

# A COMPARISON OF TIME SERIES MODELS AND ARTIFICIAL NEURAL NETWORK MODELS FOR FORECASTING TURKIYE'S MONTHLY POULTRY MEAT EXPORTS TO IRAQ

Diyar Muadh KHALIL<sup>1a</sup>, Cuma AKBAY<sup>2\*b</sup>

<sup>1</sup>Mathematics Department, Faculty of Science, Soran University, Northern Region of Iraq, Erbil, Iraq

<sup>2</sup>Kahramanmaras Sutcu Imam University, Agricultural Faculty, Department of Agricultural Economics, Kahramanmaras, Turkiye

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\*Corresponding author: cakbay@ksu.edu.tr

 <sup>a</sup>0000-0003-3456-822X,  <sup>b</sup>0000-0001-7673-7584

## Abstract

Accurate forecasting of agricultural exports is crucial for effective trade planning, particularly in markets exposed to volatility and political uncertainty. This study compares the forecasting performance of traditional time series models and artificial neural network (ANN) in predicting Türkiye's monthly poultry meat exports to Iraq. Monthly export data from January 2010 to December 2020, obtained from UN Comtrade and the Turkish Statistical Institute (TURKSTAT), were analyzed using the Autoregressive Integrated Moving Average (ARIMA) model and a Feed-Forward Neural Network (FFNN) model. The ARIMA model was constructed following the Box-Jenkins methodology, while the ANN model was applied using supervised learning with lagged export values as inputs. Forecasting accuracy was evaluated using MAE, RMSE, AIC, and R<sup>2</sup>. The results reveal that poultry meat exports exhibit nonlinear and volatile patterns, particularly during periods of regional instability. Empirical findings indicate that the FFNN model outperforms the ARIMA model, providing lower forecast errors and a better goodness of fit. These results suggest that ANN-based models offer a more reliable tool for forecasting poultry meat exports between Türkiye and Iraq and can support informed decision-making for exporters and policymakers.

**Keywords:** Forecasting, Artificial Neural Networks, Time Series, ARIMA, Poultry Meat Exports, Türkiye-Iraq Trade

## TÜRKİYE'NİN İRAK'A AYLIK TAVUK ETİ İHRACATININ TAHMİNİ İÇİN ZAMAN SERİSİ MODELLERİ İLE YAPAY SİNİR AĞI MODELLERİNİN KARŞILAŞTIRILMASI

### Özet

Tarım ürünleri ihracatının doğru bir şekilde tahmin edilmesi, özellikle dalgalanma ve siyasi belirsizliklerin yoğun olduğu piyasalarda etkili ticaret planlaması açısından kritik öneme sahiptir. Bu çalışma, Türkiye'nin Irak'a yönelik aylık tavuk eti ihracatını tahmin etmede geleneksel zaman serisi modelleri ile yapay sinir ağı modellerinin tahmin performansını karşılaştırmaktadır. Ocak 2010-Aralık 2020 dönemine ait aylık ihracat verileri, UN Comtrade ve Türkiye İstatistik Kurumu (TÜİK) kaynaklarından elde edilmiş olup, Otoregresif Bütünleşik Hareketli Ortalama (ARIMA) modeli ile İleri Beslemeli Yapay Sinir Ağı (FFNN) modeli kullanılarak analiz edilmiştir. ARIMA modeli Box-Jenkins metodolojisi çerçevesinde oluşturulurken, yapay sinir ağı modeli gecikmeli ihracat değerlerini girdi olarak kullanan denetimli öğrenme yaklaşımıyla eğitilmiştir. Tahmin doğruluğu MAE, RMSE, AIC ve R<sup>2</sup> ölçütleri kullanılarak değerlendirilmiştir. Bulgular, tavuk eti ihracatının özellikle bölgesel istikrarsızlık dönemlerinde doğrusal olmayan ve dalgalı bir yapı sergilediğini ortaya koymaktadır. Ampirik sonuçlar, FFNN modelinin ARIMA modeline kıyasla daha düşük tahmin hataları ve daha yüksek uyum iyiliği sağladığını göstermektedir. Bu bulgular,

yapay sinir ağı tabanlı modellerin Türkiye–Irak arasındaki tavuk eti ihracatının tahmininde daha güvenilir bir araç sunduğunu ve ihracatçılar ile politika yapımcılar için karar alma süreçlerini destekleyebileceğini göstermektedir.

**Anahtar Kelimeler:** *Tahmin, Yapay Sinir Ağları, Zaman Serileri, ARIMA, Etlik piliç ihracatı Türkiye-Irak ticareti*

## 1. INTRODUCTION

Forecasting constitutes a fundamental analytical tool in economics and international trade, supporting decision-making processes in both public and private sectors. Accurate forecasts are particularly critical in agricultural trade, where production cycles, demand fluctuations, and external shocks interact to generate complex and volatile patterns (Adhikari and Agrawal, 2013). In this context, selecting an appropriate forecasting methodology is not merely a technical issue, but a strategic one, as forecasting accuracy directly affects policy design, export planning, and market stability.

Agricultural export time series often exhibit non-stationarity, seasonality, structural breaks, and nonlinear dynamics. These features pose challenges for traditional statistical forecasting methods, which are typically built upon assumptions of linearity and normally distributed errors (Box and Jenkins, 1970; Hipel and McLeod, 1994; Cochrane, 2005). As a result, a growing body of literature has questioned the universal suitability of classical time series models, such as the ARIMA, particularly in environments characterized by rapid structural change.

Within agricultural trade, poultry meat represents a commodity with pronounced economic and strategic importance. Poultry meat exports are sensitive to short-term shocks arising from disease outbreaks, trade restrictions, exchange rate volatility, and geopolitical developments. Empirical studies focusing on agricultural and food markets suggest that such characteristics often lead to nonlinear export dynamics that may not be fully captured by linear models (Kohzadi et al., 1996).

