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Performance Strengthening of Milkfish Aquaculture as a Strategy for Realizing Food Security

Fortalecimiento del rendimiento de la acuicultura del sabalote como estrategia para lograr la Seguridad Alimentaria

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Contents

ABSTRACT:
This research analyzed the production factors of land, seeds, feed, labor, fertilizer, lime and marketing distribution on the milkfish aquaculture performance and food security in Demak, Indonesia. By involving 250 farmers, 10 collectors, 10 retailers, and 20 consumers analyzed through SPSS v.22 with structural equation modeling (SEM) approach, the results showed that land farm, milkfish seedlings, feed and labor have significant effects on production output, while production output and marketing distribution channels have a significant positive effect on food security.
Keywords: Production factors, production output, marketing distribution, food security, aquaculture

RESUMEN:
Esta investigación analizó los factores de producción de la tierra, las semillas, los piensos, la mano de obra, los fertilizantes, la cal y la distribución de comercialización en el rendimiento de la acuicultura del sabalote (pez-de-leche) y la seguridad alimentaria en Demak, Indonesia. Al involucrar a 250 agricultores, 10 recolectores, 10 minoristas y 20 consumidores analizados a través de SPSS v.22 con el enfoque de modelado de ecuaciones estructurales (SEM), los resultados mostraron que las granjas de tierra, las plántulas de peces de leche, los alimentos y la mano de obra tienen efectos significativos en la producción, mientras que La producción y los canales de distribución de comercialización tienen un efecto positivo significativo en la seguridad alimentaria.
Palabras clave: Factores de producción, salida de producción, distribución de marketing, seguridad alimentaria, acuicultura.

1. Introduction

Food and Agriculture Organization of the United Nations (1992) defines food security as a situation when all people at all times have adequate amounts of safe and nutritious food for a healthy and active life. Food security is explained in 4 pillars, namely food availability, physical and economic access to food, stability of supply and access, and food utilization. Fish is one of the important commodities in building food security in Indonesia whose trade has developed quite rapidly in line with the increasing population of the world. Natalia and Nurozy (2012) state that the amount of global fish consumption, both fresh and processed fish, is very large and fish is not only consumed by humans but is also used as raw material for animal feed. In line with this, the fisheries sector also plays an important role in the formation of Indonesia's Gross Domestic Product. This growth shows an increase in the purchasing power of actors in the marine and fisheries sector compared to the agricultural sector. The fisheries and aquaculture sectors are chosen as the main focus because their production always dominates compared to other sectors. As part of the national fisheries industry, aquaculture continues to grow even though it still faces various problems, including those related to the implementation of spatial policies, limited irrigation channel infrastructure, availability and distribution of broodstock and superior seeds are still limited, high feed prices, and pest attacks , diseases and pollution that affect the quality of the aquaculture environment. The total aquaculture production in Indonesia continues to increase significantly. In the 2011-2014 period, total production exceeded the production target even though in 2015 production realization only reached the target (SIMAqua, 2015).

Dahuri (2010) states that milkfish is one of the options to increase aquaculture production which has not been carried out optimally due to land constraints, even though the price is affordable, nutritious, the cultivation is easy to do, and can increase the income of coastal communities. Milkfish cultivation itself is carried out in ponds using brackish water. Indonesia has the most extensive pond land potential in the world, where more than 1.22 million hectares are spread throughout the province. As much as 452,901 hectares or 27 percent of the land has been built ponds. The milkfish (*Chanos chanos*), which is the only species that still exists from the Chektarenidae family, is one type of brackish fish that has a specific taste and is known in Indonesia even in the world. Milkfish is the main commodity in Java Island, such as Semarang's presto milkfish, and Sidoarjo's special milkfish. Milkfish production increases every year with a significant average increase in production, which is an average increase of 10.84 percent. The national milkfish production in the 2009-2013 period was 328,288 tons, 421,757 tons, 467,449 tons, 518,939 tons and 626,878 tons (Directorate General of Aquaculture of the Ministry of Maritime Affairs and Fisheries, 2014). Based on the above phenomenon, it is important to strengthen the performance of farmers who carry out milkfish aquaculture in an effort to achieve food security at the research location, namely Demak Regency, with the following research questions:

Q1. Is the combination of the use of input factors of production significant in explaining the output of milkfish aquaculture?

