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Modeling Trends in Poultry Production in the Provinces of Northern Mindanao, Philippines, Using ARIMA

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ABSTRACT: Poultry production is an essential activity in the northern Mindanao agricultural sector in the Philippines. The focus of this study was to forecast trends for poultry production (chicken, chicken eggs, duck, and duck eggs) across the provinces in Region 10 based on data from 2019 to 2023. Production trends in Bukidnon, Camiguin, Lanao del Norte, Misamis Occidental, and Misamis Oriental were analyzed using the ARIMA model. Results also pointed out that production trends from all categories usually stabilize in the long term, with Bukidnon seeing the highest production, particularly for chicken and chicken egg, and Camiguin producing the least. Production levels were relatively high in Misamis Oriental and moderate but steady in Lanao del Norte and Misamis Occidental. This work reports significant disparities in provinces and the imperative to adopt targeted strategies for continued production growth amid challenges and equitable development in the poultry sector in Northern Mindanao.

KEYWORDS: ARIMA, poultry production, forecast.

I. INTRODUCTION

Food security and livelihoods rely on the poultry sector in most parts of the Philippines because the sector provides a stable source of protein and income for rural communities [1], [2]. Chicken and egg production significantly contributes to local diets and the economy, with Northern Mindanao playing a vital role in the country's poultry production [3], [8]. The poultry industry contributes to both urban and rural areas by providing reliable and sufficient poultry supply, which is a priority for policymakers and stakeholders in the poultry industry [9].

At the same time, agricultural production is subject to environmental, economic, and health factors that can vary significantly over time, causing fluctuations in supply and demand dynamics [10]. Moreover, these fluctuations highlight the importance of reliable forecasting models so that planning and resource allocation do not keep up with demand. Indeed, most of the existing work has dealt with broader agricultural trends, such as crop yields [11], [12], but has paid little attention to the local level poultry production trends within specific provinces in the Philippines.

This study analyzes poultry production data from 2019 to 2023 in the Provinces of Northern Mindanao, Philippines, and uses the autoregressive integrated moving average (ARIMA) model to project future production trends. ARIMA is an effective and robust time series analysis solution in volatile agricultural environments [14], [13]. This study aims to ascertain the production structures in the regions to propose strategies that would foster poultry sector resilience and sustainability.

II. LITERATURE SURVEY

The Philippines' poultry industry, particularly in Northern Mindanao, is vital to food security and economic stability, as it is the source of essential protein and income for rural communities [1], [2]. Chicken and egg production plays crucial roles in the local diets and economy, and Northern Mindanao is a substantial contributor to national poultry [3], [8]. However, environmental, economic, and health factors related to agricultural production, including poultry, cause supply to fluctuate due to supply and demand [10]. Forecasts are needed to plan better and allocate resources, and these challenges emphasize that these forecasts need to be as accurate as possible.

The ARIMA (AutoRegressive Integrated Moving Average) time series forecasting method has widely predicted agricultural trends. It has shown effectiveness in volatile markets (as demonstrated by Mandal [11] for commodity price forecasting and Box, Jenkins, and Reinsel [12] for time series prediction methods). However, much less attention has been given to poultry production trends at local levels, particularly in the Northern Mindanao region, where ARIMA models should first be applied to localized data to understand production dynamics [13], [14].

This study attempts to fill it by using ARIMA to forecast poultry production in Northern Mindanao and contribute valid leads on future trends. ARIMA forecasting models are vital to improving the resilience and sustainability of the poultry sector, which helps policymakers and stakeholders make decisions under environmental and economic fluctuations [9], [12]. By focusing on regional data, this study will contribute to more effective planning and policy development in Philippine poultry.

III. METHODOLOGY

This study uses data from the Philippine Statistics Authority (PSA) Livestock and Poultry Statistics Division from 2019 to 2023. This data set gives a holistic view of livestock and poultry statistics for all the provinces and areas in the Philippines. It will allow a thorough analysis of provincial differences and production patterns. For this study, we will only use data about the provinces within Region 10 (Northern Mindanao) for the analysis.

