International Journal of Statistics and Systems
ISSN 0973-2675 Volume 20, Number 2 (2025), pp. 166-175

http://www.ripublication.com

PREDICTION OF INLAND AND MARINE FISHERIES PRODUCTION IN INDIA USING ARIMA MODEL

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ABSTRACT

The fisheries sector is a vital pillar of India's agro economy, ensuring food security, employment, and export earnings, while contributing over 7% to global fish production and 1.24% to national GVA. Over the past four decades, the sector has undergone structural shifts marked by aquaculture expansion, technological innovation, and supportive policies. Inland fisheries have emerged as the primary growth driver, particularly in states such as Andhra Pradesh, West Bengal, and Gujarat, whereas marine fisheries remain more volatile. Despite steady progress, the sector faces persistent challenges including overexploitation of resources, climate variability, habitat degradation, and post-harvest inefficiencies. Government initiatives such as the Pradhan Mantri Matsya Sampada Yojana and the Blue Revolution have been instrumental in modernizing infrastructure, enhancing sustainability, and strengthening India's global standing. The study underscores the potential of India's fisheries to evolve into a resilient and globally competitive sector, provided ecological balance and innovation remain central to future strategies.

INTRODUCTION

The fisheries sector in India is vital for food security, rural employment, and export earnings. With a 7,500 km coastline, vast inland waters, and rich biodiversity, India ranks third in global fish production and second in aquaculture. The industry has evolved from traditional practices to advanced, market-driven systems, with inland fisheries and aquaculture driving growth in states like Andhra Pradesh, West Bengal, and Gujarat. Shrimp dominates seafood exports, bolstering India's global trade position. However, challenges such as overfishing, climate change, habitat loss, and weak infrastructure persist. Government initiatives like the Blue Revolution and PMMSY focus on modernization, sustainability, and livelihood support, ensuring that future growth balances economic gains with ecological stability. Studies on Indian fisheries highlight its growing role in food security, livelihoods, and exports, while underscoring challenges of sustainability and modernization. Ahmad and Ahmed (2022) stressed the need for optimized resource use and technological adoption, whereas ecosystem-based research emphasized the vulnerability of fish stocks to climate change and the importance of adaptive management. Recent works (Kuhn & Cayetano, 2024; Kanagaraj & Gladju, 2022) explored the application of machine learning and data mining in aquaculture and fisheries, noting their potential for stock assessment, disease monitoring, and market forecasting despite concerns over data quality and operational robustness. State-level studies in Odisha, Tamil Nadu, and Andhra Pradesh highlighted the dominance of inland aquaculture, shrimp exports, and persistent infrastructural deficits. Earlier econometric approaches, including ARIMA and growth-rate models, identified structural breaks linked to policy interventions, while recommending advanced methods like Bayesian change-point detection for improved forecasting. Overall, the literature emphasizes inland aquaculture, technological innovation, and sustainability, but reveals gaps in integrating advanced statistical models with regional analyses.

METHODOLOGY

This study used secondary data from government reports, FAO statistics, RBI records, and Kaggle datasets covering 1980–2022. An ARIMA model was employed to forecast fish production. Stationarity was tested using the Augmented Dickey-Fuller test, and differencing was applied where necessary. Model parameters (p,d,q) were identified through ACF and PACF plots, with the best model chosen using AIC and BIC. Residual checks confirmed adequacy, and the final model was used for forecasting.

