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ESTIMATION OF COPRA INDUSTRY REVENUE USING MULTIPLE REGRESSION ANALYSIS

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ABSTRACT
This study utilized Multiple Regression Analysis to construct a predictive model for estimating copra industry revenue in Davao Oriental. Key predictors included selling price, production, and production cost. The secondary data from the Philippine Coconut Authority, Davao Oriental, regarding the 2022 crop cycle of copra farmers across eleven municipalities, was analyzed. The researchers employed a stratified proportionate random sampling method to select 383 samples. The multiple linear regression analysis produced a model with positive coefficients for all revenue predictors, indicating that increased selling price, production, and production cost positively impacted copra revenue while other variables were constant. The model demonstrated reliability with a strong coefficient of determination and a p-value below 0.05, denoting its significance in revenue prediction. Model validity was confirmed through split sample analysis, consistently showing a strong coefficient of determination, significant predictive power, and positive coefficients for all variables. These outcomes emphasized the credibility and reliability of the regression in forecasting copra industry revenue in Davao Oriental, providing valuable insights for policymakers, industry stakeholders, and researchers to formulate informed decisions and targeted strategies.

Keywords:
Applied mathematics, copra revenue, selling price, production, production cost, multiple linear regression analysis, Philippines

INTRODUCTION

The copra industry is currently facing instability as a result of fluctuating revenue. Most coconut farmers are part of the marginalized sector and their incomes are low and unstable (Aguilar, Lozada, & Aragon, 2022). The study conducted by Arif (2022) revealed that the farmer's income from copra production remained low despite the efforts provided by the government. Additionally, the income derived from coconut cultivation is comparatively modest, leading to more than 90% of coconut farmers residing below the poverty threshold, established at PHP 125,775 annually (Aguilar, Lozada, & Aragon, 2022). They added that most coconut farmers listed in the 2018 National Coconut Farmers' Registry System (NCFRS) struggle with food insecurity and lack of social protection.

Monitoring revenue gives valuable information about business performance and allows business owners to predict their sales trajectory, as Houston (2023) stated. He emphasized that tracking revenue offers insights into product demand, enabling business owners to make appropriate modifications as required. This idea can help farmers make informed decisions and implement strategies to maximize their revenue from copra production. Understanding copra revenue is crucial for farmers and producers who rely on coconut cultivation as a source of income. In Indonesia, coconut farming is a significant contributor to the economy. Covering a vast area of 3,631,814 hectares and yielding 3,031,310 tons of copra products, this industry serves as the primary source of income for most farmers (Batmetan, 2022). In addition, Mendoza, Teves and Miciano (2018) suggest regarding coconuts as a bonus crop that offers a consistent and reliable source of income, even if it may seem minor. By studying copra revenue, researchers and policymakers can analyze trends, fluctuations and factors affecting the profitability of coconut farming. Factors such as production cost, production and selling price are crucial when determining copra revenue. The study showed that these factors simultaneously affect the copra industry revenue. In addition, Dumais, VRBa and Kaunang (2021) verified that the income of coconut farmers relies on various factors, including the number of coconuts they produce,

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the expenses they have for production and the market prices of coconut products. They also stated that multiplying the output by the selling price determines the revenue from copra production. On the other hand, research by Chanda, Ali, Haque, Abdullah, and Sarwar (2019) found that production cost is a major factor influencing copra revenue.

According to Philippine Coconut Industry (PCA) board member Quimpan, the Davao Region remains the top coconut producer in the country. Data from the Philippine Statistics Authority (PSA) revealed that the Davao region produced 2,246,187.53 metric tons in 2015. This data is said to be the highest in the Philippines. Davao owns a coconut research center that has existed since 1996. The coconut research center produces 200,000 coco seedlings of sound and unique variety including the coconut aromatic dwarf variety. Davao Oriental is one of the country's primary sources of copra, covering 156,837 hectares of coconut farms that produce an average of one billion copra products annually (Masinading & Capili, 2021).

A feasibility study conducted by Purba and Saleh (2018) concluded that the copra business is suitable for business owners. Production is the economic process of effectively employing resources to achieve desired results in terms of quantity and quality, making it a valuable commodity for trade. In this case, the product of this process is copra merchandise, packaged in sacks. Throughout each manufacturing cycle, manufacturers typically produce 455.56 kg of copra products, selling them for an average of Rp 3,540.00 per kilogram. Consequently, each manufacturing cycle generates Rp 1,612,682.40 in total revenue and Rp 414,606.29 in profit. This study employs the linear modeling approach, Cost-Volume-Profit (CVP) analysis, and Profit Maximization as its anchors. The linear modeling approach deals with the relationship between the dependent variable and one or more independent variables, as introduced by Francis Galton (Mathur, Muralidharan, Parthasarathy, Batugal & Bonnot, 2008). Linear modeling is rooted in algebraic concepts given by the equation of a line $y = mx + b$, where b is the y-intercept and m is the slope. In statistics, the equation of the regression line, in simple regression with the formula $\widehat{Y} = B_0 + Bx$, where B_0 is the y-intercept and B is the slope of the line (Bluman, 2014). Multiple regression, where several independent or predictor variables and a dependent or criterion variable are involved, is an extension of simple linear regression (Kafle, 2019)