Türkiye's poultry meat exports to Iraq offer a particularly relevant case for forecasting analysis. Iraq has consistently been among Türkiye's most important agricultural export destinations, while Türkiye has emerged as a leading supplier of poultry meat to the Iraqi market. However, monthly export volumes between the two countries have displayed substantial volatility over time, influenced by political instability, border disruptions, and regional security concerns, including the ISIS onslaught. These conditions suggest the presence of structural breaks and nonlinear patterns in the export series, which challenges the applicability of conventional forecasting approaches.

Traditionally, ARIMA models have been widely employed in forecasting agricultural production, prices, and trade flows due to their transparency and well-established theoretical foundations. Numerous studies have demonstrated their effectiveness under conditions where data exhibit stable linear relationships (Yoo et al., 2007; Sabri, 2013; Bars et al., 2018; Nwokike et al., 2020; Meral et al., 2025). However, other empirical investigations have shown that ARIMA and related models may perform poorly when confronted with nonlinearities and regime shifts, which are common in agricultural export data (Zhang, 2003; Kihoro et al., 2004).

In response to these limitations, ANNs have been increasingly applied as alternative forecasting tools. ANNs are capable of approximating complex nonlinear functions without requiring prior assumptions regarding data distribution or functional form (Chatfield, 1997; Lingireddy and Brion, 2005). A substantial number of empirical studies have reported superior forecasting performance of ANN models compared to ARIMA in agricultural and commodity markets (Jalaei et al., 2011; Ebrahimi et al., 2012; Khalil and Akbay, 2024). For example, Ebrahimi et al. (2012) demonstrated that FFNN outperformed traditional time series models in forecasting chicken prices, while Jalaei et al. (2011) found ANN models to be more accurate in predicting agricultural export volumes.

Nevertheless, the empirical literature does not provide a unanimous conclusion regarding the superiority of ANN models. Several studies indicate that traditional time series models may perform equally well or even better under specific data conditions, such as strong seasonality or limited

nonlinearity (Yoo et al., 2007; Sebri, 2013). Nwokike et al. (2020), for instance, reported no statistically significant difference between ANN and SARIMA models in forecasting rainfall frequency. These mixed findings highlight the importance of context-specific model comparison, rather than assuming the dominance of a particular forecasting approach.

Despite the extensive literature comparing ANN and ARIMA models across various fields, empirical studies focusing specifically on Türkiye's poultry meat exports to Iraq at a monthly amount remain scarce. Existing research has predominantly examined aggregated agricultural exports or multiple product groups, potentially masking product-specific dynamics and market sensitivities. Given the economic importance of poultry meat and the volatility inherent in Turkish–Iraqi trade relations, a focused and disaggregated analysis is necessary.

This study addresses this gap by conducting a systematic comparison of ARIMA and ANN models in forecasting Türkiye's monthly poultry meat exports to Iraq over the period 2010–2020. By evaluating model performance using widely accepted accuracy measures, including MAE, RMSE, AIC, and  $R^2$ , the study aims to determine which forecasting approach is better suited to capture the dynamics of poultry meat export flows under conditions of volatility and structural change.

By explicitly grounding its methodological choices in the existing literature and addressing contradictory empirical findings, this research contributes to the ongoing debate on the relative performance of traditional and modern forecasting models. The results are expected to provide practical implications for policymakers and exporters, while also offering methodological insights for future research on agricultural trade forecasting.

## **2. MATERIAL AND METOD**

### **2.1. Data and Sources**

This study uses monthly poultry meat export data from Türkiye to Iraq for the period January 2010–December 2020. Poultry meat includes fresh, chilled, or frozen meat and edible offal of poultry as defined under the Harmonized System (HS) classification. The data were obtained from the UN Comtrade Database and the TURKSTAT, which are widely used and reliable sources in international trade research. Monthly data was preferred to capture short-term fluctuations, seasonality, and potential structural changes in export dynamics. Export values were expressed in US dollars, and the dataset was checked for missing values and inconsistencies prior to analysis.

### **2.2. Forecasting Framework**

To forecast Türkiye's poultry meat exports to Iraq, two alternative approaches were applied and compared:

1. ARIMA models, representing traditional linear time series methods (Box and Jenkins, 1970; Hipel and McLeod, 1994).
2. ANN models, representing nonlinear, data-driven forecasting techniques (Zhang, 2003; Kihoro et al., 2004).

The use of both approaches allows an objective comparison between classical statistical modeling and modern machine-learning-based forecasting under identical data conditions.

### **2.3. ARIMA Modeling**

The ARIMA modeling followed the Box–Jenkins methodology, consisting of model identification, estimation, and diagnostic checking (Box and Jenkins, 1970). Stationarity of the poultry meat export series was assessed through time plots and autocorrelation structures. Since the original series exhibited non-stationary behavior, first-order differencing was applied to achieve stationarity (Cochrane, 2005).

ARIMA models were identified using the Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF). Model selection was based on the Akaike Information Criterion (AIC), where lower values indicate better fit (Akaike, 1998). Residual diagnostics, including

residual ACF/PACF plots and the Box–Pierce test, were conducted to ensure that residuals behaved as white noise ((Box & Pierce, 1970; Adhikari and Agrawal, 2013).

#### **2.4. Artificial Neural Network Modeling**

To account for possible nonlinear relationships in poultry meat export data, FFNNs were employed. The ANN architecture consisted of an input layer, one or two hidden layers, and a single output neuron representing the forecasted export value (Zhang et al., 1998).

Lagged export values were used as input variables. Consistent with previous studies on monthly time series, 12 lagged observations were considered to capture seasonal effects (Tang et al., 1991; Sharda and Patil, 1992). The network was trained using supervised learning, and the conjugate gradient algorithm was preferred due to its efficiency and convergence properties (Groot and Wurtz, 1991).