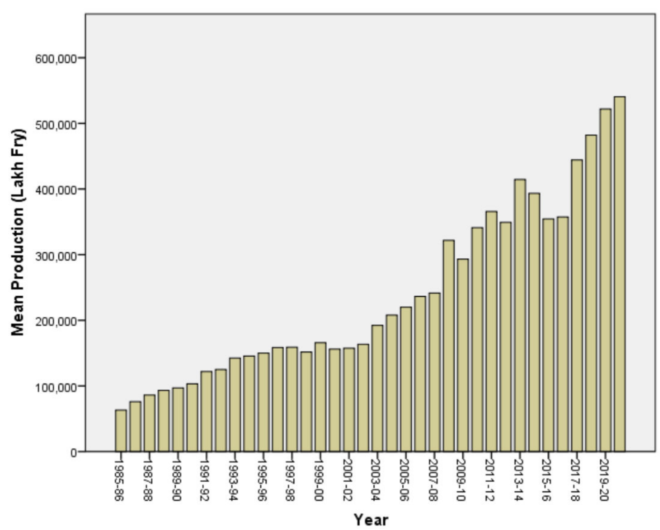

Figure 1: The Total Mean Fish Production in Each Year

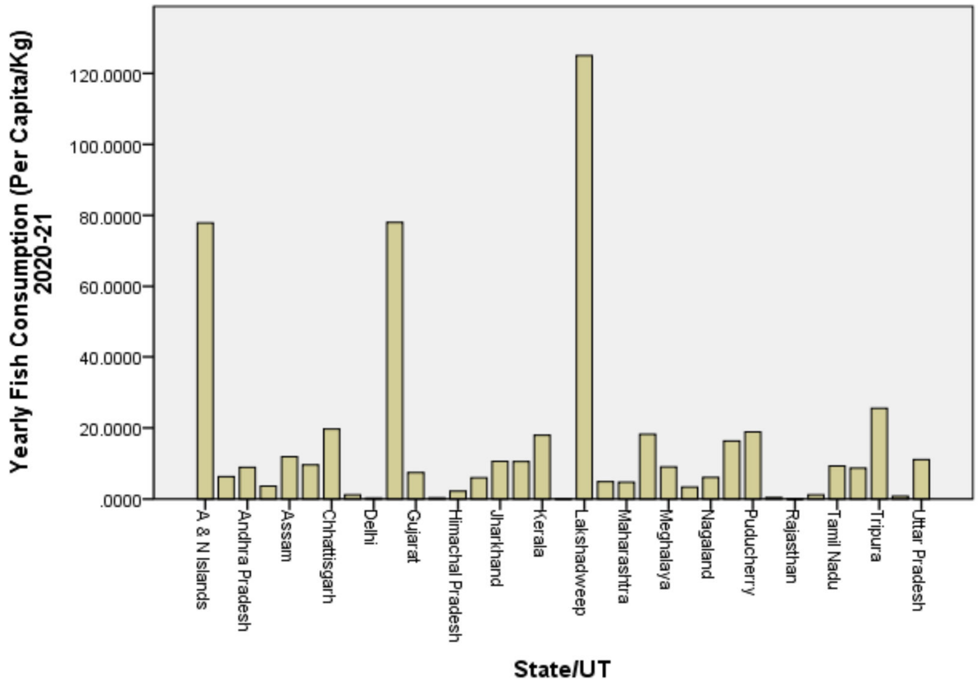

Figure 2: The Total Fish Consumption in Each State in INDIA

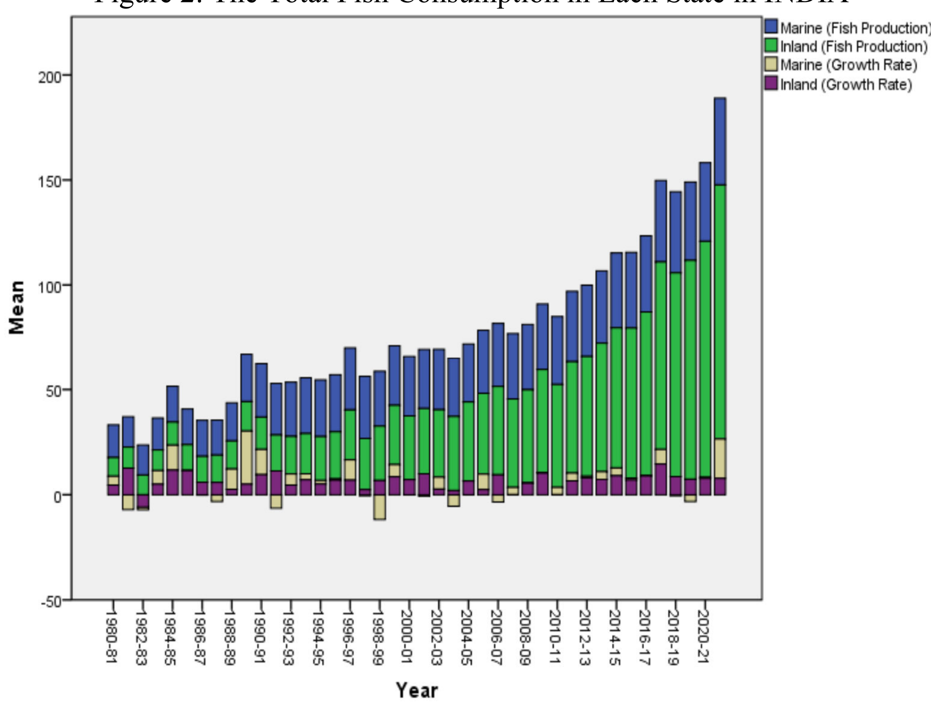

Figure 3: The inland, marine fish production and growth rate in 1980-2022.