Cost-volume-profit (CVP) analysis was initially developed by George Staubus and elaborated upon by Kaplan and Atkinson (as cited in Le, Tran, Tran, & Nguyen, 2020). It explores the linear relationships between costs, volume, and profits, allowing for insights into how changes in sales volume, prices, and expenses impact overall profitability. This technique delves into the complex relationships between changes in cost, production volume, and price, elucidating their intersections with profit dynamics. Businesses, through the application of CVP analysis, acquire the capability to forecast future revenues, enabling precise operational execution by owners.

Cost-volume-profit analysis, as explained by Lulaj and Iseni (2018), carefully examines changes in sales volume, costs, prices, and profits. CVP analysis facilitates the identification of predictive questions that consider linear relationships among selling price, production volume, and costs. For this reason, CVP analysis aids in discerning their collective impact on profit and revenue. Moreover, Abdullahi, Bello, Mukhtar, and Musa (2017) emphasize that CVP analysis evaluates the impact of variations in selling price on total profitability. In essence, the concepts of CVP analysis clearly emphasized that revenue can be forecasted by considering factors such as selling price, production, and production cost.

Profit Maximization theory is a fundamental concept in economics and business that delves into the intricate relationship between selling price, production levels, production costs, and revenue. Jafar, Muda, Zainal, and Yasin (2010) highlight the importance of companies striving to maximize profits. Brueckner (2013) discusses the concept of profit maximization, emphasizing the correlation between revenue and its determinants. The selling price directly influences revenue, while production affects revenue and production costs. Increasing production levels can lead to economies of scale, reducing the cost per unit as production increases. Conversely, minimizing production costs maximizes revenue. The researchers prefer Multiple Regression Analysis because the variables are appropriate for this method. As mentioned above, multiple regression requires more than one independent variable and exactly one dependent variable (Black & Babin, 2019). This technique is also suitable for creating a statistical model to predict the copra revenue in the Province of Davao Oriental. The proposed model $\hat{Y} = B_0 + B_1x_1 + B_2x_2 + Bx_3$ is

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expected as a result of this research, where $\widehat{Y}$ represents the copra revenue and B_0 is constant, or the value of the copra revenue without the presence of the three indicators. What's more, $B_1, B_2, and\ B_3$ there are coefficients of independent variables (x_i). Finally, x_1, x_2, and x_3 are the factors of copra revenue such as production cost, production, and selling price respectively.

Summarized in Figure 1 is the flow of the Multiple Regression Analysis on copra industry revenue. The independent variables of this research comprise the Selling Price *(x_1)*, Production Cost *(x_2), and* Production *(x_3)*, while the dependent variable is the copra revenue. The variables involved had been analyzed to develop the appropriate linear regression model. This model will be helpful to estimate the copra revenue in the Davao region. The selling price directly affects the copra revenue. Selling prices in agricultural economics is the primary means of generating income and profits for business (Nugroho, 2021). Production encompasses actions that employ labor, capital, and resources to generate desired outputs. Production cost has an inverse effect on copra revenues (Chanda, Ali, Haque, Abdullah, & Sarwar, 2019). It is the expenses derived from the costs incurred to produce coconuts to become ready-made materials for sale.

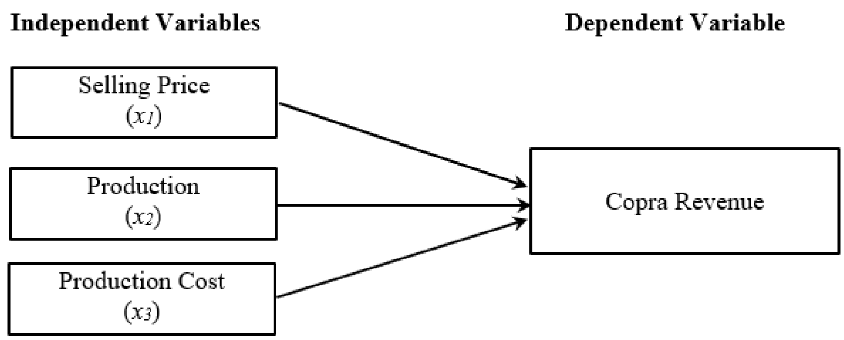

Figure 1. Conceptual model showing the relationship between selling price, production, and production cost and copra revenue

While extensive literature exists on the relationships between revenue and its key predictors, such as selling price, production volume, and production cost, several gaps remain unaddressed. Existing studies have primarily explored these relationships within specific industries or regions, and there is a limited cross-industry or cross-regional comparative research. Remarkably, very few writers have conducted extensive analyses that take into consideration the many interactions and variables that might affect these relationships in a variety of situations. Consequently, there is a need for more extensive and generalized research that can provide insights applicable to a broader range of business environments.