The study utilized the Autoregressive Integrated Moving Average (ARIMA) model, employed in many fields to construct models for forecasting time series (Li et al., & et al., 2012; Lee & Lee-Ing, 2011). In this study, The ARIMA (p,d,q) algorithm forecasts the trends in poultry production across all provinces in Region 10 (Northern Mindanao), Philippines, for the next ten years. Time series predictions are based on changes over time in historical data sets and can produce mathematical models by using statistical data that can be extrapolated (Kayacan et al., 2010; Orong et al., 2018). The ARIMA (p,d,q) model is defined as follows:

$$X_t = \Phi_1 X_{t-1} + \dots + \Phi_p X_{t-p} + a_t - \Theta_1 a_{t-1} - \dots - \Theta_q a_{t-q}$$

Where, Φ 's (phis) represents the autoregressive parameters to be estimated, Θ 's (thetas) are the moving average parameters to be determined, X denotes the original series, and A represents the unknown random errors assumed to follow a normal probability distribution.

The prediction of poultry production was carried out through three distinct steps utilizing ARIMA-related modules. First, model identification was performed through autocorrelation and partial autocorrelation analysis to assess any random, stationary, and seasonal effects on the time series data. Next, the researcher made the time series stationary by applying differencing and then identified potential models based on the autocorrelogram and partial autocorrelogram. Finally, parameter estimation and model testing were conducted to compare the potential models, and the most suitable one was selected. Predictive analysis was then performed. The study utilized GRET (Gnu Regression, Econometrics, and Time-series Library) software for graph plotting and data analysis. Figure 1 illustrates the architectural design used to predict the trends in poultry production in each province.

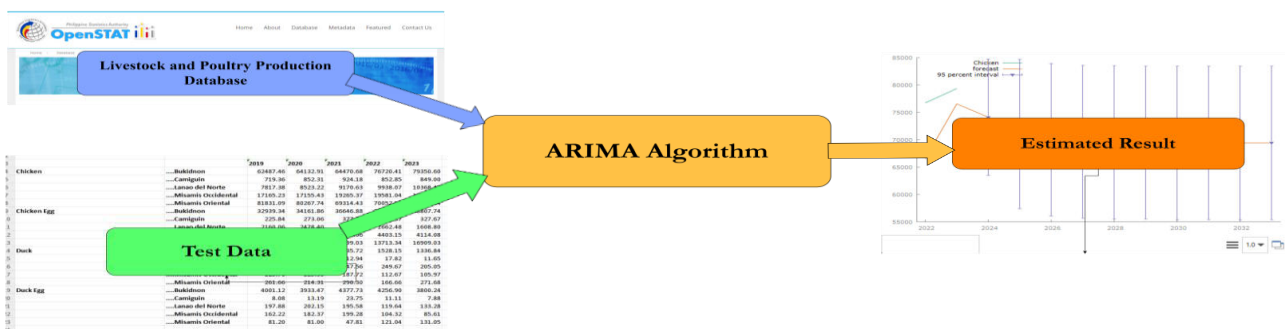


Fig. 1. Predicting poultry production trends

IV. EXPERIMENTAL RESULTS

Poultry production trends in each province of Region 10, Philippines, were analyzed using the GRETTL software. This type of analysis is needed to understand poultry production over time and assess trends that could be employed to improve it. Tables 1 to 4 present the raw data for poultry production from 2019 to 2023, specifically for chicken, chicken eggs, duck, and duck eggs.

Projected Chicken Production in Metric Tons	Year				
	2019	2020	2021	2022	2023
Bukidnon	62487.46	64132.91	64470.68	76720.41	79350.60
Camiguin	719.36	852.31	924.18	852.85	849.00
Lanao del Norte	7817.38	8523.22	9170.63	9938.07	10368.47
Misamis Occidental	17165.23	17155.43	19265.37	19581.04	19456.72
Misamis Oriental	81831.09	80267.74	69314.43	70052.90	68378.04

