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Analysis Of Factors Affecting Vaname Shrimp Production at PT Bengkulu Sukses Lestari Aquaculture (PT. BSLA)

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ABSTRACT

Vannamei shrimp has several advantages for aquaculture, including a strong feeding response, high appetite, relatively high resistance to poor environmental conditions, rapid growth, and high survival rate. In the current competitive business environment, aquaculture enterprises are required to optimize production processes to improve productivity and maintain competitiveness. This study aimed to identify the production factors affecting vannamei shrimp production at PT Bengkulu Sukses Lestari Aquaculture (PT BSLA), both partially and simultaneously. The study was conducted at a single pond site owned by PT BSLA using a quantitative descriptive method. Four independent variables were analyzed, namely land area (X1), fry (X2), feed (X3), and labor (X4), while production was used as the dependent variable. Data were analyzed using multiple linear regression with SPSS. The results showed that land area and labor had a significant partial effect on vannamei shrimp production, while fry and feed did not show a significant partial effect. Simultaneously, land area, fry, feed, and labor significantly affected vannamei shrimp production. These findings imply that optimizing land utilization and labor management is essential to improve the productivity and sustainability of vannamei shrimp farming at the company level.

INTRODUCTION

Vannamei shrimp offer several advantages for shrimp farming, including a high response to feed and strong appetite, greater resistance to disease in poor environmental conditions, faster growth, high survival rates, a relatively high stocking density, and a relatively short cultivation period of approximately 90–100 days per cycle (Purnamasari, 2017). Vannamei shrimp farming in Indonesia is currently a mainstay of the aquaculture sector and a priority for aquaculture development in Indonesia to boost the national economy. The export value of shrimp in 2024 reached USD 1.68 billion, making shrimp the highest-value export commodity in the fisheries sector, followed by Tuna–Skipjack–Bonito (TSB) at USD 1.03 billion and the Squid–Cuttlefish–Octopus group at USD 0.87 billion (Basyar et al., 2026). This indicates that shrimp plays a highly significant role in the performance of Indonesia's fisheries exports. Global shrimp production, according to FAO (2019), grew at an average rate of 5.39% per year, with aquaculture accounting for 9.59% of annual growth and wild capture fisheries contributing 0.92% per year (Soebjakto, 2019). National aquaculture shrimp production has increased rapidly over the past 5 years, rising from 638,955 tons (2013) to 920,051 tons

(2017), with an average annual increase of 10.38%. In 2022, shrimp production totaled 918,554 tons, valued at Rp 62.04 trillion (Ditjen PSDKP, 2023).

As a leading commodity that continues to grow, whiteleg shrimp cultivation in Indonesia also faces various challenges related to the efficient use of production inputs and business sustainability. Several recent studies have shown that increased production is determined not only by cultivation technology but also by the optimization of production factors such as land area, fry quality, feed management, and labor efficiency, which contribute significantly to the productivity and profitability of shrimp farming (Putra et al., 2021; Hidayat et al., 2022). Furthermore, environmental pressures, such as declining water quality and increasing disease risks, demand the implementation of more adaptive and data-driven cultivation management (FAO, 2022; MMAF, 2023). Therefore, empirical studies are needed that can comprehensively identify the influence of these production factors to support more informed decision-making in improving whiteleg shrimp production performance sustainably.

In this era, businesses are competing to find new ways to optimize their business processes to succeed in global competition, leading to a paradigm shift from transactional marketing to relationship marketing—that is, a transition in corporate business strategy from a product-oriented approach to a customer-centric one (Barnes, 2003, as cited in Apriliya et.al 2013). Most previous studies have focused on cultivation performance, shrimp growth, pond technology, or general business feasibility, but few have quantitatively examined the simultaneous or partial effects of land area, fry, feed, and labor on whiteleg shrimp production within a company's operational context. Therefore, this study is crucial to address this gap by providing empirical evidence on which production factors most influence yield, thus providing a basis for managerial decision-making to improve the efficiency and productivity of whiteleg shrimp farming. To support the future development of vannamei shrimp pond farming, it is deemed necessary to conduct an analysis of the production factors that influence vannamei shrimp production both partially and simultaneously, using four independent variables: land area (X1), fry (X2), feed (X3), and labor (X4).

METHOD

This research was conducted from November to December 2025 in PT Bengkulu Sukses Lestari Aquaculture (PT BSLA). Location for this study was selected through a deliberate choice made by the researcher at the PT BSLA fish farm. Data used for this research this research uses a quantitative method, which is an approach where the research involves fieldwork, data analysis, and writing that utilizes aspects of trends, situational descriptions, and in-depth interviews, and also support by descriptive analysis then (Musianto, 2002).