Several researchers have examined the impact of the selling price on revenue in the retail sector and investigated the relationship between production volume and revenue in the manufacturing industry. Nevertheless, a comprehensive understanding of how selling price, production volume, and production cost interact to shape revenue outcomes is frequently absent from these studies. Therefore, the current research seeks to build upon these works and expand the knowledge base by exploring the multifaceted interactions among these variables and their influence on revenue, specifically in the copra industry; thus, contributing to a more comprehensive understanding of revenue management and optimization.

OBJECTIVES

The main objective of this research is to develop a mathematical model for estimating copra revenue in Davao Oriental using Multiple Regression Analysis. Furthermore, the study aims to address critical inquiries: to assess the average

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values of Production Cost, Production, selling price, and Revenue within the Copra Industry in Davao Oriental; to construct a well-fitted regression model for estimating Copra Industry Revenue in Davao Oriental and to examine if the Production Cost, Production, and Selling Price significantly predict the Copra Industry Revenue. Finally, the study intends to conduct a split sample analysis to authenticate the reliability of the final model.

METHODOLOGY

The research primarily relied on secondary data, which includes information about the average selling price of copra products, copra production, and production costs, all derived from the last crop cycle of copra farmers in Davao Oriental in 2022. Secondary data refer to information previously collected, processed, and analyzed by someone else for a purpose other than the current one. 383 samples from the Philippine Coconut Authority Regional Office in Mati City made up the data set under analysis.

A sample size of 383 datasets was determined using the Raosoft® online sample size calculator to facilitate research on the coconut farming community in Davao Oriental. This sample size considered a 5% margin of error, a 95% confidence interval, and a known total population of 69,924 coconut farmers. Employing stratified proportionate sampling ensured representativeness by distributing respondents according to the percentage distribution of coconut farmers across eleven municipalities.

This approach, widely recognized for its precision and administrative efficiency, allowed for a statistically robust industry examination (Berndt, 2020). Stratified proportionate sampling is particularly suitable for estimating copra industry revenue through multiple regression analysis, as it ensures representation from various industry strata, accounting for regional, production method, and operational scale differences. By combining this sampling method with multiple regression analysis, researchers can comprehensively understand the factors affecting copra industry revenue across different strata, enhancing the accuracy and reliability of their inferences.

The researchers methodically employed Multiple Regression Analysis to develop a predictive model for forecasting copra revenue. This procedure adhered to crucial assumptions, including continuous measurement of the dependent variable, the copra revenue, and the presence of multiple independent variables such as selling price, production, and production cost on continuous scales. Linearity between predictor variables and the response variable was confirmed through scatter plots, while outlier detection using Cook's Distance and assessment of multicollinearity via Variance-Inflation-Factor (VIF) values ensured the accuracy of the regression equation. Additionally, the process entailed verifying the normal distribution of residuals and ensuring homoscedasticity, leading to the development of a robust model. Subsequently, the researchers evaluated the model's practicality through Analysis of Variance (ANOVA) and coefficient of multiple determination (R2). This step was necessary to determine the predictive efficacy of selling price, production cost, and copra production on copra revenue.

To validate the generated model, the study used Multiple Regression Analysis as the final step. The process utilized a split-data analysis approach, which involved three distinct regression procedures to construct models using two separate datasets with numerous variables predicting the response variable. By splitting the data, the researcher created one sample for modeling and another for testing the model's effectiveness. This method assessed whether the split modeling set replicated the unique characteristics of the original dataset (Gupta, 2013).

The researchers adhered strictly to ethical standards throughout the study, ensuring that the identities of the copra farmers remained anonymous. Before collecting data, the they obtained appropriate permissions from the Philippine Coconut Authority. Nevertheless, the researchers submitted a detailed protocol outlining ethical considerations to the University of Mindanao Ethics Review Committee (UMERC), which approved it with certificate number UMERC-2023-195.

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RESULTS AND DISCUSSION

The Average Values for Selling Price, Production, Production Cost and Revenue of Copra Industry in Davao Oriental

Presented in Table 1 are the mean and standard deviation of copra selling prices across different municipalities in Davao Oriental. Caraga recorded the highest average copra selling price at ₱36.90, followed by Governor Generoso and Cateel with means of ₱36.74 and ₱36.48, respectively. Conversely, Baganga exhibited the lowest average selling price of ₱30.89, with a standard deviation of 9.40. The overall average selling price across all municipalities stood at ₱34.83, with a standard deviation 10.46.

The selling price across various locations exhibits varying degrees of variability, with Cateel showing the highest standard deviation of 12.22, indicating significant dispersion in selling price among its observations. Conversely, Banaybanay has the lowest standard deviation at 9.07, suggesting relatively less variability in selling price. The overall standard deviation for all locations combined is 10.46, providing a general measure of the average dispersion of selling price across the entire dataset, with some places having notably higher or lower variability than this overall figure.

