**Gaziosmanpaşa Üniversitesi Ziraat Fakültesi Dergisi**
*Journal of Agricultural Faculty of Gaziosmanpasa University*
http://ziraatdergi.gop.edu.tr/

Araştırma Makalesi/*Research Article*

JAFAG
ISSN: 1300-2910
E-ISSN: 2147-8848
(2018) 35 (2), 147-151
doi:**10.13002/jafag4309**

# Use of Neural Network Model to Predict of Egg Yield

**Çiğdem TAKMA[1]* Yakut GEVREKÇİ[1]**
[1]Department of Animal Science, Faculty of Agriculture, University of Ege, Bornova, İzmir
(orcid.org/ 0000-0001-8561-8333); (orcid.org/ 0000-0002-4915-2238)
*e-mail: cigdem.takma@ege.edu.tr

Alındığı tarih (Received): 25.05.2017 Kabul tarihi (Accepted): 31.01.2018
Online Baskı tarihi (Printed Online): 17.07.2018 Yazılı baskı tarihi (Printed): 29.08.2018

**Abstract:** A neural network is a mathematical model of information processing based on the work of the human brain. An artificial neural network (ANN) is composed of a number of simple processing elements connected together in a network. In this study, the egg yield was predicted based on the individually collected hatching period, line, body weight (BW), age at sexual maturity (ASM) and body weight at sexual maturity (BWSM) records of layers using neural network model. A multilayer perceptron (MLP) ANN model trained by back propagation algorithm is developed for feed-forward neural network learning. From the available data set, training and testing sets were extracted. Goodness of fit of the model was determined with the coefficient of determination ($R^2$), root mean square error (RMSE) and Mean Absolute Deviation (MAD) values. The $R^2$ for training and test sets were estimated to be 0.80 and 0.82, respectively. Lower RMSE and MAD values were obtained. The empirical result shows that neural network can be used for the prediction of egg yield.

**Keywords:** Neural network, coefficient of determination, layer, egg yield, multilayer perception

# Yapay Sinir Ağları ile Yumurta Veriminin Tahmini

**Öz:** Sinir ağı, insan beyninin çalışmasına dayanan bilgi işlemenin matematiksel bir modeldir. Yapay sinir ağı (YSA), bir ağda birbirine bağlanan bir takım basit işlem öğelerinden oluşur. Bu çalışmada, yapay sinir ağı modeli kullanılarak yumurtacılarda bireysel olarak toplanan kuluçka dönemi, sıra, canlı ağırlık, eşeysel olgunluğa ulaşma yaşı ve eşeysel olgunluk ağırlığı ölçümlerine dayanılarak yumurta verimi tahminlenmiştir. İleri geribildirim algoritması tarafından eğitilen çok tabakalı yapay sinir ağı modeli, ileri beslemeli sinir ağı öğrenmesi için kullanılmıştır. Mevcut veri seti eğitim ve test seti olmak üzere iki kısma ayrılmıştır. Modelin iyi uyumunun belirlenmesinde belirleme katsayısı ($R^2$), hata kareler ortalamasının karekökü (RMSE) ve ortalama mutlak sapma (MAD) kriterleri kullanılmıştır. Eğitim ve test seti için $R^2$ değeri sırasıyla 0.80 ve 0.82 olarak tahminlenmiştir. Çalışmada düşük RMSE ve MAD değerleri elde edilmiştir. Uygulama sonucuna göre yumurta üretiminin tahmininde yapay sinir ağı kullanılabileceği belirlenmiştir.

**Anahtar Kelimeler:** Yapay sinir ağları, belirleme katsayısı, yumurtacı, yumurta verimi, çok katmanlı ağ

## 1. Introduction

The aim of poultry breeding is to produce layers with higher egg laying ability, lower body weight and reaching sexual maturity at an early age. There is a high correlation between the amount of eggs obtained in the first week and the age of sexual maturity. When choosing high yielding individuals at the beginning of the breeding period, they have also indirectly selected individuals who reached at early sexual maturity (Tijen, 1982). Despite selection studies, egg yield is influenced with many factors such as age, temperature, illumination, nutrition, disease and genetic structure (Ünver, 2000).