Nonlinear activation functions, including the sigmoid and hyperbolic tangent (tanh) functions, were applied in the hidden layers, while a linear activation function was used in the output layer to generate continuous forecasts (Zhang, 2003). The dataset was divided into training, testing, and validation subsets to evaluate the generalization capability of the ANN and to avoid overfitting (Zhang et al., 1998).

#### **2.5. Model Evaluation and Comparison**

The forecasting performance of ARIMA and ANN models was evaluated using commonly accepted accuracy measures of Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), Akaike Information Criterion (AIC), Coefficient of Determination ( $R^2$ ).

Lower MAE, RMSE, and AIC values indicate superior forecasting performance, while higher  $R^2$  values reflect better goodness of fit (Hamzaçebi, 2008; Adhikari and Agrawal, 2013). These criteria provide a comprehensive basis for comparing linear and nonlinear forecasting models.

Model robustness was ensured through out-of-sample evaluation for both ARIMA and ANN models. ANN performance was validated using training, testing, and validation subsets to prevent overfitting, while ARIMA robustness was assessed through residual diagnostics and the Box–Pierce test to confirm white-noise residuals. Forecast accuracy was evaluated using multiple performance criteria (MAE, RMSE, AIC, and  $R^2$ ). The consistency of results across these measures supports the validity and reliability of the forecasting comparison.

ARIMA models were estimated using R 4.4.1 and SPSS, while ANN models were constructed and trained using Alyuda Neuro Intelligence and R 4.4.1 statistical software

### **3. RESULTS AND DISCUSSION**

#### **3.1. Turkish Poultry Meat Exports to Iraq**

Türkiye's exports have increased substantially since the early 2000s, reflecting structural changes in trade policy, export-oriented growth strategies, and deeper integration into global markets. Following the adoption of export-promotion policies and the transition to a floating exchange rate regime after 2001, Türkiye's total exports expanded rapidly, increasing nearly six fold between 2001 and 2019. Despite a temporary contraction during the global financial crisis in 2009, export volumes recovered quickly and continued to grow steadily in subsequent years, indicating the resilience of Türkiye's export sector. Within this expanding trade structure, Iraq has emerged as one of Türkiye's most important export partners. According to UN Comtrade (2021) and TUIK (2022), Turkish exports to Iraq increased sharply from the early 2000s and reached a peak in 2013, when Iraq ranked among the top destinations for Turkish goods. Although exports declined during 2014–2016 due to regional instability and the ISIS conflict, Iraq remained consistently among Türkiye's top five export markets. The strong co-movement between Türkiye's global exports and exports to Iraq highlights the strategic importance of the Iraqi market for Türkiye's foreign trade, particularly in agricultural and food products.

Türkiye's poultry meat exports have increased markedly over the past two decades, both in volume and market share. Export volumes rose from approximately 21 thousand tons in 2001 to nearly 500 thousand tons by 2019, placing Türkiye consistently among the top ten global poultry meat exporters during the 2010–2020 period. The most pronounced growth occurred between 2010 and 2014, when exports expanded from about 139 thousand tons to over 526 thousand tons. Following a temporary decline during 2015–2016, largely associated with regional instability, exports recovered and exceeded 510 thousand tons in 2018 (UN Comtrade, 2021, TUIK, 2022). These figures highlight the rapid expansion and resilience of Türkiye's poultry meat sector and confirm its strategic importance within the country's agricultural export structure, particularly with respect to nearby markets such as Iraq.

Iraq has been the largest and most strategic destination for Türkiye's poultry meat exports over the last decade. In 2010, Türkiye exported approximately 62 thousand tons of poultry meat to Iraq, accounting for nearly 45% of its total poultry meat exports. This share increased steadily in subsequent years, reaching over 50% in 2011–2012 and peaking at approximately 56% in 2013, when export volumes to Iraq exceeded 240 thousand tons. These figures demonstrate Iraq's dominant role in absorbing Türkiye's poultry meat output and highlight the high degree of export concentration in a single market. Following the onset of regional instability and the ISIS conflict, Turkish poultry meat exports to Iraq declined during 2014–2016, mirroring the broader contraction in bilateral trade. Nevertheless, exports recovered strongly after 2016, reaching approximately 300 thousand tons in 2017, which represented nearly 66% of Türkiye's total poultry meat exports (UN Comtrade, 2021, TUIK, 2022). Although export volumes fluctuated in subsequent years, Iraq consistently remained Türkiye's primary poultry meat export market. The strong co-movement between Türkiye's global poultry meat exports and exports to Iraq underscores the sensitivity of the sector to developments in the Iraqi market and reinforces the relevance of accurate monthly export forecasting for this trade relationship.

The impact of pricing on the amount of poultry meat exports is presented in Table 1. Logarithmic regression was used to estimate the correlation between price and amount of export, as well as the influence of price on amount of export. The Pearson correlation between price and amount of poultry meat export is 0.473, indicating a positive relationship between price and monthly amounts of poultry meat exports from Türkiye to Iraq. Moreover, the  $R^2$  value of 0.223 indicates that poultry meat prices explain 22.3% of the entire variation in the amount of its export. The low  $R^2$  value shows that there may be other critical variables that influence the quantity of poultry meat exported. Concerning the effect of price on export quantity, price significantly effects export quantity ( $p < 0,05$ ). The regression model also accurately forecasts the amount of exports. The price coefficient is 0.976, which means that if the price of poultry meat rises by 1%, monthly exports decrease by 0.98%, and vice versa.