Municipality	SD	Mean
Baganga	9.40	30.89
Banaybanay	9.07	32.00
Boston	9.13	31.71
Caraga	10.47	36.90
Cateel	12.22	36.48
Governor Generoso	9.49	36.74
Lupon	10.76	35.59
Manay	11.28	35.32
Mati	9.92	35.88
San Isidro	10.84	34.56
Tarragona	9.28	32.96
Overall	**10.46**	**34.83**

Table 1. Average Selling Price (in Pesos)

This result in the study of Adams and Williams (2019) suggest that a range of factors, including market integration, local demand-supply dynamics, transportation costs, quality considerations, and weather conditions influenced pricing. They highlight how transportation infrastructure impacts agricultural product pricing, potentially leading to higher selling prices in municipalities with better transport access due to reduced logistical costs.
Copra Production

Displayed in Table 2 is the average copra production across various locations. San Isidro recorded the highest output at 2,067.56 kg, with a standard deviation of 1,060.28 kg. Mati followed closely with 2,042.54 kg and a standard deviation of 1,039.09. Conversely, Baganga showed the lowest production, totaling 823.95 kg, with a standard deviation of 449.24 kg. The average overall output was 1,644.92 kg, with a standard deviation of 1,036.87 kg. The standard deviation in copra production varies significantly across different locations. Banaybanay has the lowest standard deviation at 189.49, indicating relatively low variability in copra production compared to other places. Conversely, Tarragona exhibits the highest standard deviation of 1,193.09, signifying considerable variability in copra production among its observations. The overall standard deviation for all locations combined is 1,036.87, showcasing the average dispersion of copra production values across the entire dataset, with some locations experiencing notably higher or lower variability than this overall figure.

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Municipality	SD	Mean
Baganga	449.24	823.95
Banaybanay	189.49	921.75
Boston	739.73	1,026.74
Caraga	1,063.48	1,550.76
Cateel	991.37	1,766.60
Governor Generoso	1,126.95	1,837.32
Lupon	939.30	1,799.86
Manay	1,006.70	1,918.62
Mati	1,039.68	2,042.54
San Isidro	1,060.28	2,067.56
Tarragona	1,193.09	1,923.96
Overall	**1,036.87**	**1,644.92**

Table 2. Average Copra Production (in kilograms)

The result about production suggested relatively less variability around this lower mean. Research on agricultural production factors highlights the diverse influences on copra production levels, including soil quality, climate conditions, farming practices, technology access, and agricultural input investments. For instance, De, Boogaard, Fumagalli, Janssen, Knapen, Kraalingen, and Diepen (2019) underline the impact of climate variability and farming techniques on crop yields, indicating how these factors contribute to production fluctuations across regions.
Production Cost

Shown in Table 3 are the production costs across various locations. Tarragona incurred the highest production cost at ₱24,453.28, accompanied by a standard deviation of ₱21,034.02. Mati City followed closely with a production cost ₱23,740.10 and a standard deviation of ₱17,094.95. In contrast, Banaybanay reported the lowest production cost at only ₱2,562.50, with a standard deviation of ₱1,55.97. The overall mean production cost is ₱18,150.10, with a standard deviation of ₱15,973.51.

Municipality	SD	Mean
Baganga	4,188.40	5,012.94
Banaybanay	1,553.97	2,562.50
Boston	10,045.30	11,160.00
Caraga	14,859.90	19,814.52
Cateel	13,654.77	17,695.27
Governor Generoso	16,124.94	19,665.62
Lupon	16,742.40	21,712.40
Manay	17,159.42	20,519.55
Mati	17,094.95	23,740.10
San Isidro	14,377.76	21,847.83
Tarragona	21,034.02	24,453.28
Overall	**15,973.51**	**18,150.10**

Table 3. Production Cost (in Pesos)

The standard deviation in production cost varies notably across different locations. Banaybanay has the lowest standard deviation at 1,553.97, indicating relatively low variability in production cost compared to other places. Conversely, Tarragona exhibits the highest standard deviation of 21,034.02, signifying substantial variability in production cost among its observations. The overall standard deviation for all locations combined is 15,973.51, representing the average dispersion production cost values across the entire dataset, with some locations experiencing significantly higher or lower variability than this overall figure.

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The result on production cost sheds light on the factors contributing to cost variations, including labor expenses, input prices like fertilizers and pesticides, equipment costs, land rents, and regulatory compliance. Ehrenberg, Smith, and Hallock (2021) emphasize the impact of input prices and labor costs on overall production expenses, highlighting how these factors lead to cost disparities among locations.

Outlined in Table 4 are the copra revenues across different municipalities. The overall copra revenue amounts to ₱38,748.23, with a standard deviation of ₱27,167.06. Mati City secured the highest revenue at ₱46,852.67, accompanied by a standard deviation of ₱29,204.12, followed closely by San Isidro with an income of ₱44,973.52 and a standard deviation of ₱29,918.61. Conversely, Boston, Banaybanay, and Baganga reported the lowest revenues, averaging ₱28,368.02, ₱26,744.69, and ₱22,162.79, respectively.