Table 1. Raw data of chicken production by province

Projected Chicken Egg Production in Metric Tons	Year				
	2019	2020	2021	2022	2023
Bukidnon	32939.34	34161.86	36646.88	39592.48	48807.74
Camiguin	225.84	273.06	377.74	292.57	327.67
Lanao del Norte	2160.06	2478.40	1685.54	1662.48	1608.80
Misamis Occidental	2634.40	3539.82	4071.06	4403.15	4114.08
Misamis Oriental	11244.24	11640.24	11199.03	13713.34	16909.03

Table 2. Raw data of chicken egg production by province

Projected Duck Production in Metric Tons	Year				
	2019	2020	2021	2022	2023
Bukidnon	1314.44	1403.24	1635.72	1528.15	1336.84
Camiguin	4.42	9.22	12.94	17.82	11.65
Lanao del Norte	143.50	139.93	247.56	249.67	205.05
Misamis Occidental	125.76	125.93	187.72	112.67	105.97
Misamis Oriental	261.66	214.31	290.30	166.66	271.68

Table 3. Raw data of duck production by province

Projected Duck Egg Production in Metric Tons	Year				
	2019	2020	2021	2022	2023
Bukidnon	4001.12	3933.47	4377.73	4256.90	3800.24
Camiguin	8.08	13.19	23.75	11.11	7.88
Lanao del Norte	197.88	202.15	195.58	119.64	133.28
Misamis Occidental	162.22	182.37	199.28	104.32	85.61
Misamis Oriental	81.20	81.00	47.81	121.04	131.05

Table 4. Raw data of duck egg production by province

The ARIMA forecast results for chicken production in Region 10 provinces, as shown in the figures, indicate initial fluctuations or declines in the early years before ultimately leveling off in the long term. Fig. 1 shows the production trend in Bukidnon, where slight fluctuations are observed initially, followed by a decline that eventually stabilizes. Fig. 2 illustrates Camiguin's forecast, which remains essentially flat throughout the period. Fig. 3 highlights Lanao del Norte's gradual decline in production. Fig. 4 presents Misamis Occidental's trend, showing minor fluctuations before leveling off, while Fig. 5 depicts Misamis Oriental's significantly higher production levels, with slight fluctuations that stabilize over time. The widening of 95% confidence intervals across all provinces represents increased uncertainty of long-term forecasts and underlines the need to interpret carefully and employ sophisticated strategies aimed towards tackling the production challenges and sustaining chicken production in the region.