Q2. Has the distribution channel of milkfish aquaculture products been efficiently reached by consumers?

Q3. Is milkfish aquaculture production can be seen from the availability, affordability is relatively resistant to support food security in Demak Regency?.

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2. Theoretical review and hypotheses

2.1. Production factors and food security

The cultivation of milkfish ponds requires efficiency considerations, especially in the use of production factors. Efficiency according to Yotopoulos and Nugent (1976), is the transformation of inputs (labor, finance, tools/technology) to get the maximum output. Based on this understanding efficiency can be interpreted more towards maximizing output than minimizing input. Farel (1957) differentiated the conceptualization of efficiency between technical, allocative, and economical aspects. Timmer (1970), defines engineering efficiency as the ratio of inputs that are actually used to the available outputs. In other words, a quantity that shows a comparison between actual production and maximum production. Allocative efficiency is achieved if milkfish aquaculture is able to maximize profits by equating the marginal product of each factor of production with the price, while economic efficiency is a quantity that shows a comparison between actual profits and maximum profits. Understanding the meaning of efficiency concluded that efficiency is an indicator of the performance of milkfish pond farming. Achieving technical efficiency, especially how farmers minimize the use of high input factors aimed at increasing competitiveness and profits. According to Adiyoga (1999) basically, milkfish pond farmers want to maximize profits, but in their behavior farmers cannot be separated from the changes that occur in their daily work environment. Managing milkfish ponds farming, farmers may make deviations that have consequences. The dynamics of milkfish aquaculture can change the technical and economic environment continuously, causing difficulties for farmers in adjusting their allocative decisions in response to changes in their production environment.

Technical efficiency is one component of overall economic efficiency. Kumbhakar and Lovell (2000) found that there are three ways to maximize profits from a farm to (i) maximize output on the use of certain inputs or often called technical efficiency, (ii) obtain maximum benefits can be obtained through an appropriate combination of inputs at a given input price level (allocative efficiency), and (iii) produce the right combination of production at a certain price level of production. According to Fuglie (2002) factors of production or input are directly related to productivity growth. Productivity connects the amount of output produced with the amount of input used to produce that output. Margono and Sharma (2006) state that one measure of productivity is Total Factor Productivity (TFP), which is a measure of productivity that is not caused by the addition of inputs (eg capital and labor) but is a measurement of productivity caused by increased production quality. This is what makes economic growth, due to the high TFP, be sustainable. TFP can be interpreted as a collection of all quality factors that use resources available optimally to produce more output from each input unit. TFP describes the efficiency and effectiveness when the factors of production are processed together to produce output, both in the form of goods or services.

Evenson and Rosegrant's (1995) study showed that India had achieved significant TFP growth. That made the Indian economy able to increase its food production even though India started a period with high population density and limited development of planting areas which were a source of output growth. The high growth of TFP was mainly due to investment, especially in the field of research, as well as the addition of markets and irrigation. High rates of return especially for research in public agriculture indicate that the Indian government has not made excessive investments, but remains at the level of public investment that is considered profitable. Fuglie (2003) also conducted a study to look at the performance of agricultural productivity in Indonesia during the period 1961--2000 using the Tornqvist Index. This study uses time series data from output of plant and animal categories as many as 49 and input categories as many as 18. The results of the study show that between 1961--2000 output of agricultural and livestock commodities in Indonesia grew an average of 3.4% annually; the use of conventional inputs in the agricultural sector (planting land, labor, animal husbandry, fertilizer, and machinery) increased by 1.9%; and TFP grew by 1.5%. The use of modern industrial input is growing rapidly from a low initial level, although it is still underutilized when compared to marginal productivity costs.