The standard deviation in copra revenue shows considerable variability across different locations. Banaybanay has the lowest standard deviation at 12,266.02, indicating relatively low variability in copra revenue compared to other places. Conversely, Tarragona exhibits the highest standard deviation of 32,022.45, signifying substantial variability in copra revenue among its observations. The overall standard deviation for all locations combined is 27,167.06, representing the average dispersion of copra revenue values across the entire dataset, with some locations experiencing significantly higher or lower variability than this overall figure.

Municipality	SD	Mean
Baganga	13,076.80	22,162.79
Banaybanay	12,266.02	26,711.69
Boston	19,541.20	28,368.03
Caraga	29,187.96	39,558.94
Cateel	28,720.74	39,532.09
Governor Generoso	26,945.04	40,836.92
Lupon	27,622.95	43,348.57
Manay	25,696.29	41,931.98
Mati	29,204.12	46,852.67
San Isidro	29,918.61	44,973.52
Tarragona	32,022.45	43,168.64
Overall	**27,167.06**	**38,748.23**

Table 4. Copra Revenue (in Pesos)

The revenue results underscore significant disparities within the copra industry, influenced by factors like market access, infrastructure development, value chain integration, technological advancements, and policy frameworks. Gyan and Bezemer (2022) highlight the vital role of market linkages, infrastructure investment, and supportive policies in fostering sustainable rural development and enhancing income opportunities for agricultural producers.

Development of the Well-Fitted Regression Model for Estimating Copra Industry Revenue

Before delving into the outcomes aligned with the second objective, which is to generate a best-fit model that predicts Copra revenue using Multiple Linear Regression Analysis, the study conducted several tests to ensure the fulfillment of various assumptions. These precautionary steps were crucial to guarantee the model's reliability in forecasting copra revenue concerning selling price, production, and production cost. Multiple Regression Analysis relies on several critical assumptions, and deviation from these assumptions can compromise the accuracy and dependability of the findings. Neglecting these assumptions can lead to unreliable outcomes, potential Type I or Type II errors, and inaccurate estimations of significance or effect sizes (Osborne & Waters, 2019).

The initial assumption suggested that the dependent variable is a continuous scale. In this study, copra revenue serves as the dependent variable, and the data associated with copra revenue are inherently continuous. Moving on to the second assumption, a prerequisite for conducting multiple linear regression analysis is the presence of at least two

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independent variables. Simple linear regression is more appropriate when only one independent variable is present. However, this study utilized three independent variables: selling price, production, and production cost. The first two assumptions do not necessitate testing; their presence was evident. The study explored the linear relationship between each of the independent variables and the dependent variable using a linearity test. Displayed in Table 5 is the correlation between each independent variable and the dependent variable, where the correlation coefficient between Revenue and Selling Price is 0.4 with a p-value of 0.000. Similarly, Revenue and Production show a correlation coefficient of 0.825 with a p-value of 0.000, while Revenue and Production Cost exhibit a correlation coefficient of 0.841 with a p-value of 0.000. These findings confirm a significant correlation among all variable pairs, indicating no violation of the assumption of linearity.

The statistical tool utilized to test the correlation was the Pearson Product-Moment correlation coefficient. It unveiled the linear relationship between copra revenue and its key predictors: selling price, production, and production cost. The presence of this correlation is crucial as regression analysis relies on the assumption of linearity between variables. Without the correlation, regression analysis would not be suitable for this study, highlighting the importance of confirming linearity as a fundamental assumption before conducting regression analysis.

Dependent Variable	Independent Variable	r	p-value
Copra Revenue	Selling Price	0.400	.000
	Production	0.825	.000
	Production Cost	0.841	.000

Table 5. Test of Linearity

The correlation results reveal significant relationships between copra revenue and its key predictors: selling price, production, and production cost. With correlation coefficients of 0.4 between Revenue and Selling Price, 0.825 between Revenue and Production, and 0.841 between Revenue and Production Cost, strong positive correlations are evident, indicating that as one variable increases, the other tends to increase. These correlations align with established principles in agricultural economics, as supported by Marquez and Singh (2023), which demonstrated a positive correlation between crop selling price and farm revenue, highlighting the direct impact of market prices on agricultural income. Similarly, studies by Graham, Iyer, Hejazi, Kim, Patel, and Binsted (2021) showcase the positive relationship between production levels and revenue, emphasizing how increased production leads to higher revenue generation.
In view of these, the correlation between revenue and production cost is consistent with the findings from economic studies on production economics.

Research by Knapp, Mazzi, and Finger (2021) emphasizes the inverse relationship between production costs and profitability, indicating that higher production costs can lead to lower net revenue. These correlations underscore the interplay between market factors, production levels, and cost considerations in determining revenue outcomes for copra producers, reflecting essential economic principles in agriculture. The absence of significant outliers is another essential assumption for conducting multiple linear regression. Cook's distance, a measure of influence, was computed using Statistics Software. Using Jamovi Statistical Software, Cook’s Distance table is generated. It shows that the maximum distance is 0.105 as shown in Table 6.