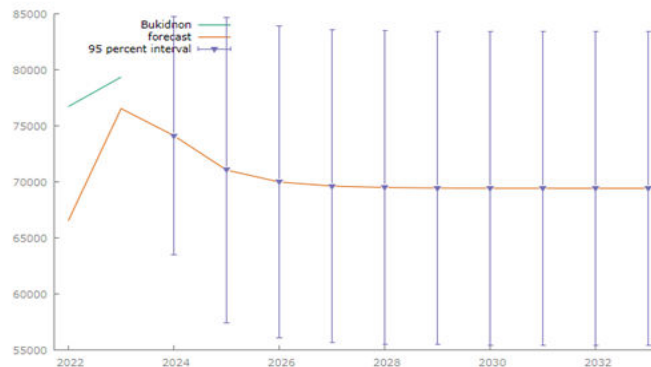


Fig. 2. Forecasted chicken production in Bukidnon

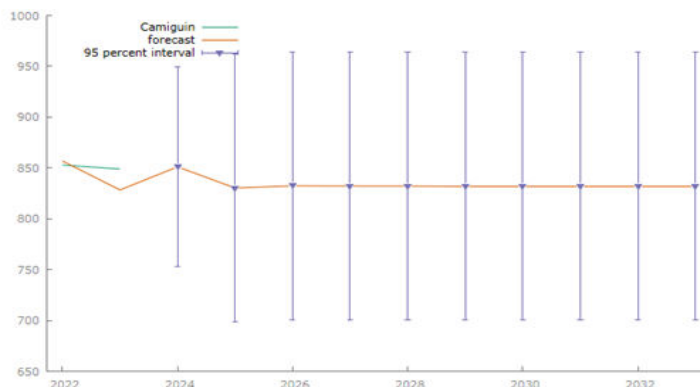


Fig. 3. Forecasted chicken production in Camiguin

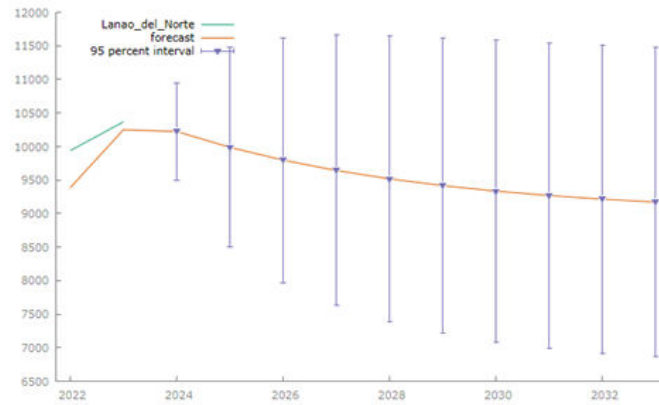


Fig. 4. Forecasted chicken production in Lanao del Norte

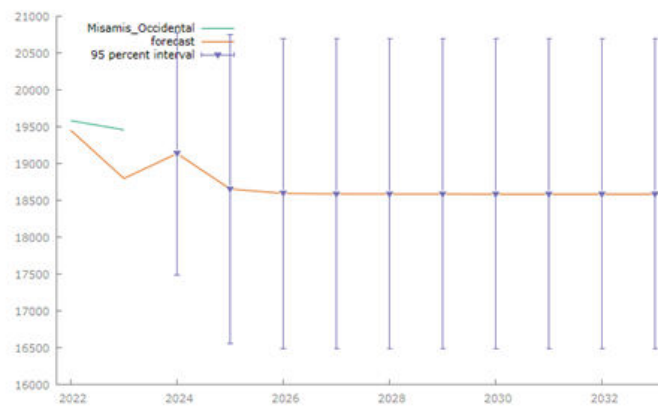


Fig. 5. Forecasted chicken production in Misamis Occidental

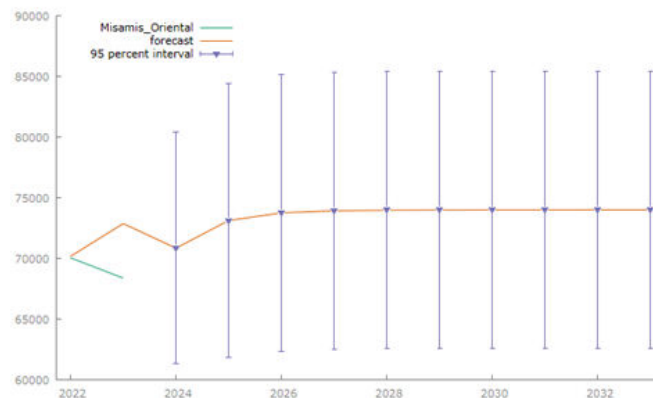


Fig. 6. Forecasted chicken production in Misamis Oriental

In Region 10 provinces, the ARIMA forecast results for chicken egg production exhibit long-term stabilization as well as initial fluctuations or declines in a few provinces. As illustrated in Fig.7, Bukidnon presents the highest production, initially increasing before stabilization, and Fig.8 depicts a consistently low and flat trend for Camiguin. Fig. 9 exemplifies the trends in Lanao del Norte's relatively steady but unchanging production, Fig. 10 represents the onset and stabilization of production in Misamis Occidental, and Misamis Oriental's rapid growth, followed by fluctuation

and stabilization are shown in Fig. 11. Widening 95% confidence intervals for all provinces show increasing uncertainty over time and emphasize the need for targeted strategies to sustain and enhance chicken egg production, especially in provinces with low egg output or declining trend.