The conceptual framework of this study is systematically outlined in Figure 1.

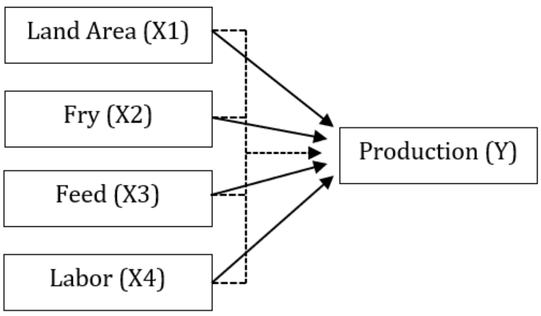

Figure 1. Conceptual Framework

Notes:

——→ = Partial Effect

-------→ = Simultaneous Effect

The collected primary and secondary data were then tabulated. The number of samples is 10 data units (possibly 10 production cycles, pond plots, or observation periods) with the the sampling technique used is purposive sampling. Data tabulation for production factors was performed by summing similar production factors and dividing them to determine the average value. The data then analyzed using Regression Analysis to make a regression model. The model used to analyze the relationship between production factors in vannamei shrimp farming and vannamei shrimp production involves identifying the production factors that influence vannamei shrimp production both partially and simultaneously, using four independent variables: land area (X1), fry (X2), feed (X3), and labor (X4).

The multiple linear regression model used is as follows (Illahi et al, 2023).

$$Y = \alpha + \beta 1X1 + \beta 2X2 + \beta 3X3 + \beta 4X4 + \mu$$

Notes:

Y	= Production	$\beta 1$	= Regression coefficient of X1
α	= Constant	$\beta 2$	= Regression coefficient of X2
X1	= Land area	$\beta 3$	= Regression coefficient of X3
X2	= Fry	$\beta 4$	= Regression coefficient of X4
X3	= Feed	μ	= Error
X4	= Labor		

Classical assumption tests are conducted to determine whether the variables used meet the criteria for the Best Linear Unbiased Estimator (BLUE). The classical assumption tests used include the normality test, which is used to determine whether, in a regression model, the dependent and independent variables follow a normal distribution. A good regression model requires that the data distribution be normal or approximately normal (Mona et al., 2015).

RESULT AND DISCUSSION

Normality test

The Normal Probability–Probability (P–P) Plot of the standardized residuals for the dependent variable indicates that the data points are generally distributed along the diagonal reference line. This pattern suggests that the residuals approximately follow a normal distribution. A regression model is said to be normally distributed if the plotted data points representing the actual data follow the diagonal line (Ghozali, 2016)

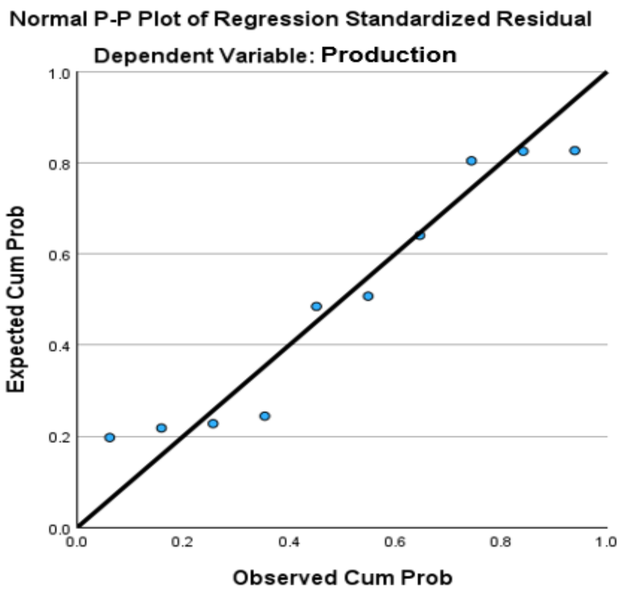

Figure 2. Normal probability plot

Based on the Normal P–P Plot of Regression Standardized Residuals, most residual points are located around the diagonal line and follow its direction. This pattern indicates that the residual distribution is close to a normal distribution; therefore, the normality assumption in the regression model can be considered fulfilled. In regression analysis, residual normality can be evaluated graphically using a normal probability plot or Q–Q/P–P plot, where residual points that tend to follow the diagonal line indicate that the normality assumption is reasonably satisfied (Kim, 2019; Li et al., 2024). Although minor deviations are observed at the lower and upper ends of the distribution, these deviations are not substantial and do not indicate a serious violation of the normality assumption. Thus, the regression model is suitable for further analysis.

