The role of research and technology in post tsunami shrimp production in Aceh Province

Mujiburrahmad1*, A Nugroho1, F Ramadhanti1, Kurniawan D1 and M Iga2

1Department of Agribusiness, Agriculture Faculty, Universitas Syiah Kuala
2Department of Social and Human Environment, Graduate School of Environmental Studies, Nagoya University, Japan

*E-mail: mujiburrahmad@unsyiah.ac.id

Abstract. Shrimp is the prime commodity of Indonesian fishery exports, with the largest export volume and value among other fishery commodities. Therefore, shrimp farming becomes a very attractive business due to the high potential of foreign exchange generated. Approximately 55% of the Aceh population depends on the fisheries sector both directly and indirectly. This study examines the role of research and technology in the development of shrimp culture and its impact on post-tsunami farmers’ economy in Aceh Province. The purpose of this study is to determine whether or not research and technology play a role in shrimp farming, analyze what technology research results are utilized, and their impact on improving farmer productivity and economy. The data was obtained from interviews with 47 farmers in four central to shrimp production districts in Aceh. Interviews results were then transcribed and analyzed using qualitative descriptive methods and path analysis. It can be concluded that partial mediation occurred between research and technology variables on shrimp production and the economy of shrimp farmers.

1. Introduction

Shrimp is one of the important fisheries commodities in Indonesia. In the Indonesian economy, shrimp contributes around 1.8% of non-oil and gas foreign exchange and employs 1.7 million people [1]. Several types of shrimps are widely maintained by farmers in Indonesia, namely tiger prawn, vannamei shrimp, fire shrimp, white shrimp, and giant prawns. Shrimp cultivations associated with the Indonesian export market are tiger shrimp and vannamei shrimp, while other types of shrimps are used for domestic market needs [2]. The government has determined that the shrimp commodity is a non-oil and gas export commodity in the 6th position among ten main export commodities in Indonesia [3]. Aceh Province has the potential in the cultivation and development of shrimp commodities. Approximately 55% of the population in Aceh depends on the fisheries sector both directly and indirectly [4]. The development of the fisheries sector continues to be one of the development priorities in Aceh Province and can positively impact economic development in general [5].

In shrimp culture, shrimp health is important. Shrimp health is greatly influenced by water quality as good water quality can support growth optimally. This is related to shrimp stress factors due to changes in water quality parameters [6]. Pollution in the pond environment also causes stunted shrimp growth, decreased resistance to disease, and shrimp death. The disease is a major obstacle in increasing shrimp
production. Unequal life categories of shrimp make shrimp susceptible to viruses that cause death, slow growth, and deformation. Diseases in shrimp can be divided into diseases without infection and those with infection. Viral disease is the most important pathogen in shrimp culture [7] [8].

The use of technology in the implementation of shrimp aquaculture will be seen by the intensity of the use of production inputs. The main inputs that can be used as an indicator of the level of technology use in aquaculture include the use of feed and aerators or tools to help dissolve oxygen in the air into the water column or aquarium. The working principle of this tool makes the surface of the water as much as possible come into contact with air. The purpose is that enough oxygen in the water and gases can be obtained, and substances that usually cause a foul odor can be driven out of the water. Traditional technology prioritizes the use of natural food and is usually carried out without the pond water aerator process. On the other hand, intensive shrimp farming uses commercial feed widely, and the use of aerators is a basic requirement.

The efficiency of technology can be used as an indicator that the technology introduced by the change agents can be utilized optimally by shrimp farmers and based on the farmers' conditions [9]. One of the factors that influence the acceleration of innovation acceptance is the nature of innovation itself. The nature and characteristics of this technology can also be used simultaneously as an indicator to which extent the use of technology is appropriate for shrimp farmers. The innovation to be introduced must have a lot of suitability or adaptive power to the existing conditions and the appropriate environmental conditions [9].

Shrimp pond condition in Aceh Province has been better after the tsunami, especially in terms of technology use. Before the tsunami, most farmers applied traditional farming systems, but nowadays, more farmers practice semi-intensive and intensive farming systems. This is influenced by the development of research and technology that produces innovation in shrimp farming. The relations between the use of technology with better production results must certainly be optimized given the world's needs for shrimp commodities that will never be fulfilled. Therefore technology and innovation are needed to prosper the lives of the farmers.