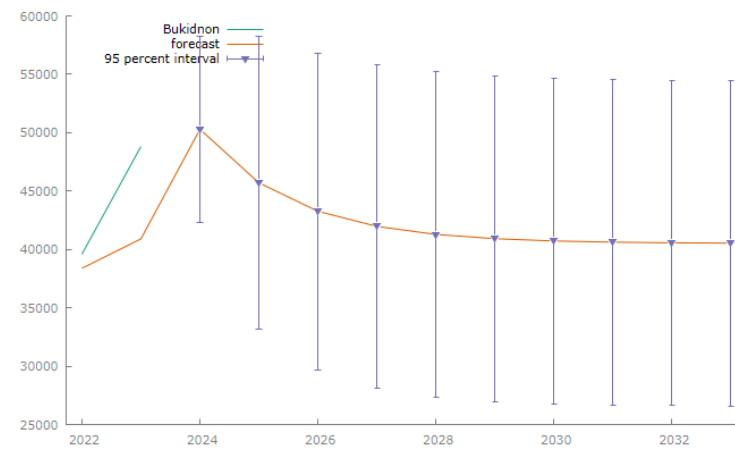


Fig. 7. Forecasted chicken egg production in Bukidnon

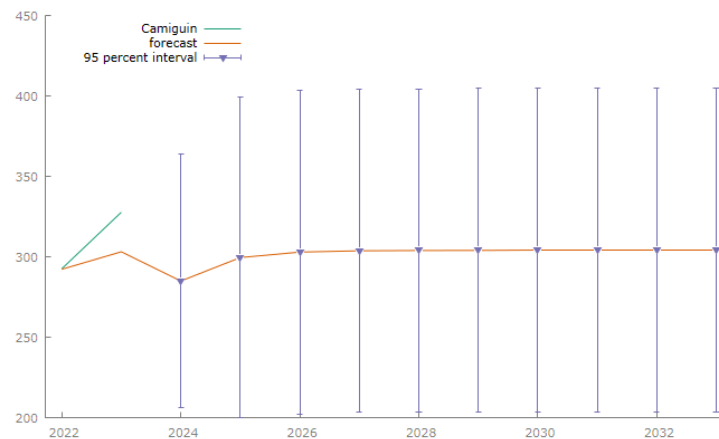


Fig. 8. Forecasted chicken egg production in Camiguin

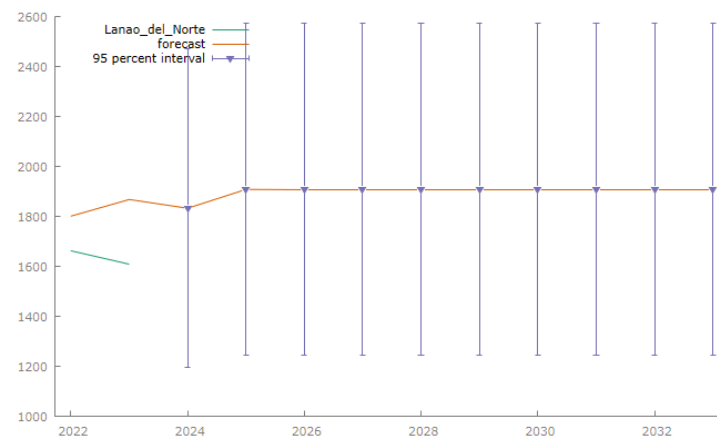


Fig. 9. Forecasted chicken egg production in Lanao del Norte

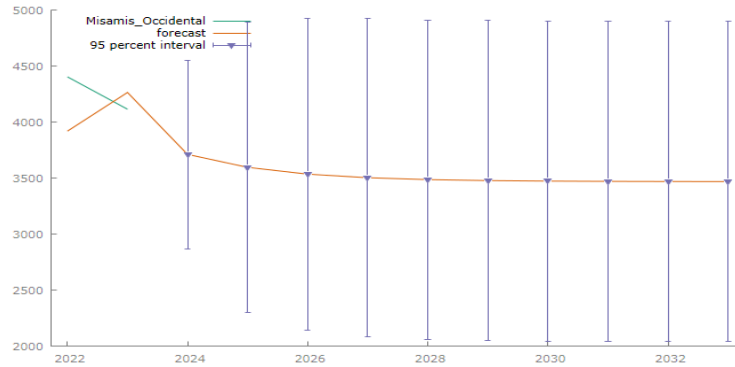


Fig. 10. Forecasted chicken egg production in Misamis Occidental

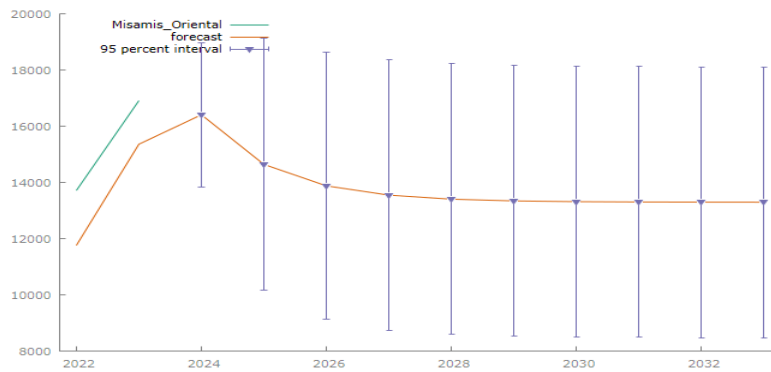


Fig. 11. Forecasted chicken egg production in Misamis Oriental

The ARIMA forecasts for duck production across the regions, as shown in Figures 12 to 16, reveal an overall trend of stabilization following initial fluctuations. Fig. 12 shows that in Bukidnon, production experiences a slight dip before stabilizing at a consistent level beyond 2024. Fig. 13 highlights Camiguin, where production remains minimal with little change over time. Fig. 14 shows that Lanao del Norte's production after initial changes will stabilize at relatively low levels. Fig. 15 presents Misamis Occidental's notable short-term fluctuations, which eventually level off into steady production levels, while Fig. 16 depicts a similar pattern for Misamis Oriental. The wide 95% confidence intervals during the early forecast periods indicate some short-term uncertainty, but they narrow after 2024, reflecting greater confidence in long-term stability.