H1: Land has a significant effect on production outputs

H2: Seedlings have a significant effect on production outputs

H3: Feed has a significant effect on production outputs

H4: Labor has a significant effect on production output

H5: Fertilizer has a significant effect on production outputs

H6: Lime has a significant effect on yield

2.2. Production output and food security

Shiu and Heshmati (2006) showed that in 30 provinces in China during high growth, ie 1993—2003, TFP recorded positive growth in all provinces in China during the study period. The East and Central Region has the highest TFP growth rates compared to the West. Foreign direct investment and investment in information and communication technology (ITC) are factors that contribute significantly to TFP differences in the region. Although these two factors have a significant relationship affecting TFP, the influence of these two variables is relatively small compared to the number of inputs from the factor of production. Thirtle et al. (1993) show that Zimbabwean agricultural sector's Total Factor Productivity (TFP) index, both for commercial and communal agriculture since independence, by using the Tornqsvist-theil analysis tool, TFP for the commercial agriculture sector and the communal agriculture sector increased significantly since the country gained independence which was contributed mainly by new technologies derived from the allocation of expenditure for R&D or technology imported from abroad as well as the dissemination of these technologies to farmers through extensive services. Furthermore, Karadag (2004) showed that during the research period TFP experienced a small increase due to economic instability that occurred in Turkey, namely in 1994 and 1998. Changes in efficiency played an important role in the contribution of TFP growth, although technical changes did not significantly influence. The change in TFP for the public sector was 1.4% and for the private sector it was 1.2%.

Matshe's (2009) research conducted to analyze the relationship between increased production and food security, which was analyzed by several approaches shows evidence that there is a relationship between increasing smallholder production for food security in sub-Saharan Africa. Likewise, research by Schneider and Gugerty (2011) found that increasing agricultural output is more likely to reduce poverty. Muzari (2016) found that agricultural productivity also had an effect on reducing poverty and increasing food security of farmers. By identifying four main components in the global food system, namely technology, institutions, communities, and natural resources, Yengoh et al. (2010) state that these four components play an important role in developing a framework and characterizing the orientation of agricultural growth in Cameroon as a way to achieve food security.

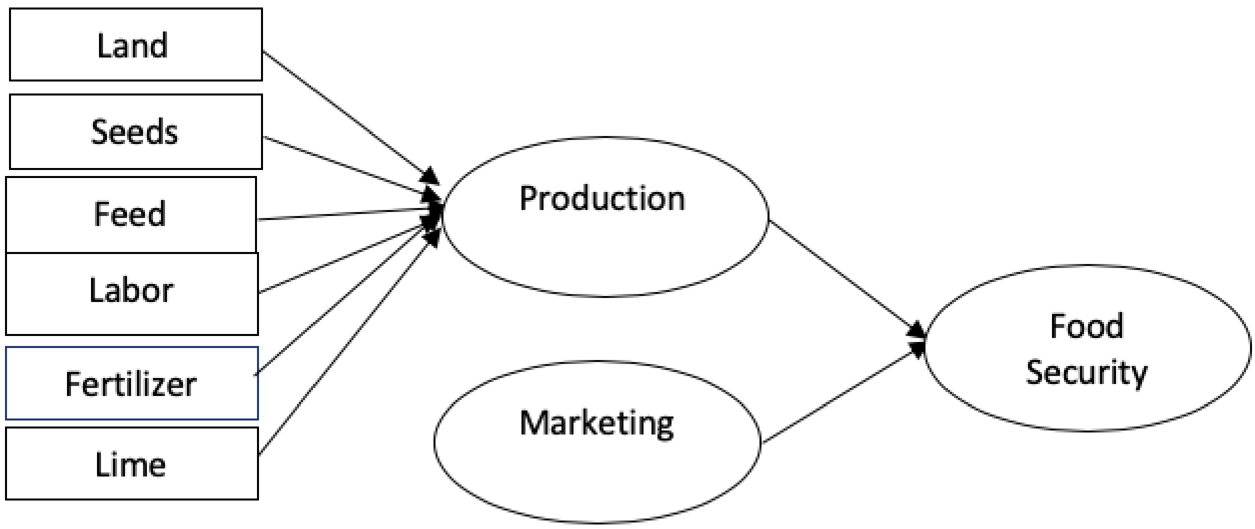
H7: Production outputs have a significant effect on food security