Multicolinearity test

The multicollinearity diagnostics presented in the coefficients table indicate the absence of severe multicollinearity among the independent variables in the regression model. A regression model is said to be free of multicollinearity if the tolerance value is greater than 0.100 and the VIF value is less than 10.00 (Ghozali, 2016)

Table 1. VIF Result of Multicolinearity Test

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
1 (Constant)	1.871	.333		5.619	.002		
Land area (X1)	.233	.072	.079	3.229	.023	.670	1.493
Fry (X2)	-.118	.064	-.051	-1.849	.124	.534	1.873
Feed (X3)	-.042	.085	-.030	-.501	.638	.110	9.096
Labor (X4)	1.015	.058	1.026	17.547	<.001	.118	8.461

a. Dependent Variable: Production (Y)

Based on the regression coefficient table, the model shows that partially the variables of land area (X1) and labor (X4) have a significant effect on vaname shrimp production, indicated by the significance values of 0.023 and <0.001 ($p < 0.05$), respectively. Land area has a positive effect with a coefficient of 0.233, which means that increasing land area will increase production, while labor has the most dominant effect with a coefficient of 1.015. In contrast, the variables of fry (X2) and feed (X3) do not have a significant effect on production because their significance values are 0.124 and 0.638 ($p > 0.05$), respectively, although both have a negative direction of influence. In addition, the results of the multicollinearity test show that all variables have a tolerance value > 0.10 and VIF <10, so it can be concluded that there is no multicollinearity problem in the regression model and the model is suitable for further analysis.

Specifically, the tolerance values for Land area (X1), Fry (X2), Feed (X3), and Labor (X4) are 0.670, 0.534, 0.110, and 0.118, respectively. All tolerance values exceed the commonly accepted threshold of 0.10, suggesting that multicollinearity is not problematic. Although the tolerance values for Feed (X3) and Labor (X4) are relatively close to the lower bound, they remain within acceptable limits. Similarly, the Variance Inflation Factor (VIF) values range from 1.493 to 9.096. While the VIF values for Feed (X3) (9.096) and Labor (X4) (8.461) are comparatively high, they are still below the critical threshold of 10, indicating that multicollinearity does not reach a level that would severely distort the regression estimates. In conclusion, based on both tolerance and VIF criteria, the regression model does not exhibit serious multicollinearity.

These findings indicate that land area and labor are key determinants of increased whiteleg shrimp production, consistent with aquaculture production theory that suggests that scale and labor efficiency play a crucial role in determining output. Several recent studies have also confirmed that optimizing land use and effective labor management can significantly increase pond productivity, particularly in intensive farming systems (Tran et al., 2020; Ahmad & Mustafa, 2022). Meanwhile, the insignificant effects of fry and feed variables in this study indicate that relatively uniform operational standards exist or that input use is already at an optimal level, with variations no longer significantly impacting production increases. Therefore, management should focus on the efficient use of key production factors to sustainably improve aquaculture performance.

Heteroscedasticity test

A regression model is said to be free of heteroscedasticity if there is no clear pattern (wavy, widening then narrowing) in the scatterplots, and the data points are scattered above and below the 0 line on the Y-axis (Ghozali, 2016).