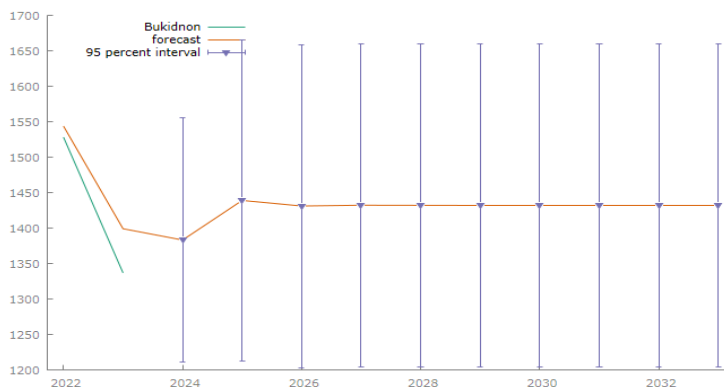


Fig. 12. Forecasted duck production in Bukidnon

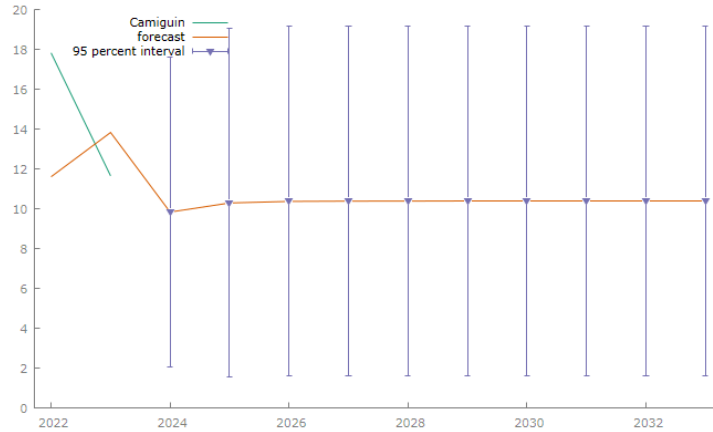


Fig. 13. Forecasted duck production in Camiguin

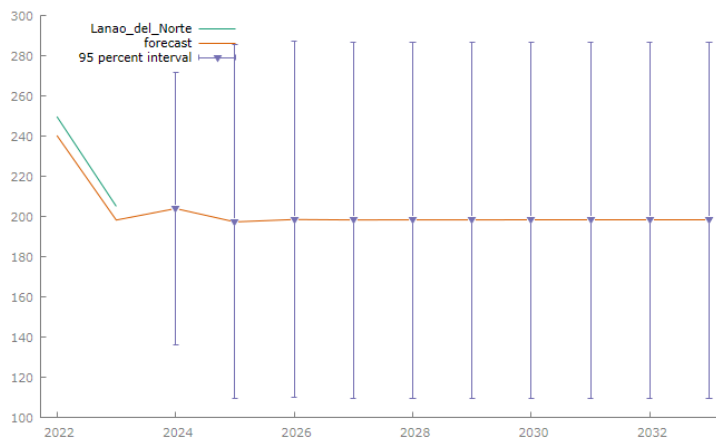


Fig. 14. Forecasted duck production in Lanao del Norte



Fig. 15. Forecasted duck production in Misamis Occidental

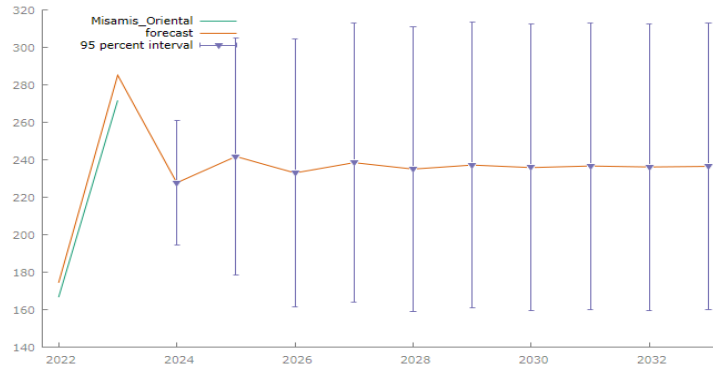


Fig. 16. Forecasted duck production in Misamis Oriental

The ARIMA forecasts for duck egg production across the regions, as shown in Figures 17 to 21, reveal a trend of stabilization following initial fluctuations. Fig. 17 shows that in Bukidnon, production stabilizes at around 4,100 units beyond 2024 after an initial fluctuation. Fig. 18 highlights Camiguin, where production remains low, peaking near 2024 before stabilizing around 14 units. Fig. 19 illustrates Lanao del Norte’s production, which experienced a dip before leveling off at approximately 170 units. Fig. 20 presents Misamis Occidental, where production shows a sharp decline early on, followed by stabilization near 150 units. At the same time, Fig. 21 depicts Misamis Oriental, where production peaks around 2023 and stabilizes at approximately 90 units. Across all regions, the narrowing 95% confidence intervals after 2024 indicate increased certainty in long-term forecasts, suggesting stable duck egg production levels in the future.