Mean	Median	SD	Range	
			Min	Max
0.00376	0.00085	0.00903	0.000	0.105

Table 6. Cook's Distance

Multicollinearity is a crucial assumption, as depicted in Table 7 showcasing collinearity diagnostics conducted via Jamovi Statistics software. The examination includes tolerance and VIF values. Selling Price exhibits a tolerance of 0.674 with a Variance Inflation Factor (VIF) of 1.483. For Production, the tolerance is 0.355, accompanied by a VIF of 2.819. Additionally, Production Cost shows a tolerance of 0.305 and a VIF of 3.280. These findings suggested an

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absence of multicollinearity in the analysis. The interpretation of these results aligns with the criteria established by Daoud (2017), wherein values below 0.10 for tolerance and above 5 for VIF indicate the presence of collinearity.

Independent Variables	Tolerance	VIF
Selling Price	0.674	1.483
Production	0.355	2.819
Production Cost	0.305	3.280

Table 7. Multicollinearity Statistics

The next step in assessing assumptions was to examine the normality of residuals. This step includes generating standardized residual values in SPSS and subjecting them to a Kolmogorov-Smirnov test. The findings, detailed in Table 8, displayed a test result of 0.045 with a p-value of 0.062, indicating a value greater than 0.05. Thus, we accept the claim, signifying that the distribution of residuals adheres to normality.

Test	Statistic	p-value	Remarks
One-Sample Kolmogorov-Smirnov Test	0.045	0.062	The distribution of Residuals is normal.

Table 8. Test of Normality

The Breusch-Pagan test is an appropriate tool to assess the violation of the homoscedasticity assumption and to gauge the extent of this deviation by interpreting the test-generated values, as shown in Table 10. The test yielded a 97.32 Lagrange Multiplier (LM) with a p-value of 0.000, thereby rejecting the claim that assumes the presence of homoscedasticity. This result aligned with the observations derived from the scatterplot earlier. Consequently, it was evident that the data set violated the assumption of homoscedasticity.

	LM	p-value
BP	97.32	0.000

Table 9. Breusch-Pagan Test Statistics for Homoscedasticity

Out of the seven assumptions, six of them were satisfied. The only assumption violated is the assumption of homoscedasticity of the residuals. In other words, the residuals are heteroscedastic. Heteroscedastic residuals in regression analysis pose consequential challenges and limitations. When residuals display unequal variances across the range of predictor variables, it violates the assumption of homoscedasticity. This inconsistency can lead to biased parameter estimates, affecting the accuracy and reliability of the regression model's predictions, especially in smaller sample sizes. Renowned authors such as Li and Yao (2019) extensively discussed these consequences and limitations. Remedies such as weighted least squares or transforming variables can alleviate heteroscedasticity concerns. Yet, they don't always completely resolve the issue and can complicate the interpretation of results, emphasizing the ongoing challenge of dealing with heteroscedastic residuals in regression analysis.

Despite heteroscedasticity, the utilization of multiple regression analysis remained viable for this purpose. However, it persisted to be essential to acknowledge the presence of heteroscedasticity and its potential influence on result reliability. Various authors, including Müller, Stock, and Watson (2019), have deliberated on this perspective. Furthermore, they emphasized that in situations where precision in coefficient estimation takes a backseat to accurate predictions, certain practitioners may choose to overlook direct intervention for heteroscedasticity. This decision may mainly occur if its impact on predictions is negligible and doesn't significantly hinder the model's predictive capability.

The study’s purpose was to develop a mathematical model that can forecast the copra revenue in the Province of Davao Oriental using Multiple Regression Analysis. The analysis resulted in a model expressed by the formula $\hat{Y}=-25,567.40+827.574(x_1)+17.1(x_2)+0.405(x_3)$, wherein x_1, x_2, and x_3 represented the selling price, production, and production cost respectively. The value -25,567.40 is constant, indicating that in the absence of these

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predictors, each farmer incurs a deficit of ₱25,567.40. The model stated that with every unit increase in the selling price, the revenue increases by 827.574. Likewise, for every unit rise in production, the revenue sees a rise of ₱17.1, and for each unit increase in production cost, the revenue escalates by ₱0.405.

Variables	Beta	SE	95% CI		*β*	*p-value*
			LL	*UL*		
Constant	-25,567.40	2,304.24	-30,098.09	-21,036.72		< 0.001
Selling Price (x_1)	827.57	59.29	710.10	944.15	0.319	< 0.001
Production (x_2)	17.10	0.83	15.48	18.72	0.653	< 0.001
Production Cost (x_3)	0.41	0.06	0.29	0.52	0.238	< 0.001
R^2	0.867					
F	821.99					
p-value	p < 0.001					

Table 10. Multiple Linear Regression Analysis for Estimating Copra Revenue

Another important objective of this research was to determine whether the selling price, production, and production cost were significant predictors of copra industry revenue in Davao Oriental. The analysis revealed a positive association between the three predictors and copra revenue. The results demonstrated that 86.7% of the variance in copra revenue is explained by these factors (F (3,379) = 821.99, p < .001). Specifically, the selling price (B = 827.57, t = 13.96, p < .001), production (B = 17.1, t = 20.7, p < .001), and production cost (B = 0.41, t = 7.02, p < .001) each exhibit significant association. This result suggested that the selling price, production, and production cost significantly predict copra revenue in Davao Oriental.