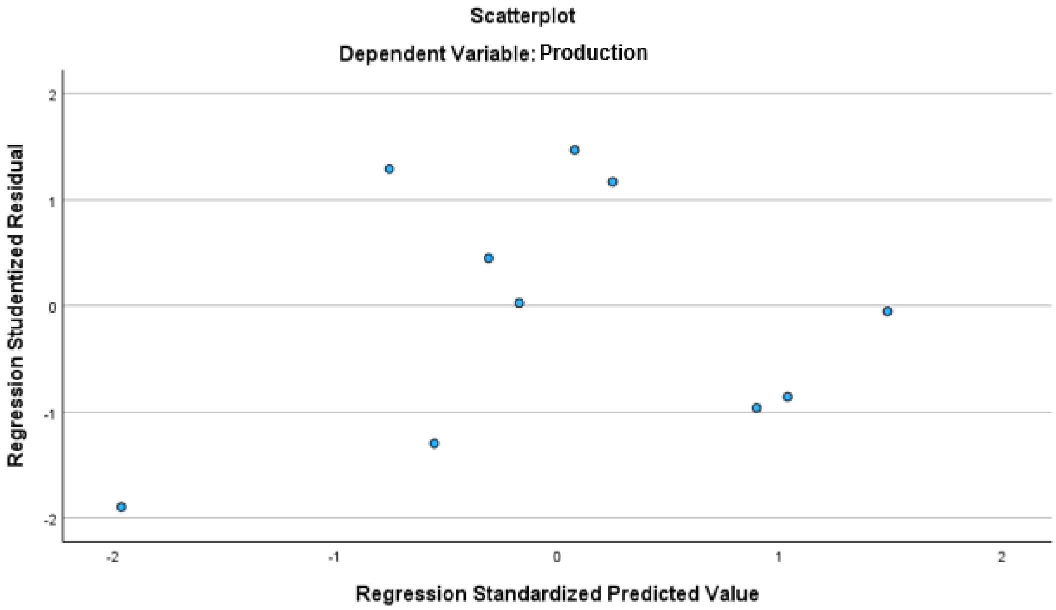

Figure 3. Scatterplot

Based on the figure, the residuals appear to be randomly dispersed around the horizontal axis (zero line) without forming any clear systematic pattern, such as a funnel shape or a specific curvature. The spread of residuals is relatively constant across the range of predicted values, indicating homogeneity of variance. Although a few observations show slight deviations, these do not form a structured pattern that would suggest heteroscedasticity. Therefore, the variation of the residuals can be considered stable. This result indicates that the regression model meets the homoscedasticity assumption, meaning that the residual variance remains relatively constant across predicted values. Homoscedastic residuals are important in multiple linear regression because unequal variance may reduce the reliability of standard errors, significance tests, and confidence intervals (Astivia & Zumbo, 2019; Knief & Forstmeier, 2021). Therefore, the absence of heteroscedasticity in this model strengthens the validity of the regression results and supports the use of the model for explaining factors affecting vannamei shrimp production.

Coefficient of Determination

The coefficient of determination (R Square) in this model is 0.998, indicating that 99.8% of the variation in the dependent variable (Production) can be explained by the independent variables included in the model, namely land area, fry, feed, and labor. This result suggests that the regression model has an extremely strong explanatory power.

Table 2. R Square

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.999[a]	.998	.996	.0070394	1.575

a. Predictors: (Constant), Land area, Fry, Feed, Labor

b. Dependent Variable: Production

The Adjusted R Square value of 0.996 indicates overfitting, that after adjusting for the number of independent variables and sample size, approximately 99.6% of the variation in production is still explained by the model. The small difference between R Square and Adjusted R Square suggests that the independent variables included in the model are relevant and do not excessively inflate the model's explanatory power. The very high Adjusted R Square value should be interpreted carefully because the model uses a relatively small number of observations compared with the number of independent variables. In regression analysis, a high coefficient of determination does not always indicate strong predictive ability, particularly when the model may fit sample-specific patterns rather than generalizable relationships (Babyak, 2004; Lever et al., 2016). Therefore, although the model shows strong explanatory power, further validation using additional observations or repeated production-cycle data is recommended to ensure the robustness of the model.

Results of the multiple linear regression analysis

The multiple linear regression equation is:

$$Y = 1.871 + 0.233(X1) -0.118(X2) - 0.042(X3) + 1.015(X4)$$

Interpretation:

The regression equation indicates that, holding other variables constant:

1. Constant (Intercept) = 1.871
   This means that when all independent variables (X_1, X_2, X_3, X_4) are equal to zero, the predicted value of production is 1.871 units. The constant represents the baseline level of production when no independent variables are considered.
2. Coefficient of X_1 (Land area) = 0.233
   This indicates that for every one-unit increase in X_1 (land area), production will increase by 0.233 units, assuming other variables remain constant. This variable has a positive effect on production.
3. Coefficient of X_2 (Fry) = −0.118
   This means that for every one-unit increase in X_2 (Fry), production will decrease by 0.118 units, assuming other variables remain constant. This variable has a negative effect on production.
4. Coefficient of X_3 (Feed) = −0.042
   This indicates that for every one-unit increase in X_3 (Feed), production will decrease by 0.042 units, ceteris paribus. This variable also has a negative effect, but the effect is relatively small.
5. Coefficient of X_4 (Labor)= 1.015
   This means that for every one-unit increase in X_4 (Labor), production will increase by 1.015 units, assuming other variables remain constant. Among all variables, X_4 has the largest influence on production.