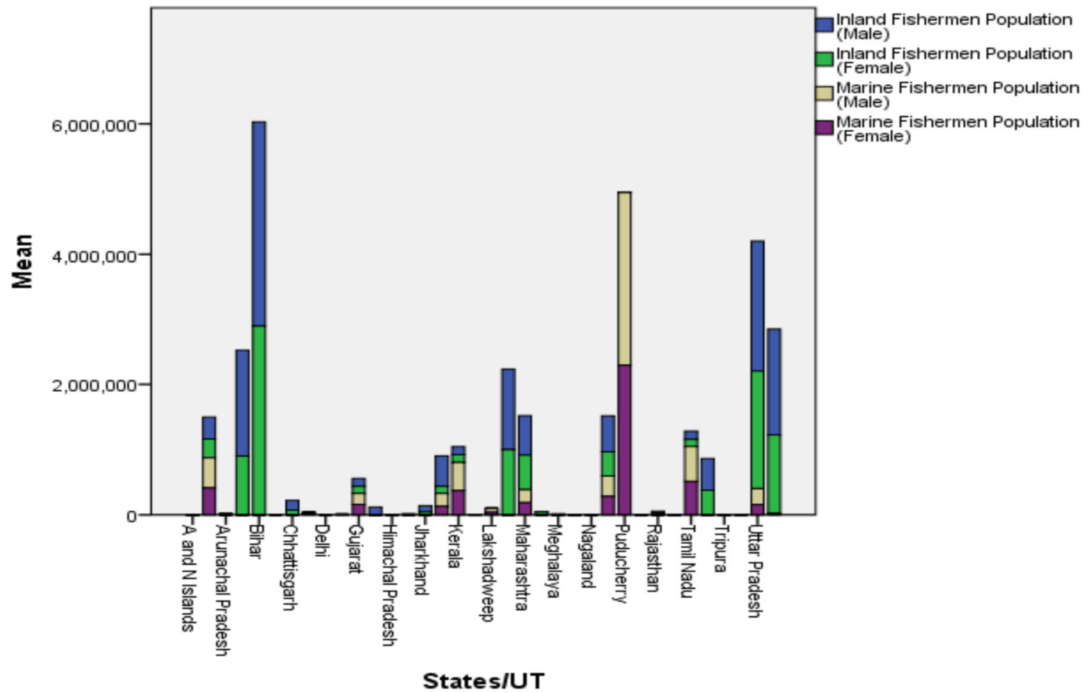

Figure 4: The inland, marine fishermen population in both male and female

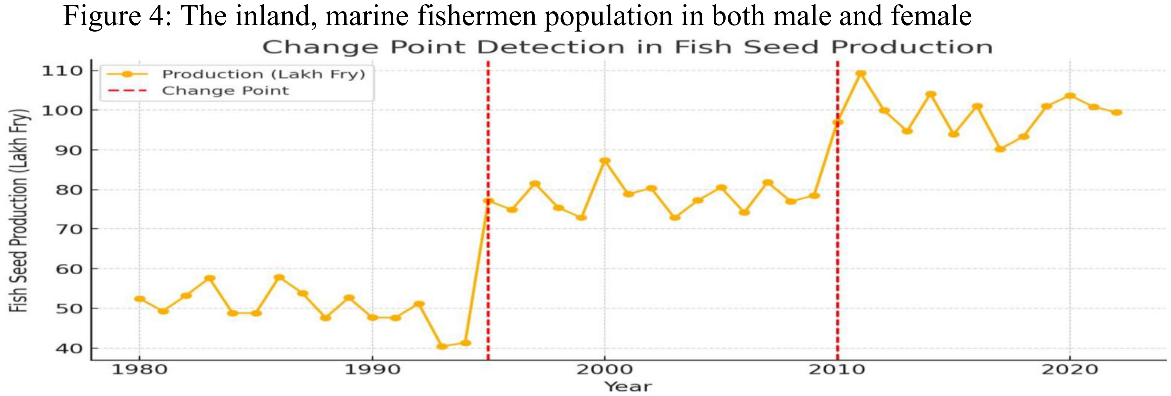

Figure 5: The changing point of the fisheries production over the years

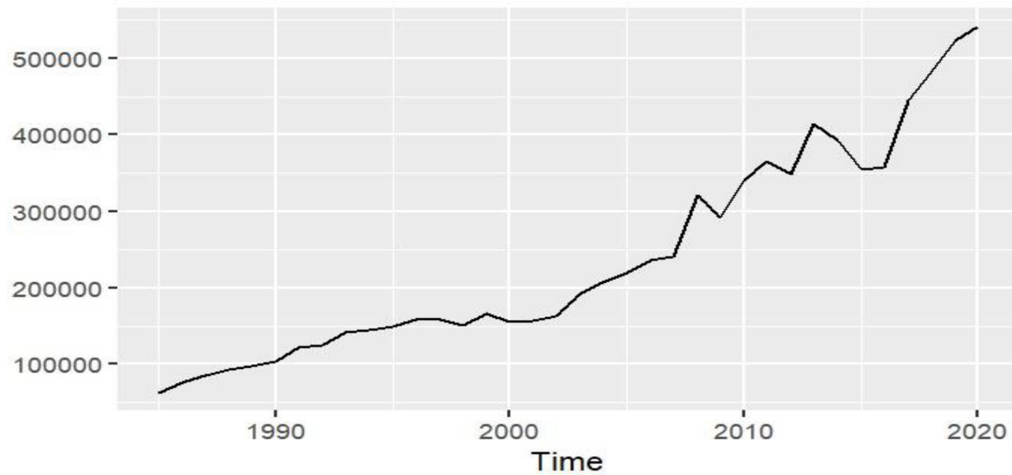

Figure 6: The steadily increasing trend over the years(Fish seed production in India) in production after 2015.

Table 4: Augmented Dickey-Fuller (ADF) test results

DATA	DICKEY-FULER	P-VALUE	RESULT
Level	3.2721	1.0000	Non-stationary
Differenced	-6.4872	0.0000000125	Stationary

At the level form (original data) the p-value is much greater than 0.05, meaning we fail to reject the null hypothesis of the ADF test. Therefore, the original series is non-stationary. After first differencing, the p-value is much less than 0.05, so we reject the null hypothesis. This confirms that the first-differenced series is stationary.

MODEL IDENTIFICATION

Model identification in ARIMA involves determining the appropriate values for the parameter's 'p', 'd', and 'q' by examining the time series data's autocorrelation and partial autocorrelation functions (ACF and PACF). ACF is used to determine the order of MA(q), PACF is used to determine the order of AR(p) and differencing is done to identify the differencing order (d)