2.3. Marketing and food security

Food security is related to the system of increasing production to maintain the availability of sufficient food (both sourced from domestic and imported), physically and economically affordable. Stable in meeting food needs in difficult seasons, and safe for consumption. Food security should meet the proportion of healthy and balanced food requirements, namely carbohydrates 60-65 percent, fat 20 percent, protein 15-20 percent of total daily needs (Irianto, 2006). Based on meeting these needs, the notion of food security is not only sourced from carbohydrate commodities (such as seeds and tubers), it also comes from animal protein and fat, such as fish. According to Lelono and Susilowati (2010 (2010), marketing distribution channels in supporting food security are related to the ability to spread products to and affordable by consumers. To understand this, a structure-performance-conduct (SPC) approach is often used. The structural approach is often directed at the physical distribution of pond products in the public market. The approach to implementation in the public market focuses on marketing margins, in an efficient marketing system three things are discussed, such as transportation costs, handling costs and profits, while the implementation approach is related to behavior patterns in market interactions, it is usually directed at the way of selling and pricing policies. Generally, milkfish products are perishable food ingredients, which must be balanced with good distribution capabilities (such as by actors, means of transportation, refrigeration, road access, travel time) from initial loading at the production site on the way to being enjoyed by consumers. Distribution actors in this area are generally carried out by farmers who act as collectors. The results of the ponds are picked up by collectors at the production site. So that the distribution channel that is considered the most efficient is directly or short channel. This study wants to know the physical marketing distribution channels in support of food security in the study area, through collecting traders.

H8: Marketing has a significant effect on food security

Figure 1
Research Model



3. Research methods

This type of research includes Explonatory research, namely research that highlights the relationship between research variables and tests of hypotheses that were formulated previously. This research will be carried out in Demak Regency, Central Java Province, on traditional pond farmers in 5 (five) districts, namely: Bonang District, Wedung District, Karangtengah District, Sayung District and Sri Wulan District. Sampling/respondents in this study were conducted by random sampling method. The study was conducted in the period March 2019 - July 2019. Primary data for the production aspects were collected from 160 farm farmers, 10 collectors, 10 retailers, and 20 milkfish consumers. The efficiency discussed in this study is the efficient use of production factors of milkfish pond production consisting of: Land (Ha), the area of milkfish cultivation one planting season; seeds, the number of milkfish seeds for one growing season; labor (hours), the number of hours of work allocated by a worker for one planting season. On average 5-6 hours/person/day for one growing season (4 months); feed (kg), the amount of feed used for one growing season; Fertilizer (Kg), Amount of fertilizer used once in the Lime planting season (Kg), Amount of lime used once in the planting season; Production (Y), the amount of production in one harvest. Data collection techniques are carried out through observation, in-depth interviews, and conducting a literature study. Model testing is carried out using Structural Equation Modeling (SEM) with a two step approach. In the Two-Step Approach to SEM, the measurement model is first formulated and evaluated separately and then set in the second step when the structural model is estimated (Hair et al., 1998).

4. Results

4.1. Data conformity assessment - model

The fit-model data assessment is based on many indices, chosen from: (a) X2 chi square statistics (b) CMIN/DF (Normed Chisquare) (c) GFI (Goodness of Fit Index) (d) AGFI - Adjusted Goodness of Fit Index (e) NFI (Normed Fit Index) (f) TLI (Tucker-Lewis Index) (g) CFI (Comparative Fit Index) (h) RMR (The Root Mean Square Residual) (i) RMSEA (The Root Mean Square of Approximation), the results of the analysis are presented in table 1.