Table 1. Regression analysis for amount of poultry meat and price

	Coefficients	Standard Error	t-value	P-value
Constant	17.111	0.100	171.121	0.000
Ln Price of Meat	-0.976	0.160	-6.115	0.000
F= 37.391; P-value = 0.000; $R^2 = 0.223$				

### 3.2. Application of ARIMA and ANN models to forecast the monthly export amount of products from Türkiye to Iraq

It has been shown that there is a strong relationship between Türkiye and Iraq, and that they are each a major agricultural trading partner of the other. ARIMA and ANN models were applied on the datasets to select the best model for forecasting the monthly amount of poultry meat exported from

Türkiye to Iraq between 2010 and 2020. The best model was then used to forecast the poultry meat export value from Türkiye to Iraq in 2021.

### 3.2.1. Application of ARIMA on poultry meat time series

The monthly average of poultry meat export value from Türkiye to Iraq is 28.02MM US dollar, with the highest value of poultry meat export in July 2013 at 59.2MM US dollar, and the lowest monthly value of export in June 2015 at 1.65MM US dollar. Moreover, Shapiro-Walk and Kolmogorov-Smirnov tests are used to determine the normality of the dataset. As shown in Table 2, the data is normal because the p-values of Shapiro-Walks and Kolmogorov-Smirnov are both greater than 0.05, indicating that the data is normal.

Table 2. Normality test for poultry meat exports dataset

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	Df	P-value	Statistic	df	P-value
Poultry Meat	0.043	120	0.200	0.991	120	0.531

After applying 192 different models to the data-set to find the best model, it is discovered that ARIMA (0,1,1) is the best model to forecast the value of poultry meat exports from Türkiye to Iraq from 2010 to 2020. The estimated model is statistically significant, as shown in (Table 3). As well as, the model's parameters are also statistically significant, as shown in (Table 4). Figure 1 showed the predicted value and actual values of poultry meat by using ARIMA (0,1,1).

Table 3. ARIMA Model Parameters

	Estimate	SE	T-test	P-value
MA1	0.650	0.067	9.672	0.000

Table 4. Model Statistics ARIMA (0,1,1)

R-squared	RMSE	MAPE	MAE	AIC
0.538	7987873.41	31.68	5829822.94	4640.36

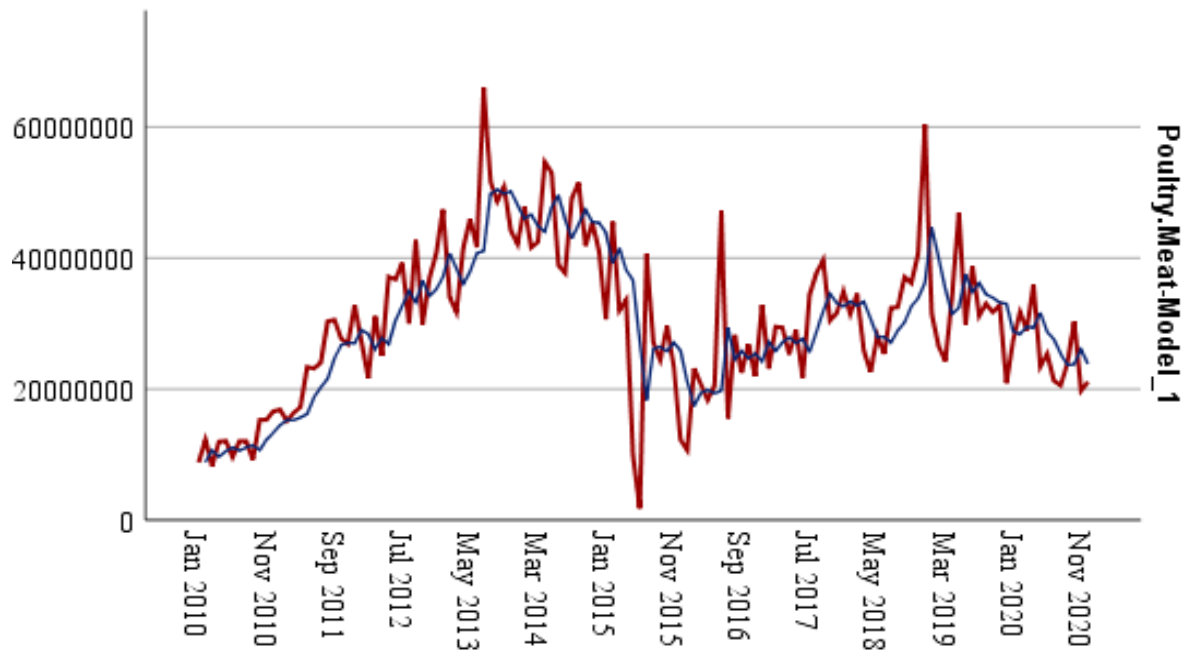


Figure 1. Predicted value and actual values of poultry meat by using ARIMA (0,1,1)

After identifying and estimating the candidate ARIMA (0,1,1) model, it must assess the model's fit to the data. This step in the model diagnostic checking process includes both parameter and residual analysis. Diagnostic testing of the residuals for the ARIMA (0,1,1) model using autocorrelation function (ACF) and partial autocorrelation function (PACF) plots for residuals, as shown in Figure 2, reveals that all ACF and PACF residuals values are statistically significant at the %95 confidence level. This indicates that the residuals are random white noise, and the model is appropriate for the data.