These results indicate that land area and labor are the main production drivers in this model, while fry and feed require more cautious interpretation because their coefficients are negative and statistically insignificant. In shrimp aquaculture, production performance is generally influenced by input allocation, farm scale, feed efficiency, seed quality, labor management, and technical efficiency; therefore, insignificant coefficients may reflect relatively uniform input use, limited sample variation, or operational conditions specific to the study site. Recent studies also emphasize that feed, labor, and seed are among the key inputs in Litopenaeus vannamei production, while economies of scale can improve production efficiency in larger farming units. Similarly, productivity studies on vannamei shrimp farming show that land area, seed, feed, and labor may positively contribute to production when managed efficiently.

F-test for Simultaneous Effect

The F-test is used to determine whether all the independent variables included have a combined or simultaneous effect on the dependent variable. In the F-test, if the significance level (sig) is less than 0.05, it means that the independent variables (X) have a simultaneous effect on the dependent variable (Y) (Ghozali, 2016).

Table 3. ANOVA Result

	Model	Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.122	4	.031	617.299	<.001[b]
	Residual	.000	5	.000		
	Total	.123	9			

a. Dependent Variable: Production
b. Predictors: (Constant), Land area, Fry, Feed, Labor

Based on the ANOVA table, the regression model has an F value of 617.299 with a significance level (Sig.) <0.001, which means it is much smaller than 0.05. This indicates that the overall regression model is significant at the 95% confidence level, so that the independent variables used, namely land area, fry, feed, and labor, simultaneously have a significant effect on whiteleg shrimp production. The regression Sum of Squares value of 0.122, which is close to the total variation (0.123), also indicates that most of the production variation can be explained by the model. This finding is in line with previous research which states that the combination of production input factors has an important role in determining cultivation output, so the model used is considered feasible and relevant to explain variations in whiteleg shrimp production and can be used as a basis for managerial decision making. This result indicates that the independent variables land area, fry, feed, and labor simultaneously have a significant effect on the dependent variable production. In other words, the multiple linear regression model is appropriate and can be used to explain the variation in production.

t-test for Partial Effect

The t-test is used to determine the partial effect of each independent variable on the dependent variable (production). The decision rule is that if the significance value (p-value) is less than 0.05, then the independent variable has a significant effect on the dependent variable (Ghozali, 2016)

Table 4. t-Test Result

	Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	1.871	.333		5.619	.002		
	Land area (X1)	.233	.072	.079	3.229	.023	.670	1.493
	Fry (X2)	-.118	.064	-.051	-1.849	.124	.534	1.873
	Feed (X3)	-.042	.085	-.030	-.501	.638	.110	9.096
	Labor (X4)	1.015	.058	1.026	17.547	<.001	.118	8.461

a. Dependent Variable: Production

Based on the t-test results:

1. Land Area (X_1)
   The significance value is less than 0.05, indicating that land area has a significant positive effect on production. This means that increasing land area will significantly increase production, ceteris paribus.
2. Fry (X_2)
   The significance value is greater than 0.05, indicating that fry has no significant effect on production. This means changes in fry quantity do not significantly affect production when other variables are held constant.
3. Feed (X_3)
   The significance value is greater than 0.05, indicating that feed has no significant effect on production.

4. Labor (X_4)
   The significance value is less than 0.05, indicating that labor has a significant positive effect on production and is one of the most influential variables affecting production.

The t-test results indicate that land area and labor are the most decisive factors in vannamei shrimp production at PT BSLA. This finding is relevant to previous aquaculture studies showing that land area, seed, feed, and labor are important inputs in shrimp farming, although their significance may vary depending on farm management, input efficiency, and production scale. Kasim (2024) found that vannamei shrimp productivity was positively influenced by land area, seed, feed, and labor, while Yunus (2022) also identified land area, fry stocking density, feed, and labor as production-related factors in shrimp pond farming. Therefore, the insignificant effect of fry and feed in this study may indicate that these inputs have been applied relatively uniformly or have reached an operational threshold, whereas land utilization and labor management remain key areas for improving production performance.

CONCLUSION

The conclusion of this study indicates that whiteleg shrimp production at PT Bengkulu Sukses Lestari Aquaculture is influenced by the production factors analyzed, both simultaneously and partially. Simultaneously, the variables of land area, fry, feed, and labor were shown to have a significant effect on production. However, partially, only land area and labor had a significant effect, while fry and feed did not show a significant effect on production. The regression model used had very high explanatory power, indicating that these variables were able to explain most of the variation in whiteleg shrimp production. Therefore, efforts to increase production should be focused on optimizing land use and labor efficiency, accompanied by more effective and proportional management of other inputs to support the sustainability of whiteleg shrimp cultivation businesses.

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