Table 1
Structural Equation Modeling Feasibility Testing Index

No	Goodness of fit index	Cut-off-value	Results	Evaluation
1	χ 2 - Chi-Square	< 108.78	98.65	Good
2	Significance Probability	≥ 0.05	0.067	Good
3	CMIN/DF	≤ 2.00	1.886	Good
4	GFI	≥ 0.90	0.873	Marginal
5	AGFI	≥ 0.90	0.864	Marginal
6	TLI	≥ 0.95	0.972	Good
7	CFI	≥ 0.95	0.968	Good
8	RMSEA	≤ 0.08	0.072	Good

4.2. Reliability test

The reliability test is carried out to find out whether the measuring instrument used can provide relatively the same results if it is re-measured on the same subject. Based on the calculation results in Table 2 it can be seen that all construct reliability values are greater than 0.7. This indicates that all constructs of the study are reliable.

Table 2
Reliability testing

Variables	Standard Loading	Standard Error	Reliability

Land	2.755	0.715	0.991
Seeds	4.213	0.494	0.896
Feed	4.387	1.014	0.918
Labor	3.129	0.561	0.882
Fertilizer	2.905	0.986	0.783
Lime	3.235	1.980	0.890
Production	4.762	1.854	0.798
Marketing	4.078	0.954	0.912
Food security	3.785	1.870	0.913

4.3. Hypothesis testing

Hypothesis 1 states that land has a significant positive effect on yield. The analysis shows that the Critical Ratio (CR) value of 4.462 is higher than the t-table value of 3.00 with a probability level of 0.037<0.05 with a beta value of 0.366. Thus, the hypothesis (Ha) which states that land has a significant positive effect on productivity is accepted. The results support the research of Lelono and Susilowati (2010) and Faisyal et al. (2016) who state that land factors play an important role in increasing the productivity of fishponds and needs to intensify land from two harvests to three harvests a year.

Hypothesis 2 states that seedlings have a significant positive effect on production yields. The calculation results show that the C.R value of 3.743 is higher than the t-table value of 3.00 with a probability level of 0.024<0.05 with a beta value of 0.251. Thus, the hypothesis which states that the seedlings has a significant positive effect on production outputs accepted. The results of the study support the research of Mangampa and Burhanuddin (2014) and Sembiring et al. (2018) who stated that seedlings had a significant effect on milkfish production.

Hypothesis 3 states that feed has a significant positive effect on production outputs. The calculation results show a C.R value of 3.861 that value is higher than the t-table value of 3.00 with a probability level of 0. 041<0.05 with a beta value of 0.495. Thus, the hypothesis which states that the Seedlings has a significant positive effect on production outputs accepted. The results support the research of Usman et al. (2011) and Kamaruddin et al. (2017) showing that the specific growth rate (weight, carapace width, and carapace length), as well as crab survival, feed conversion ratio, and feed protein efficiency, not significantly different (p>0.05) between treatments. showed that the specific growth rate (weight, carapace width, and carapace length), as well as crab survival, feed conversion ratio, and protein protein efficiency, were not significantly different (p>0.05) between treatments.

Hypothesis 4 states that labor has a significant positive effect on production outputs. The analysis showed that the C.R value of 5.644 was higher than the t-table value of 3.00 with a probability level of 0.00<0.05 with a beta value of 0.557. Thus, the hypothesis which states that labor has a significant positive effect on production outputs is accepted. The results of the study support the research of Indra and Susilo (2017) and Lelono and Susilowati (2010) who stated that labor had a significant effect on increasing the productivity of milkfish ponds.

Hypothesis 5 states that fertilizer has a positive and significant effect on productivity. Based on the calculation results it is known that the C.R value of 2.578 shows that this value is smaller than the t-table value of 3.00 with a probability of 0.058>0.05 with a beta value of 0.018. Based on the results of this study, the hypothesis which states that fertilizer has a positive and significant effect on production outputs is rejected. The results of this study are not in accordance with the research of Hijrah et al. (2017) which shows that the administration of super petroganik organic fertilizer has a very good effect on the growth of milkfish (*Chanos chanos*).