2. Research method
This research was conducted in 4 districts in Aceh Province (Pidie, Pidie Jaya, Bireuen, and Aceh Utara) since these areas are the largest shrimp production areas in Aceh Province. The objects of this study were shrimp farmers in Aceh Province. While the research scope is limited to the role of research and technology in the development of shrimp culture and its impact on the economy of shrimp farmers after the tsunami in Aceh Province. Data sources used in this study included primary and secondary data. Research sites were selected using the purposive sampling method, and samples were selected using the snowball sampling method. Using this approach, several potential respondents were contacted and asked if they knew other people with characteristics intended for research purposes. Initial contacts will help get other respondents through recommendations. This study involved several informants who were farmers, individuals from offices, laboratories (research centers), both government and private companies. The total samples in this study were 47 respondents consisting of 12 respondents from Pidie, Pidie Jaya, Bireuen, and 11 respondents from Aceh Utara Regency. This study applied qualitative and quantitative methods: descriptive and path analysis.

3. Result and discussions
3.1. Respondents' characteristics
The respondents' characteristics in this study were based on gender, age, education, and occupation. Based on the results of the study, the number of male respondents was more in number compared to female respondents. The total male respondents were 95.7 percent of the total respondents, while the remaining 4.3 percent were female respondents. Gender factor also determines a person's level of participation and productivity at work. Labor basically cannot be segregated by gender. But in general, men will be more productive in jobs that rely on physical strength, such as farming. Therefore, technology will be more helpful for farming works, which are generally done by men.
Based on the education level, 36.2 percent of respondents were high school graduates, and the highest education level for farmers was a Bachelor's Degree (14.9 per cent). This shows that most respondents who work as farmers have a fairly good education, completing the 9-year compulsory education program. Education has a relationship with general knowledge and understanding of the human environment and developing knowledge, skills, thoughts, character, etc.

Work experience is knowledge or skills possessed and controlled by a person in a certain field resulting from an act or job he has done for a certain period [10]. The length of work experience will help solve the problems for farmers. The percentage of experienced and beginner farmers was 42.6 per cent each. Meanwhile, the remaining 14.9 per cent were respondents who have farmed between 5 - 10 years. This was deliberately done to obtain data from respondents to find out the length of their farming experience.

3.2. The role and development of research and technology in shrimp culture
The difference in the level of use of technology in the implementation of shrimp aquaculture was identified with the intensity of the use of production inputs in the shrimp culture. The main inputs that can be used as an indication of the level of technology utilization in aquaculture include the use of feed and the use of aerators. Traditional technology prioritizes the use of natural food and is usually carried out without the aeration process of pond water. On the other hand, intensive shrimp farming is widely used as commercial feed, and the use of aeration is a basic requirement in shrimp farming [11].

Research and technology development roles are divided into three categories: extensive pond, semi-intensive pond, and intensive pond. From these three, intensive pond is the highest category of the three types of ponds. This means that there has been much research technology used to assist in shrimp farming. In intensive ponds, the use of windmills, pumping machines, and tarpaulins is optimal. Besides, other technologies are also used, such as pH gauges, salinity gauges, etc. Land preparation for the maintenance and use of production materials such as lime, fertilizers, and chemicals are also needed in intensive ponds. Cultivation using intensive ponds is usually done on a large scale and carried out by farmers who have a large capital.

3.3. Research result technology that is utilized in shrimp culture and method of dissemination of research or technology results on farmers
Research and technology in shrimp farming in this study are divided into three categories: research and production technology, research and policy technology, and marketing research and technology. The production itself consists of research and technology of fry quality, water quality research and technology, disease research and technology, and research and feed technology. While policies consist of export/import research and technology and research and regulatory technology. Then for marketing category consists of research and marketing system technology and prices.

Shrimp productivity depends on the quantity and quality of the fry. Many factors affect the quality of the fry, including the availability of feed and handling of the fry in the nursery.

Many farmers also have their own hatcheries, and they use various technologies such as windmills, aerator engines, pumping machines, and others. Water quality is vital in shrimp culture, and finding out the ingredients contained in the pond indicated as pollutants that are toxic or materials that are useful to support the cultivation process becomes crucial.