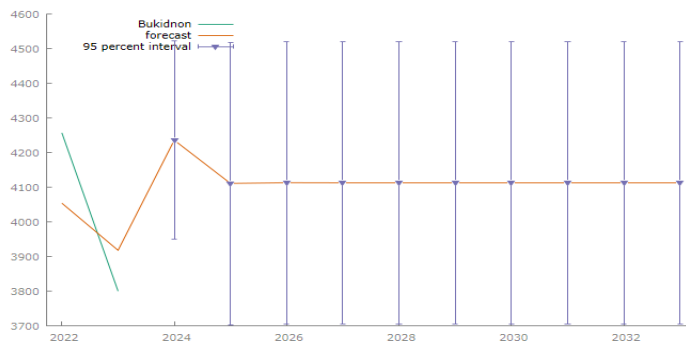


Fig. 17. Forecasted duck egg production in Bukidnon

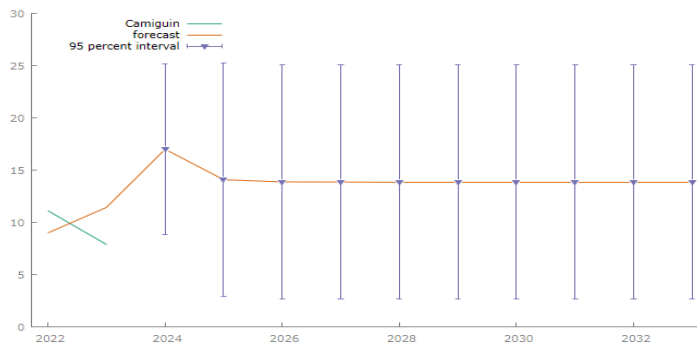


Fig. 18. Forecasted duck egg production in Camiguin

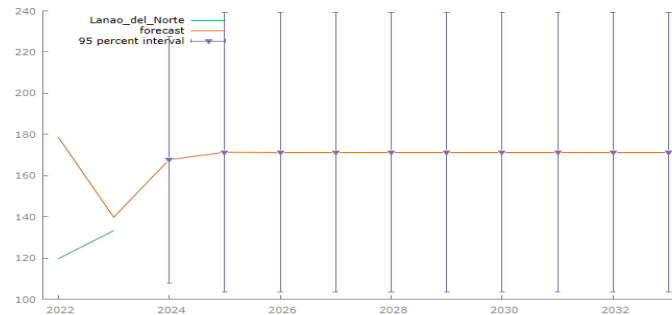


Fig. 19. Forecasted duck egg production in Lanao del Norte

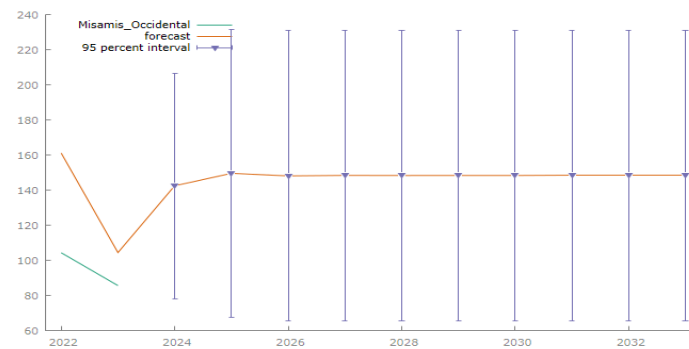


Fig. 20. Forecasted duck egg production in Misamis Occidental

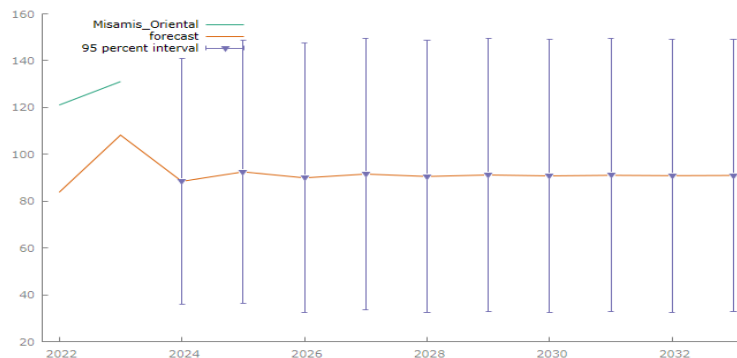


Fig. 21. Forecasted duck egg production in Misamis Oriental

V. CONCLUSION

Poultry production trend ARIMA modeling for Northern Mindanao, Philippines, shows an overall pattern of stabilization on a long-term basis, going through initial fluctuation or decline in all poultry categories (chicken, chicken eggs, duck, and duck eggs). Production levels vary significantly across provinces, with Bukidnon virtually always leading for most categories and Camiguin at the bottom. Chicken and chicken egg production has also been shown to have higher production trends in Misamis Oriental, moderate but stable in Lanao del Norte and Misamis Occidental.

Widening 95% confidence intervals of the early forecast periods indicate uncertainties and variabilities of short-term prediction, so caution should be taken in interpreting the results. However, for forecast stability, and in particular in order to rely on long-term trends, the more comprehensive confidence intervals no longer apply beyond 2024. These

findings suggest that targeted, province-specific strategies are needed to sustain or enhance poultry production in provinces with lower outputs or lower trends.

Therefore, policymakers and stakeholders should put extra effort into finding solutions to production challenges, better resource allocation, and supporting technology and management interventions to sustainably grow the poultry sector in Northern Mindanao.

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