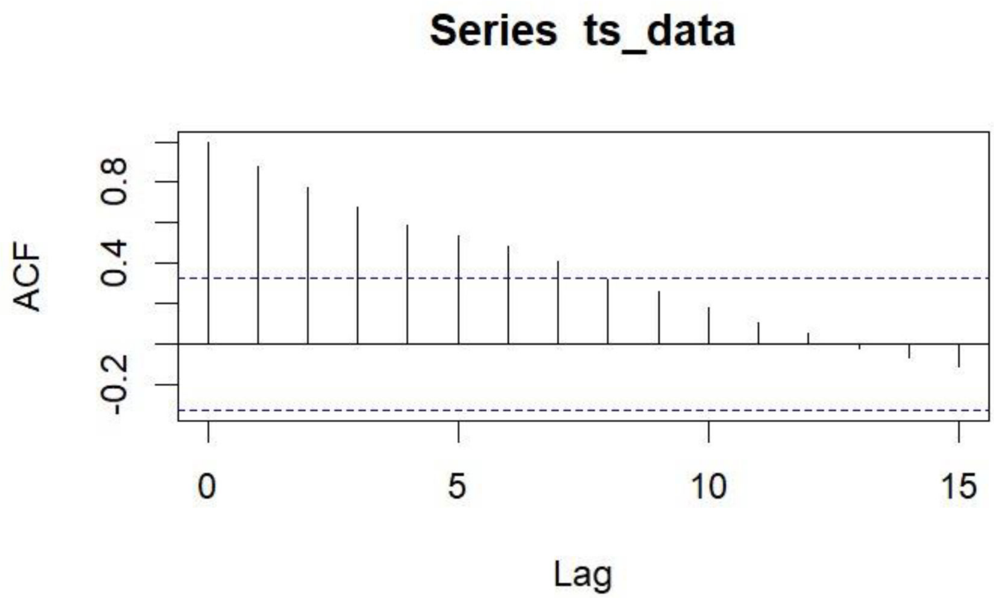

Figure 7: Autocorrelation function for yearly production in India

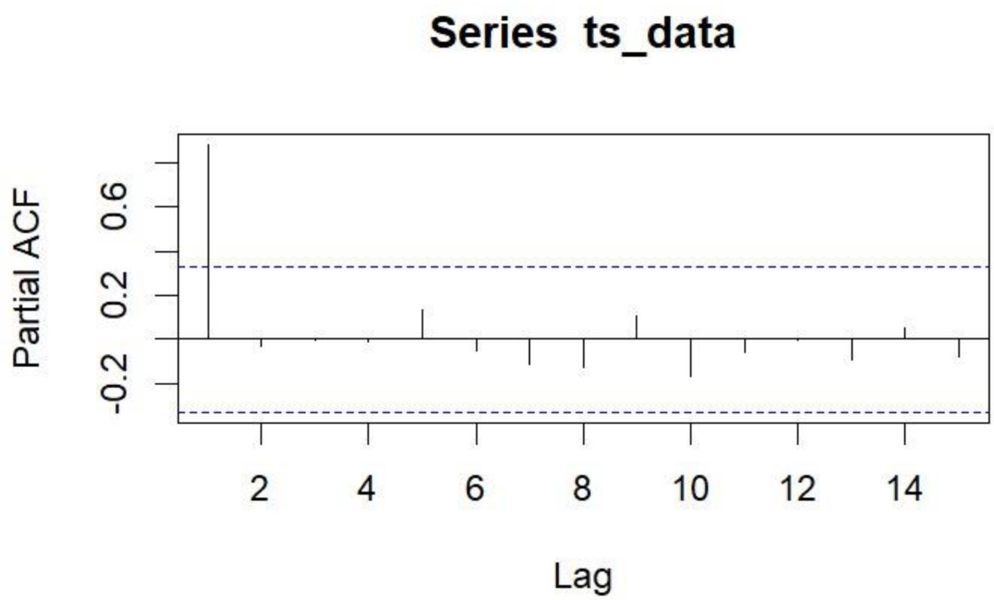

Figure 8: Partial Autocorrelation function for yearly production in India

Figure 7,8 shows time series plot. The diagrammatic representation of ACF and PACF are shown in the above plots that confirm the original time series data is not stationary, and need some treatments to be transformed to a stationarity series. Therefore, we used transformations and we found that the most suitable transformation is by differencing the series.