Technologies applied to stabilize water quality include the use of windmills, tarpaulins, pumping machines, aerator machines, pH gauges, salinity gauges, and temperature gauges. Pollution in the pond environment causes stunted shrimp growth, decreased resistance to shrimp disease, and death. Some shrimp diseases that are often found in the field can be caused by viral, bacterial, parasitic, or fungal pathogens. The diseases in shrimps can be minimized by improving water quality, regulation of feed, and dense distribution settings. The main sources of shrimp feed nutrients are protein, carbohydrates, and fat or lipids. The content of feed protein is a very important factor in supporting the success of shrimp farming. Research technology has created many kinds of commercial quality feed for shrimps.
The marketing system of vannamei shrimp cultivation is a pattern of relationships of marketing agents (institutions that carry out marketing tasks on shrimp) that influence each other and shape and influence the relationship between companies and their markets, which have a transactional purpose. With technology, the shrimp marketing process becomes cheaper; for example, vehicle functioning as a conveyance. The prices depend on the type, quality, and size of the shrimp. Also, the use of technology can affect the price. Farmers who use technology cultivation can produce shrimp with better quality and have a larger size.

| Dissemination | Category |
|---------------|----------|
| Culprit       | Individuals or groups that carry out activities of distributing innovations that are planned, directed, managed and addressed to the target group or individuals like instructors, service providers, technicians, and others. |
| Product       | The dissemination process between the perpetrators and farmers is carried out through discussion: question and answer session. The disseminator provides material in the form of presentations or a guide book on shrimp farming. |
| Time          | The frequency of individuals or groups provides direction to the target group or target individuals. The more often disseminators visit farmers, the more effective the information will be received. Usually done 2-3 times per month. |
| The place     | The venue where the process of delivering good information in the form of innovation, facilities, and others takes place. Usually, the extension agents or officials visit the farms. However, for formal events such as meetings, the farmers will gather at one farm. The farmers can also visit the office at any time to ask questions related to farming. |
| Impact        | The dissemination impact is for farmers to obtain information, raise awareness, receive, and ultimately utilize the information to better cultivate the farming so that productivity can increase. |

3.4. The relationship of research and technology on shrimp production and its impact on the shrimp farmers’ economy

Path analysis was used with the help of SPSS (Statistical Packages for Social Science) to determine the relationship between research variables and technology on shrimp production and its impact on shrimp farmers’ economy. The results of the analysis are as follows:

| No | Path                                                                 | Unstandardized beta | Standardized beta | p-value     |
|----|----------------------------------------------------------------------|---------------------|-------------------|-------------|
| 1  | Research and technology on shrimp production                         | 0.242               | 0.323             | 0.027*      |
| 2  | Production of the farmer's economy                                   | 0.165               | 0.656             | 0.000***    |
| 3  | Research and technology on the farmer's economy                       | 0.086               | 0.457             | 0.001**     |
| 4  | Research and technology through production of the farmer's economy   | 0.051 and 0.143     | 0.274 and 0.568   | 0.000***    |
| 5  | Aquaculture of shrimp production                                     | 0.134               | 0.096             | 0.521       |
The results obtained from 13 research and technology path analysis on the development of shrimp culture and its impact on the economy of shrimp farmers after the tsunami in Aceh Province, 11 showed significant results, where the p-value was <0.05, and 2 tests showed insignificant results, where p-value was > 0.05.

3.5. Path analysis testing model

To examine the relationship between research variables and shrimp culture technology and shrimp production on shrimp farmers' economy, an intervening variable (intermediate variable / mediating) was used, which served to mediate the relationship between independent and dependent variables or what is called a path analysis. The results of the analysis are as follows:

| No | Path | Unstandardized beta | Standardized beta | p-value |
|----|------|----------------------|-------------------|---------|
| 6  | Cultivation of the farmer's economy | 0.078              | 0.221             | 0.136   |
| 7  | Cultivation through production of the farmer's economy | 0.056 and 0.161    | 0.159 and 0.641   | 0.000***|
| 8  | Policy on shrimp production | 1.470              | 0.390             | 0.007** |
| 9  | Policy on farmer's economy | 0.464              | 0.490             | 0.000***|
| 10 | Policy through production to the farmer's economy | 0.138              | 0.549             | 0.000***|
| 11 | Marketing of shrimp production | 0.540              | 0.375             | 0.009** |
| 12 | Marketing of the economy | 0.169              | 0.466             | 0.001** |
| 13 | Marketing through the production of the farmer's economy | 0.141              | 0.561             | 0.000***|

Source: Primary Data (Processed), 2019.
Information :
*** = High Level of Significance.
** = Medium Significance.
* = Low Significance Rate.

Figure 1. Mediating testing model.