This finding aligned closely with the outcomes observed in a prior study by Suzan (2020). She employed selling price, and production, as independent variables, while revenue as the dependent variable. Her study similarly indicated that these predictors significantly predict copra revenue. Specifically, they achieved a coefficient of determination of 69%. The investigation, parallel to the current findings, underscored a strong relationship between the selling price, production, and production cost and their influence on copra revenue. The study's substantial coefficient of determination further substantiated the significance of these factors in predicting copra revenue, mirroring the results obtained in our present analysis.

Split Sample Analysis

	Model 1 *(All data)*		**Model 2** *(First, split half data)*		**Model 3** *(Second Split half data)*	
Variables	***B***	***p***	***B***	***p***	***B***	***p***
Constant	-25,567.40	< 0.001	-28,371.92	< 0.001	-23,235.23	< 0.001
Selling Price	827.57	< 0.001	884.942	< 0.001	773.24	< 0.001
Production	17.1	< 0.001	16.752	< 0.001	17.64	< 0.001
Production Cost	0.41	< 0.001	0.46	< 0.001	0.34	< 0.001
		383		184		199
R^2		0.867		0.861		0.872
F		821.99		371.76		441.01

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p-value	p < 0.001	p < 0.001	p < 0.001

Table 11. Validation of the Regression Model Using Split Samples

The final objective of this study was to examine the validity of the regression model using split samples. Shown in Table 11 are the three models with their corresponding coefficient of determination and F values including the p-value. This procedure showed the corresponding coefficients and p-values of each variable in the three models. The first model is the result of the regression analysis shown in Table 11. Models 1 and 2 are the resulting regression models using the split samples.

The original model achieved an 86.7% coefficient of determination ($F(3, 379) = 371.76$, $p < .001$) using the predictors: selling price ($B = 884.942$, $t = 13.96$, $p < .001$), production ($B = 17.1$, $t = 20.7$, $p < .001$), and production cost ($B = 0.41$, $t = 7.02$, $p < .001$). Model 2 yielded an 86.1% coefficient of determination ($F (3, 180) = 371.76$, $p < .001$), showcasing values for selling price ($B = 884.94$, $t = 9.995$, $p < .001$), production ($B = 16.75$, $t = 13.06$, $p < .001$), and production cost ($B = 0.46$, $t = 5.42$, $p < .001$). Meanwhile, Model 3 demonstrated an 87.2% coefficient of determination ($F (3, 195) = 441.01$, $p < .001$) with selling price ($B = 773.24$, $t = 9.72$, $p < .001$), production ($B = 17.64$, $t = 16.549$, $p < .001$), and production cost ($B = 0.34$, $t = 4.27$, $p < .001$) as its predictors.

This outcome underscores the validity of the regression model, a concept explored extensively by Black and Babin (2019). The consistency in R-squared values across the three models validates their collective ability to predict copra revenue accurately. Notably, the predictors—selling price, production volume, and production cost—remained significant across all models, highlighting their substantial impact on the predictive capacity of each model in evaluating copra revenue.

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CONCLUSION

Significant fluctuations in selling price, production, production cost, and revenue were seen in the copra industry throughout municipalities in Davao Oriental, highlighting the dynamic and varied character of the local market. The findings from the study underscore the multifaceted nature of pricing in the copra industry. Factors including market integration, local demand-supply dynamics, transportation costs, quality considerations, and weather conditions significantly influence pricing strategies. Remarkably, the role of transportation infrastructure emerges as a critical determinant, affecting logistical costs and consequently impacting selling prices across different regions.

To address pricing disparities and enhance market efficiency, Stakeholders are advised to invest in upgrading transportation networks that can lead to reduced logistical costs; maintain high-quality standards throughout the copra supply chain; collaborate and integrate among market players to create a more unified and efficient copra market, which can help stabilize prices and reduce volatility; and implement systems for price reporting and dissemination of market information for transparency purposes. By implementing these strategies, stakeholders can work towards managing pricing challenges effectively, optimizing returns for copra producers, and fostering a more resilient and competitive copra industry.

The analysis of copra production across municipalities in Davao Oriental reveals significant variation in production level. The average production and standard deviation provide a benchmark for understanding general trends across all municipalities in Davao Oriental. Based on these findings, stakeholders should focus on optimizing copra production, reducing variability, and enhancing productivity. Implementing recommendations such as allocating resources and investments to areas with consistently high copra production levels, like San Isidro and Mati can achieve these goals.

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Additionally, targeted interventions such as improved agricultural practices, resource access, and training programs should be implemented to stabilize production and minimize fluctuations, especially in areas with low productivity.

