Sustainable Fisheries Partnership.
- Perdana, A. (2005). *Risk Management for the Poor and Vulnerable*. Jakarta: CSIS.
- Undercurrentnews. (2014, May 14). *Indonesian Farmers Report Panic Selling on Falling Shrimp Prices*. Retrieved from [www.undercurrentnews.com: https://www.undercurrentnews.com/2014/05/27/indonesian-farmers-report-panic-selling-on-falling-shrimp-prices/](http://www.undercurrentnews.com:https://www.undercurrentnews.com/2014/05/27/indonesian-farmers-report-panic-selling-on-falling-shrimp-prices/)
- World Bank. (2005). *Managing Agricultural Production Risk*. Washington DC: The International Bank for Reconstruction and Development / The World Bank.