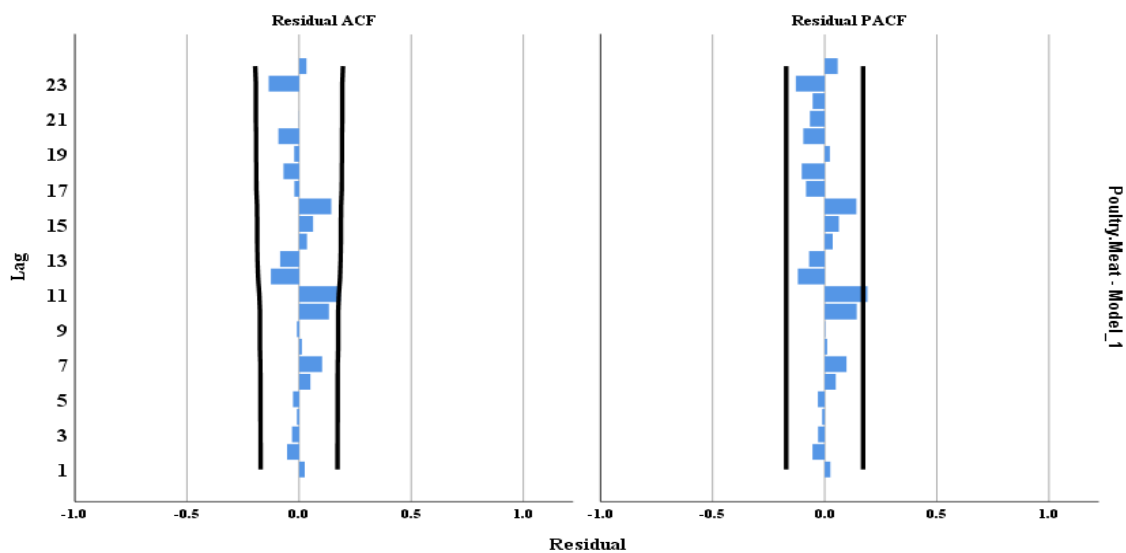


Figure 2. Residual ACF and PACF for ARIMA (0,1,1)

In the last step of model performance checking, the Box-Pierce test used to verify the correct user model and the residual autocorrelation test to see if there is any autocorrelation (Box & Pierce, 1970). The results of Box-Pierce show that the p-value for this test is 0.377 and it is significantly larger than 0.05, implying that the residuals have no significant autocorrelation and are therefore white noise. So, it concludes that the model ARIMA (0,1,1) is the best fit for the poultry meat export data because it passed model construction diagnostic tests.

Forward forecasting is the final step in time series analysis, which occurs after diagnosing the fitted model and selecting the best one. Based on the original data and the estimated model, the monthly value of Turkish poultry meat exports to Iraq in 2020 was forecasted, as shown in (Table 5).

Table 5. Actual and predicted value of Poultry meat export in 2020

Date	Actual	Forecast
Jan-20	27469720	28331045
Feb-20	31764546	29532833
Mar-20	28971582	29336385
Apr-20	35913954	31638653
May-20	23415599	28760435
Jun-20	25370267	27573815
Jul-20	21256354	25362589
Aug-20	20556719	23680447
Sep-20	23942896	23772309
Oct-20	30303357	26058294
Nov-20	19760828	23854067
Dec-20	21110889	22893905

Furthermore, the ARIMA (0,1,1) model was used to forecast the value of monthly poultry meat exports from Türkiye to Iraq in 2020. As illustrated in Figure 3, the plot demonstrates that predicted values in 2021 behave similarly to actual values, i.e., the predicted values converge to the actual values series.

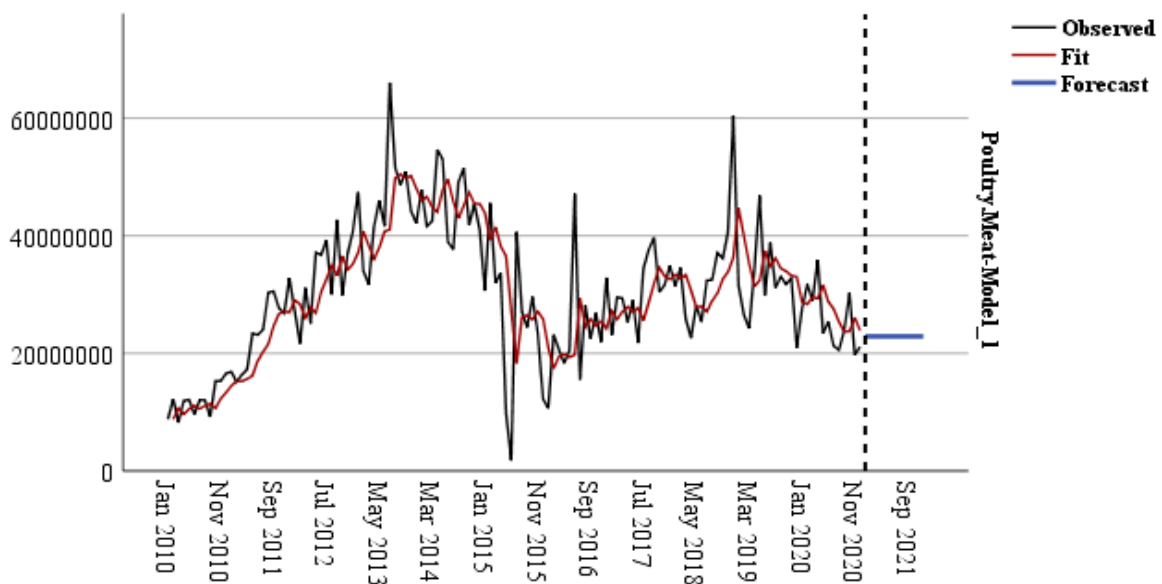


Figure 3. Predicted value of poultry meat export in 2021

### 3.2.2. Applying the artificial neural networks on poultry meat exports time series

According to Tang et al., (1991); Sharda and Patil (1992), and Khalil D.M. (2022), the total number of input neurons required in this model must be 12 because the data is monthly and there is no seasonality in the data. Then just one output unit is required. As mentioned previously trial and error is the most effective method for determining the ideal amount of concealed units. Here, 80% of the data was used as a training set, 10% as a validation set, and 10% as a test set. Logistics activation function has been applied in both the hidden and output layers. In order to discover the optimal ANN, the conjugate gradient descent algorithm was employed to train the network. In addition, 1000 iterations were performed with a single time retrain, with the learning rate set to 0.9 and the momentum set to 0.5.