Table 3
Standardized Weight Regression
of Structural Equation Model

Hypotheses	Estimate	S.E.	C.R.	P
Production ← Land	0.366	0.093	4.462	0.037
Production ← Seeds	0.251	0.114	3.743	0.024
Production ← Feed	0.495	0.158	3.861	0.041
Production ← Labor	0.527	0.230	5.644	***
Production ← Fertilizer	0.018	0.391	2.578	0.058
Production ← Lime	0.023	0.219	2.819	0.065
Food Security ← Production	0.557	0.328	4.093	0.028
Food security ← Marketing	0.462	0.245	3.984	***

Hypothesis 6 states Lime has a positive and significant effect on production yield. The result of calculation shows that the C.R value of 2,819 shows that this value is smaller than the t-table value of 3.00 with a probability of 0.065>0.05 with a beta value of 0.023. Based on the results of this study, the hypothesis which states that Limestone has a positive and significant effect on production outputs is rejected. The results of this study is not in line with WWF Fisheries Team (2014) and Mustafa et al. (2010) which state that liming is intended to neutralize soil pH which will further increase the productivity yield of milkfish ponds.

Hypothesis 7 states that production outputs have a significant positive effect on food security. The analysis shows that the C.R value of 4.093 is higher than the t-table value of 3.00 with a probability level of 0.028<0.05 with a beta value of 0.557. Thus, the hypothesis which states that yields have a significant positive effect on food security is accepted. The results of the study support the research of Dhelia et al. (2018) and Prabowo (2010) which stated the results of production had a significant effect on increasing food security.

Hypothesis 8 states that marketing distribution channels have a significant positive effect on food security. The analysis shows that the C.R value of 3.984 is higher than the t-table value of 3.00 with a probability level of 0.00<0.05 with a beta value of 0.462. Thus, the hypothesis which states that marketing distribution channels have a significant positive effect on food security is accepted. The results of the study are in accordance with the research of Fagi (2013) and Lelono and Susilowati (2010) which states that marketing distribution channels have a significant effect on increasing food security (Table 3).

5. Conclusion

The results of testing of eight hypotheses show that the six proposed hypotheses are acceptable, and two hypotheses are rejected. More specifically, the land farm, milkfish seedlings, feed, and labor have a significant positive effect on yield, have a significant positive effect on production outputs. However, fertilizers and lime proved to not significantly affect production outputs. Meanwhile, production outputs have a significant positive effect on food security. Finally, marketing distribution channels have been shown to have a significant positive effect on production output. The results of the study provide several important considerations for pond farmers and efforts to improve food security in Demak Regency. Aquaculture land is a physical environment consisting of soil, topography, hydrology, vegetation and climate which in certain limits affect the ability of land use. Soil and water quality factors are the dominant determinant in milkfish aquaculture, so it is important to consider it as a criterion in the suitability of land for aquaculture. Pond environmental factors are important factors that affect production in milkfish ponds.

Based on the development of milkfish aquaculture business in Demak Regency, it can be seen that the milkfish pond business is a potential business that is a supporter of the family income of farmers and also plays an important role as a driver of the local people's economy. Therefore, the fisheries development strategy still needs to be directed at increasing income, mastering new technologies that are appropriate for increasing productivity, and improving the welfare of existing farmers/cultivators. The improvement strategy needs to be synergized with the development of national and international milkfish fish agro-industry systems so that the benefits can be maximized. However, it will be more effective if the farmers can work together or make partnership with various partners so that the management and marketing of milk fish yields can be improved. This partner can be done by collaborating with the milkfish fish processing industry to become a processed material such as the presto milkfish industry that requires milkfish raw materials, where in this way it is expected that the price of milkfish will remain stable.

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