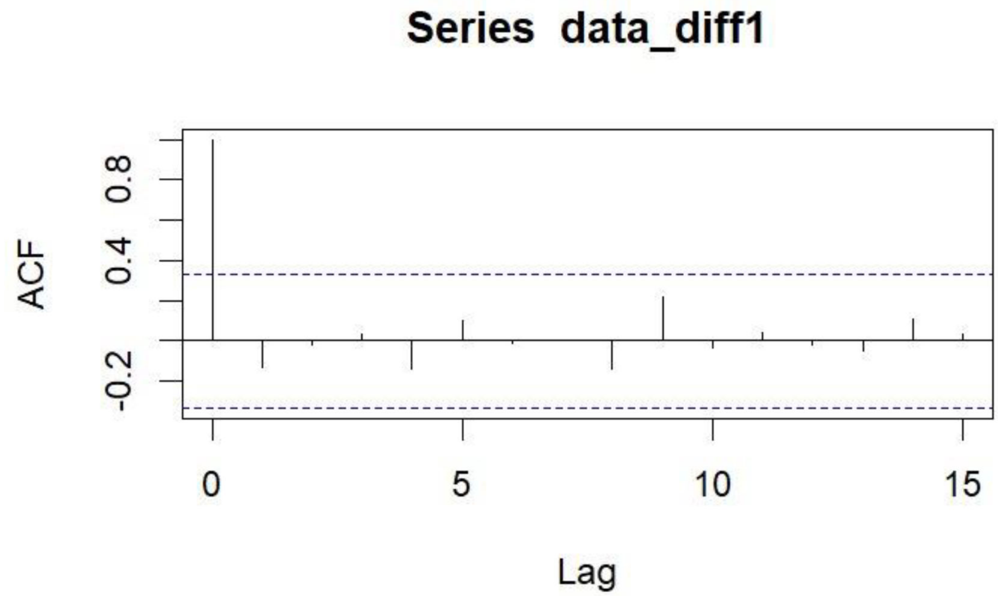

Figure 9: Auto correlation function by differencing the series for first time

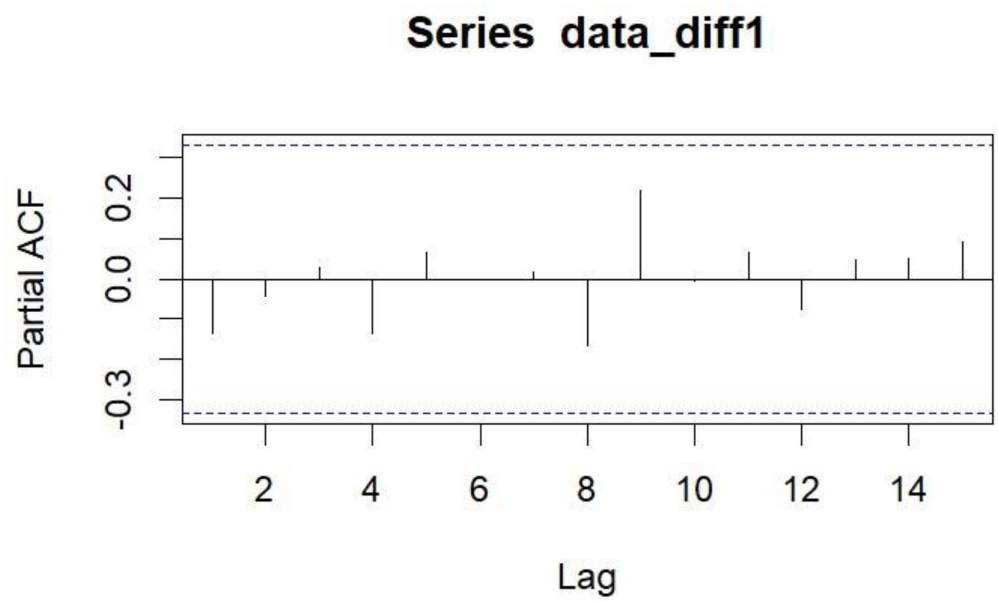

Figure 10: Partial Auto Correlation Function by differencing the series for first time

In the ACF plot, there is a strong spike at lag 1 followed by a rapid decline, with all subsequent lags falling within the confidence bounds. This pattern typically indicates that the series has no significant autocorrelation beyond the first lag. Similarly, the PACF plot does not show any dominant spikes beyond the initial lags, with most values also staying within the confidence interval. These characteristics imply that the differencing has successfully removed trends and made the series stationary. Therefore, the data is now suitable for time series modeling, such as

ARIMA.

FINDING THE BEST MODEL

Based on the analysis, the Augmented Dickey-Fuller (ADF) test produced a p-value of 0, indicating that the original series is non-stationary. After applying first-order differencing (d = 1), the series became stationary. From the ACF and PACF plots, the appropriate values for the autoregressive (p) and moving average (q) components were determined to be 0.

Table 5 :ARIMA(0,1,0)With Drift-Model Parameter

ARIMA (0,1,0) WITH DRIFT-MODEL PARAMETER	VALUE
Drift	13,642.000
S.E	4,438.458
Sigma 2	70,977,588.0
Log likelihood	- 405.81
AIC	815.63
AICc	816.00
BIC	818.74

Therefore, the selected ARIMA model is ARIMA (0, 1, 0). The model was fitted with a drift term, and the resulting AIC = 815.63, which suggests a good fit for the data. Hence, the ARIMA (0,1,0) model is identified as the most suitable model for forecasting in this analysis.