After training the network multiple times and testing 399 different networks, which are given in the appendix G, it is founded that the best network has two hidden layers, with the first layer having 7 nodes and the second layer having 13 nodes. Figure 4 displays the structure of the desired network.

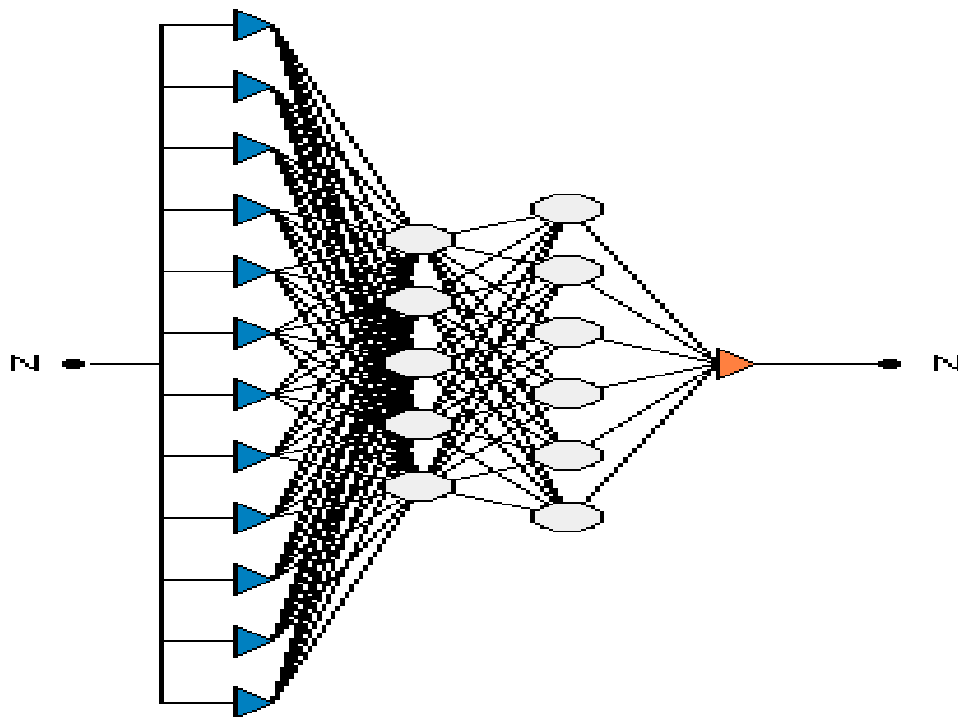


Figure 4. Architecture of FFNN (12:7:13:1) for predicting the poultry meat

The forecasting skills of the network were determined using statistical metrics such as MSE, MAE,  $R^2$  and AIC. The findings are summarized in (Table 6).

Table 6. FFNN (12:7:13:1) Model Results

R-squared	MAE	AIC	RMSE
0.72	3285382.16	1355.60	2819416.08

As well as, The FFNN's (12:7:13:1) predicted and actual values are showed in (Figure 5).

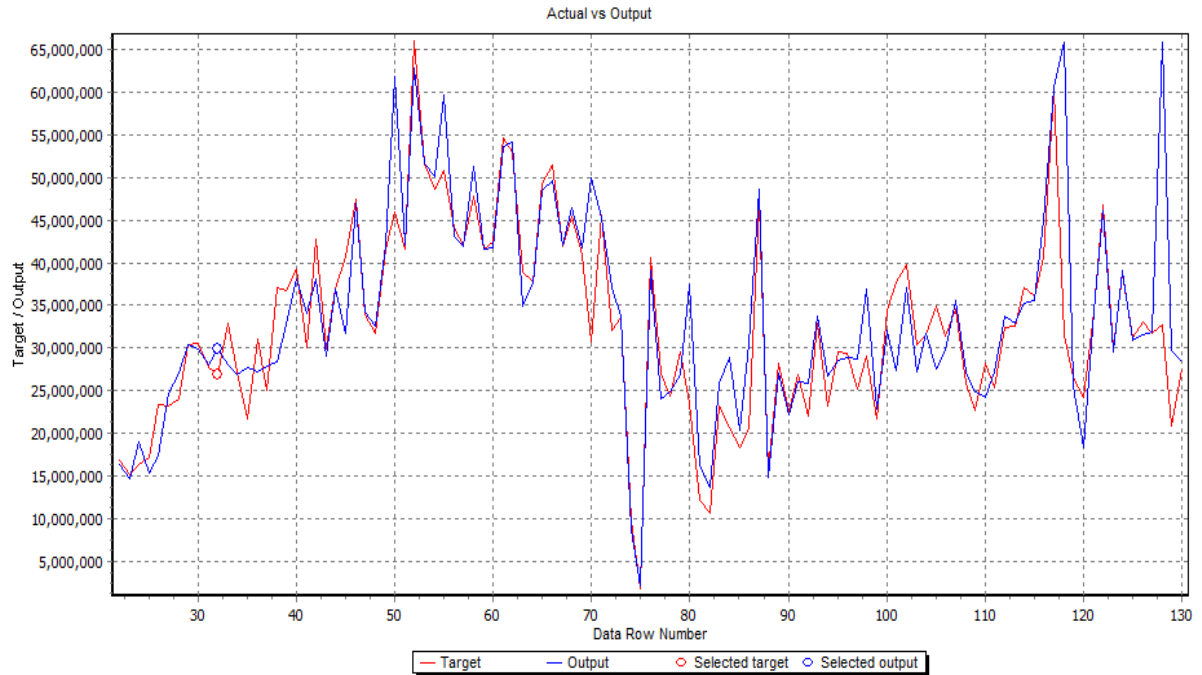


Figure 5. Predicted and actual values of poultry meat exports by FFNN (12:7:13:1)

Table 7 shows the actual and expected monthly values of poultry meat exported from Türkiye to Iraq in 2020 based on FFNN (12-7-13-1).