The findings of the analysis on production cost hold significant implications for Copra industry stakeholders. Farmers, cooperatives, and policymakers must comprehend and address the drivers of production cost variability to optimize profitability and encourage sustainable agricultural practices. Strategies such as efficient resource use, cost-effective input procurement, technology adoption for productivity boosts, and regulatory compliance management can help mitigate cost differentials and ensure equitable returns for copra producers across diverse areas. Continual research into the specific drivers of cost variation and ongoing cost trend monitoring is crucial for devising targeted interventions and strategies to achieve cost-effective copra production across various geographical regions.

Addressing the root causes of revenue disparities is essential to promote inclusive growth, reduce economic inequalities, and ensure equitable returns for copra producers across various municipalities. Strategies such as improving market connectivity, upgrading infrastructure, fostering value chain partnerships, supporting technology adoption, and implementing targeted policy interventions can narrow revenue gaps and create more equitable economic opportunities in copra-producing regions.

Continually monitoring revenue trends, benchmarking against best practices, and knowledge sharing among stakeholders is essential for designing effective interventions and strategies that drive sustainable economic growth and resilience in copra-dependent areas. Collaborative efforts involving farmers, cooperatives, government agencies, research institutions, and private sector partners are instrumental in achieving these objectives and fostering a thriving copra industry that contributes positively to rural livelihoods and overall economic development.
This study revealed a strong relationship between the copra revenue and the independent variables such as selling price, production, and production cost. Examining individual coefficients, all positive implies that an increase in selling price, production, and production cost, while holding other variables constant, positively impacts copra revenue. The linear regression analysis suggests that the selling price has a substantial impact on copra revenue. Still, other factors (such as production and production cost) also played a role in explaining the variation in revenue. When the analysis included only the selling price, the model's predictive power decreased significantly. Comprehensive evaluation of the model and the inclusion of additional predictors are crucial for achieving more accurate predictions. The research successfully addressed its objectives, confirming the significance of selling price, production, and production cost as predictors of copra industry revenue in Davao Oriental. The regression coefficients for selling price, production, and production cost demonstrate statistically significant associations with copra revenue. These findings offered robust insights for policymakers, industry stakeholders, and researchers to make informed decisions and implement targeted strategies. Despite the model's reliability and statistical significance, caution is warranted when interpreting results, considering the study's limitations and the specific context of the copra industry in Davao Oriental. In conclusion, the regression analysis provides a valuable tool for estimating copra revenue, emphasizing the need for a nuanced interpretation and consideration of practical implications in real-world decision-making.

The split-data analysis undertaken in this study to evaluate the validity of the regression model has yielded robust and consistent results across three distinct models. The initial regression model and the subsequent models derived from split samples demonstrated remarkably similar coefficients of determination, with percentages ranging from 86.1% to 87.2%. This remarkable consistency underscores the reliability and effectiveness of the regression models in accurately predicting copra revenue. Notably, predictors such as selling price, production, and production cost maintain their significant roles across all models, reaffirming their substantial influence on the predictive capacity of the regression models. The collective findings affirm the overall validity of the regression model and highlight the enduring importance of the identified predictors in assessing copra revenue. This study provides valuable insights for stakeholders and decision-makers in the relevant domain, emphasizing the stability and reliability of the regression models for forecasting purposes.

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The results obtained from the regression analysis confirmed the effectiveness of employing a linear modeling approach for comprehending and predicting copra industry revenue in Davao Oriental. The derived regression equation aligns seamlessly with the foundational principles of linear modeling. Essentially, the conducted regression analysis, within the context of linear modeling, not only furnishes a predictive equation but also validate the appropriateness of adopting a linear methodology to model the intricate relationships among selling price, production, and production cost, influencing copra industry revenue in Davao Oriental. This outcome establishes a strong groundwork for subsequent research endeavors, policy formulation, and strategic planning within the copra industry, all rooted in the principles of linear modeling.

Future researchers on Copra revenue should consider employing a diverse range of statistical analyses and approaches to enrich the findings. Multiple Linear Regression remains a valuable tool for modeling relationships among predictors like selling price, production, and production cost concerning copra revenue, allowing for assessing individual predictor impacts while controlling for others. Time Series Analysis, mainly using techniques like ARIMA or Exponential Smoothing, proves beneficial in capturing trends and cyclic patterns over time. Panel data analysis provides valuable insights into both cross-sectional and time-series variations, particularly when analyzing data from diverse entities such as various regions or farms. Cluster Analysis can unveil distinct patterns within predictor values, such as high-revenue versus low-revenue groups. Econometric models, particularly production function models, are relevant in agricultural economics for understanding input-output relationships. Additionally, incorporating Bootstrapping for confidence intervals and conducting Sensitivity Analysis to assess result robustness are recommended practices to enhance the reliability of findings in copra revenue research. Furthermore, the exploration of additional factors influencing copra revenue incorporating qualitative data for a holistic understanding.

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