Table 6: Forecast future value with the lower and upper 95% confidence interval

YEAR	PIONT FORECAST	L0 95	Hi 95
2025	608900	492140.1	725659.9
2026	622542	494638.0	750446.0
2027	636184	498031.9	774336.1
2028	649826	502135.1	797516.9
2029	663468	506818.2	820117.8
2030	677110	511986.6	842233.4

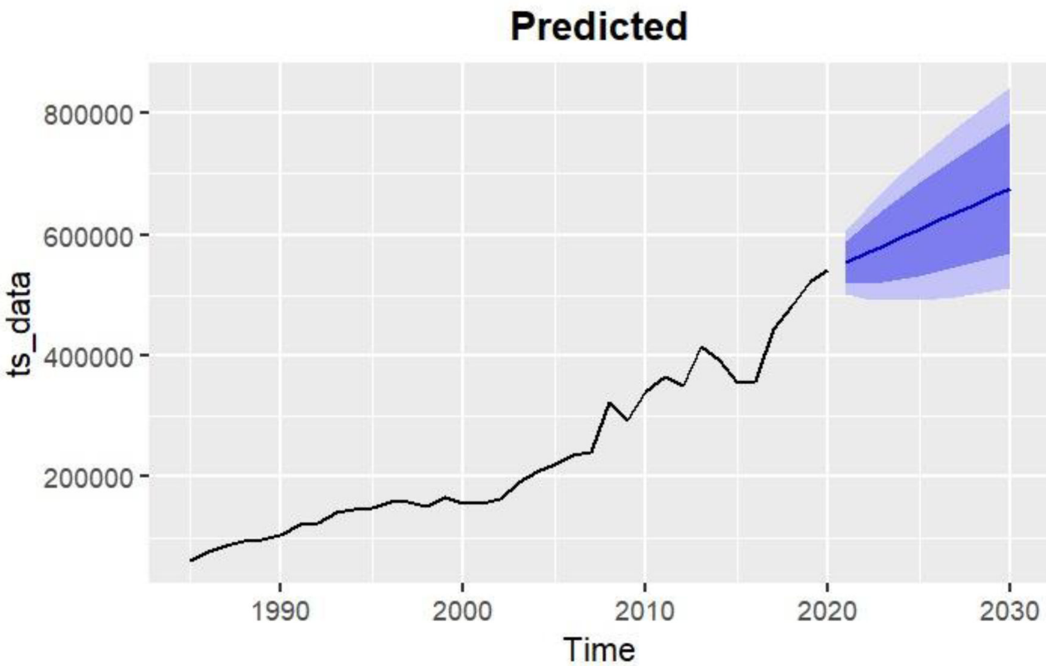

Figure 11 : The forecast for the fish seed production in India

The ARIMA(0,1,0) model with drift effectively captures the sustained upward trend in India's fish seed production. Historical data (black line) exhibit steady growth, while the forecasted trajectory (blue line) extends this pattern plausibly into the future. Shaded bands denote 80% and 95% confidence intervals, widening with the forecast horizon, reflecting increasing uncertainty. The projections are stable, devoid of abrupt fluctuations, indicating the model's reliability for short-term forecasting and its capacity to extrapolate the underlying linear trend

CONCLUSION

The study elucidates the strategic significance of India's fisheries sector in bolstering food security, sustaining rural livelihoods, and augmenting export revenues. Temporal analysis of production patterns from 1980 to 2022 revealed two pronounced growth phases, predominantly catalyzed by aquaculture proliferation, technological innovation, and enabling policy frameworks. Inland fisheries emerged as the principal contributor, whereas marine production manifested higher variability. Prospective forecasts project sustained expansion, underscoring the sector's escalating economic relevance. Nonetheless, enduring challenges—including resource overexploitation, climate-induced perturbations, post-harvest inefficiencies, and infrastructural inadequacies—necessitate targeted interventions. Policy initiatives such as the Pradhan Mantri Matsya Sampada Yojana and the Blue Revolution are instrumental in modernizing infrastructure, fostering sustainable practices, and enhancing global competitiveness. Collectively, with continued strategic support, technological advancement, and ecological stewardship, India's fisheries sector possesses immense potential to evolve into a resilient, sustainable, and globally preeminent industry.

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