Table 7. FFNN (12-7-13-1) predicted and actual values of Poultry Meat

No.	Date	Actual	Forecast
1	Jan-20	27469720	27,829,075
2	Feb-20	31764546	31,765,838
3	Mar-20	28971582	28,856,661
4	Apr-20	35913954	36,430,893
5	May-20	23415599	22,912,963
6	Jun-20	25370267	24,596,482
7	Jul-20	21256354	21,417,928
8	Aug-20	20556719	21,021,318
9	Sep-20	23942896	24,143,134
10	Oct-20	30303357	30,551,653
11	Nov-20	19760828	19,894,633
12	Dec-20	21110889	16,300,310

Moreover, Figure 6 shows the predicted value of monthly poultry meat exports from Türkiye to Iraq from 2010 to 2021.

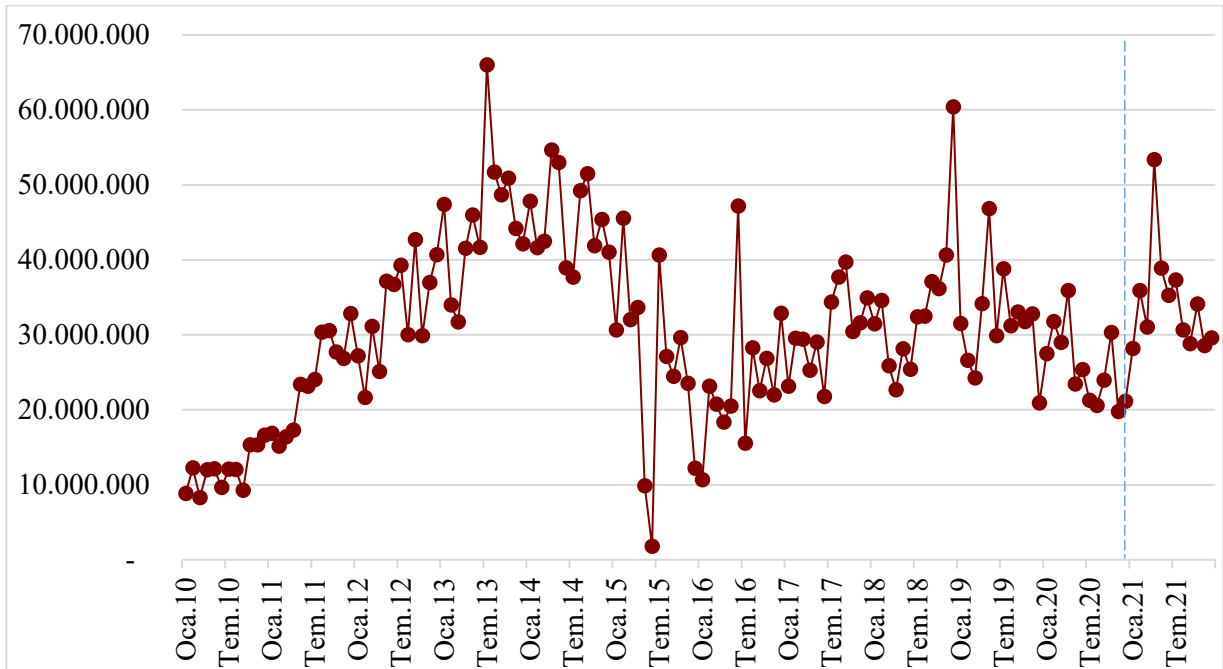


Figure 6. Predicted values of poultry meat exports by using FFNN in 2021.

### 3.3. Comparison of ARIMA and FFNN Results

After using the FFNN and ARIMA models to forecast the amount of monthly exports of poultry meat from Türkiye to Iraq, the next step was comparing the results to determine the best model. There are some conclusions obtainable from the previous results, the main ones being:

1. Because the MAE value of the FFNN models for the poultry meat export is less than the MAE value of the ARIMA models, the FFNN model fit better than the ARIMA model.

Table 8. Comparison of the MAE value of both models (Table 8)

Model	Poultry Meat
MAE of FFNN	3285382.16
MAE of ARIMA	5829822.94

2. In terms of model error, when the RMSE value of the two models is compared, it is clear that the FFNN model have less error than the ARIMA model (Table 9).

Table 9. Comparison of the RMSE value of both models

Model	Poultry Meat
RMSE of FFNN	2819416.08
RMSE of ARIMA	7987873.41

3.  $R^2$  is another measure used to compare the FFNN models and ARIMA. The results clearly show that the  $R^2$  value of the FFNN model is higher than the  $R^2$  value of the ARIMA model (Table 10).

Table 10. Comparison of the  $R^2$  value of both models

Model	Poultry Meat
$R^2$ of FFNN	0.720
$R^2$ of ARIMA	0.538

4. Because the AIC values of the FFNN model is much lower than those of the ARIMA model, the FFNN model is significantly superior to the ARIMA model in terms of goodness of fit. This means that the FFNN model outperform the ARIMA model (Table 11).

Table 11. Comparison of the AIC value of both models

Model	Poultry Meat
AIC of FFNN	1355.60
AIC of ARIMA	4640.36

5. When both models are used for prediction, the results show that the FFNN models are more accurate and have less error than the ARIMA models, as shown in the Table 12.