Based on the intervening variable testing requirements in the path analysis, it can be concluded that the coefficient value of \( c < \) of the \( c \) coefficient value. It indicates that partial mediation occurs between
research and technology variables on the economy of shrimp farmers after the tsunami in Aceh Province. This finding is in line with Ghozali’s opinion [12], where the determination of intervening variables depends on the theoretical form, for example, on the a-b-c model where the relation of a to c is not direct. It must pass through b. So if a to b is significant, b to c is also significant, then b is intervening in a to c relations.

Based on the results of this study, it can be seen that research and technology, and production can have a direct or indirect effect on the economy of shrimp farmers after the tsunami in Aceh Province. The direct influence of research and technology partially on shrimp production occurred on the research and technology variables of the policy dimension and research and technology marketing dimensions. While for research and technology, the shrimp culture dimension did not directly influence shrimp production and the economy of shrimp farmers [13]. However, the relations of research and technology in the aggregate had the greatest influence on shrimp production. Thus, this shows that the presence of research and high category technology elements contributed to an increase in shrimp production, which has an impact on the economy of the shrimp farmers.

4. Conclusions
Research and technology in shrimp farming in this study proved to play an important role, especially in intensive ponds to facilitate the cultivation process, make work easier, speed up the harvesting process, minimize the risk of crop failure, improve the shrimp size, the facilitate shrimp growth by the presence of oxygen regulator, maintain water quality and the most important is to increase the production and productivity resulted in an increase in income of the farmers. As for the traditional ponds, research and technology play less role in the cultivation process, with the cost factor as the main contributing factor. The results of research and technology on shrimp farming in this study are divided into three categories, namely research and production technology, research and technology policy, and marketing research and technology. The results of research and technology in the production aspects include the quality of fry using superior quality and certified fry, water quality by conducting routine checks and screening, minimizing the presence of disease by providing intake of vitamins and medicines and the feed provided is increasingly diverse with the development of technology. The results of research and technology in the policy aspects include exports/imports with the possibility of large exports and small imports and regulations, that is, the partnership with established regulations. The results of research and technology in marketing aspects include the marketing system. Using the marketing process technology can broaden the market reach and affect prices because technology can help shrimp grow faster and have a larger size so that the selling price can be higher.

Research and technology and shrimp production are significantly related to the economy of shrimp farmers. The relations of research and technology and shrimp production to the economy of shrimp farmers are partially mediated, which means that the existence of research and technology will increase shrimp production in realizing a better economy for shrimp farmers after the tsunami in Aceh Province.

References
[1] International Finance Corporation 2007 Environmental, Health, and Safety Guidelines for Printing London
[2] Marine and Fisheries Ministry 2013 Marine and fisheries in figures 2013 Center for Statistical and Information Data Jakarta (16) 12
[3] Ministry of Trade of the Republic of Indonesia 2015 Towards the ASEAN Economic Community Director General of International Trade Jakarta
[4] Yusuf Q 2006 Empowerment of Panglima Laot In Aceh International Workshop On Marine Science Banda Aceh
[5] Muchlisin Z A 2015 Diversity of freshwater fishes in Aceh Province, Indonesia with emphasis on several biological aspects of the Depik (Rasbora tawarensis) an endemic Species in Lake Laut Tawar Disertasi Ph.D Universiti Sains Malaysia Penang
[6] Haliman R W and Adijaya D S 2004 Vannamei shrimp Self-Help Spreader Jakarta
[7] Rahman M M 2007 Differences in virulence between white spot syndrome virus (WSSV) isolates and testing of some strategic control in ESSV infected shrimp. Laboratory of Virology Department or Virology, Parasitology and Immunology Faculty of Veterinary Medicine Ghent University India

[8] Purnamasari, Indah D, Purnama and M A F Utami 2017 Growth of Vaname Shrimp (Litopenaeus vannamei) in Intensive Ponds. Enggano's Journal 2 58 - 67

[9] Ibrahim, Tatang, M dan Musyafak, Akhmad 2005 Strategi percepatan adopsi dan difusi inovasi pertanian mendukung prima tani. Jurnal Analisis Kebijakan Pertanian. Jakarta.

[10] Trijoko dan Prasatya 2000 Basic Cultural Sciences Renika Jakarta

[11] Bayu A 2009 Mangrove Forest as a Source of Natural Marine Products. Oseana 34(2) 15-23

[12] Ghozali dan Imam 2011 Application of Multivariate Analysis with SPSS Program Diponegoro University Publishing Agency Semarang

[13] Agussabti, Rahmaddiansyah, Satriyo P, Munawar AA 2020. Data Br. Apr 1;29.