Table 12. Predicted and actual values of poultry meat exports

Date	Actual	Forecast by FFNN (12:7:13:1)	Forecast by ARIMA (0,1,1)
Jan-20	27469720	27,829,075	28,331,045
Feb-20	31764546	31,765,838	29,532,833
Mar-20	28971582	28,856,661	29,336,385
Apr-20	35913954	36,430,893	31,638,653
May-20	23415599	22,912,963	28,760,435
Jun-20	25370267	24,596,482	27,573,815
Jul-20	21256354	21,417,928	25,362,589
Aug-20	20556719	21,021,318	23,680,447
Sep-20	23942896	24,143,134	23,772,309
Oct-20	30303357	30,551,653	26,058,294
Nov-20	19760828	19,894,633	23,854,067
Dec-20	21110889	16,300,310	22,893,905

Figures 7 proves that in terms of poultry meat, forecast values produced by both methods follow the actual values, but the FFNN model values seem to have a superior forecasting performance in comparison to the ARIMA model, confirming the FFNN model' prediction and accuracy for these data.

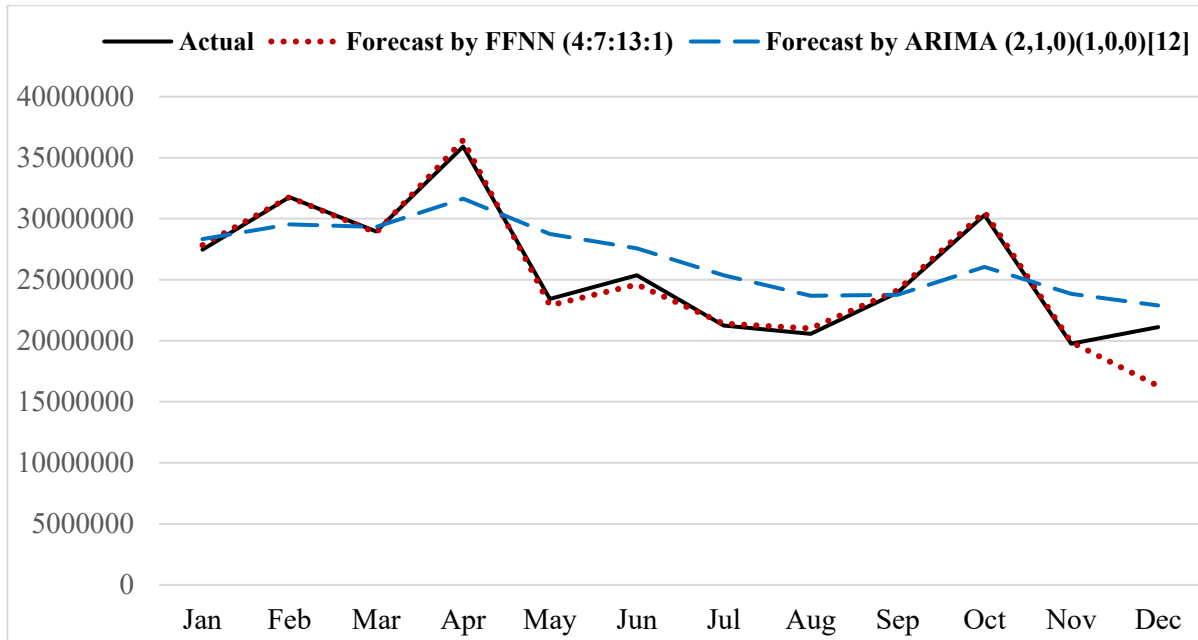


Figure 7. Actual and predicted values of poultry meat exports in 2020 using FFNN and SARIMA models.

### 3. CONCLUSIONS AND RECOMENDATIONS

This study compared the forecasting performance of traditional time series models and ANN models for Türkiye's monthly poultry meat exports to Iraq over the period 2010–2020. The results indicate that poultry meat exports exhibit substantial volatility, seasonality, and structural changes, largely reflecting economic conditions and political developments in the region. In particular, the sharp decline in exports during the 2014–2016 period confirms the sensitivity of Turkish poultry meat exports to regional instability, while the strong recovery observed after 2016 highlights the resilience and strategic importance of the sector.

Empirical findings show that although the ARIMA model is capable of capturing the general linear structure of the poultry meat export series, its forecasting accuracy is limited when nonlinear patterns and abrupt changes are present. In contrast, the FFNN model demonstrated superior forecasting performance, yielding lower error measures (MAE and RMSE) and better goodness-of-fit indicators. These results suggest that ANN-based models are more effective in modeling the complex dynamics of poultry meat exports, particularly in markets characterized by high uncertainty and demand fluctuations such as Iraq.

The dominance of Iraq as Türkiye's primary poultry meat export destination further reinforces the importance of accurate forecasting. Throughout the study period, Iraq consistently accounted for a substantial share of Türkiye's poultry meat exports, exceeding 50% in most years and reaching nearly two-thirds of total exports at its peak. This high degree of market concentration implies that shocks in the Iraqi market can have immediate and significant effects on Türkiye's poultry sector. Therefore, reliable monthly forecasts are essential for exporters, producers, and policymakers to anticipate demand changes and mitigate potential risks.

Based on these findings, several policy and practical recommendations can be drawn. First, exporters and industry stakeholders should integrate nonlinear forecasting tools, such as ANNs, into their planning and decision-making processes to improve demand anticipation and inventory management. Second, policymakers should consider strategies aimed at export market diversification to reduce dependency on a single destination and enhance the sector's resilience to external shocks. Finally, future research may extend the present analysis by incorporating exogenous variables—such as exchange rates, feed prices, or trade policy changes—or by applying advanced deep learning models to further improve forecasting accuracy.

Overall, this study contributes to the agricultural trade forecasting literature by providing product-specific evidence that ANN models outperform traditional time series approaches in forecasting Türkiye's poultry meat exports to Iraq, and by highlighting the critical role of accurate forecasting in supporting sustainable export growth.

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