The development of an automation system based on prediction of egg yield and classification with artificial neural network (ANN) models will benefit the egg industry (Lin et al., 2011; Mehdizadeh et al., 2014). ANN models are commonly used in poultry researches (Sefat et al., 2014; Amraei et al., 2017). ANN is the one of the machine learning technique which has the ability to get relationships between several variables (Gianola et al., 2011). This computer system performs the abilities of learning and discovering new information through properties of the human brain. These capabilities of the artificial neural network system have been improved by taking biological structure of human (Fausett, 1994). Artificial neural networks are able to produce solutions by learning from existing examples that are available for linear or nonlinear relationships between input and output for any event. For this reason, the algorithmic solution has increased its use in solving unexplained problems.

Recently, ANNs have been applied to analyze data in poultry experiments such as prediction of egg yield curves (Ahmadi and Golian, 2008; Savegnago et al., 2011; Ghazanfari et al., 2011; Cruz et al., 2013; Felipe et al., 2015), weight (Faridi et al., 2013) and numbers of egg (Semsarian et al., 2013). Ahmadi and Golian (2008) aimed to evaluate the fitness of the ANN model to two sets of empirical weekly data obtained from the first and the second cycle of egg yield. They concluded that the ANN model with high adjusted $R^2$ may provide an effective mean to draw the pattern of egg yield. Ghazanfari et al. (2011) used ANN to predict egg yield of pullet and hen flocks. They learned the relationship between the age of hen and egg yield. The ANN model provided an effective means of recognizing the patterns in data and accurately predicting the egg yield of laying hens based on investigating their age. Savegnago et al. (2011) analyzed annual egg yield of White Leghorn strains by using Logistic and Neural Network models. They concluded that the ANN models could be used as an alternative tool to fit egg yield. Cruz et al. (2013) used multilayer perceptron neural networks to learn to predict the breeding values for total egg yield. The results suggest that ANN could be efficient to predict the breeding values for total egg yield using phenotypic measurements of the birds and the family information. Felipe et al. (2015) compared multiple linear regression and artificial neural network for prediction of total egg yield in meat type quails. Faridi et al. (2013), predicted egg weight in broiler breeder hens by ANN models. According to goodness of fit statistical criteria, the ANN based models could effectively estimate egg weight in broiler breeder hens.

With traditional approaches such as multiple regression and various classification methods, it is only possible to reveal the relationship and importance levels between egg production and related traits. However, these approaches are insufficient for future prediction of egg yield. The ANN takes into account nonlinearities in the relationship between independent and dependent traits. It is a flexible technique with regard to changing independent and dependent values of traits, interpolation capabilities and fault tolerance (Zhang et al., 2007). The objective of this study was to predict egg yield using several predictor variables as hatching period, line, body weight (BW), age at sexual maturity (ASM) and weight at sexual maturity (BWSM) by an ANN model against other mentioned methods.

## 2. Material and Method

Egg yield records from six generations of artificially inseminated commercial sire line (L1) were used as a data set. Total of 1955 layers from 43 sires and per sire 8 dams at four hatching periods were utilized in the analysis. The period of data collection was extended from the $22^{nd}$–$40^{th}$ week of age that known as early part of record. Eggs were collected daily and individually.

Data sets obtained from the experiments were used for training and testing the neural networks. A multilayer perceptron (MLP) ANN model trained by back propagation algorithm is proposed for feedforward neural network learning with hatching period, line, BW, ASM and WSM inputs. The data set (1955 layers) was divided randomly into two parts: training and testing sets: 75% of records (1466) were used for training and 25% records (489) were used as a testing data set. As an activation function the hyperbolic tangent was used.

The ANN model was analyzed simulated in JMP (Release 5.0.1a, SAS Institute, Inc., 2002).

Quantitative examination of the predictive ability of model was done by coefficient of determination ($R^2$), Root Mean Square Error (RMSE), and Mean Absolute Deviation (MAD) for both training and test sets. The higher $R^2$, lower RMSE, and lower MAD values show the acceptable goodness of fit for the model. The RMSE, and MAD values were obtained by as given below:

$$RMSE = \sqrt{\frac{\sum_{i=1}^{n}(y_i - \hat{y_i})^2}{n}} \quad [1]$$

$$MAD = \frac{\sum_{i=1}^{n}|y_i - \hat{y_i}|}{n} \quad [2]$$

In the formulas n, number of records; p, independent variables; $y_i$, observation and $\hat{y_i}$, predicted values for training and test sets.

Finally repeated experiments in ANN with test set, the number of hidden layers was appropriated one and the number of hidden nodes in this layer was taken as 37. The sigmoid activation function that commonly used function was used between the layers. The convergence criterion is $1.10^{-6}$, the maximum number of iterations is 50 and 20 epoch are taken for termination of the algorithm in each run. The studied model was given in Figure 1.

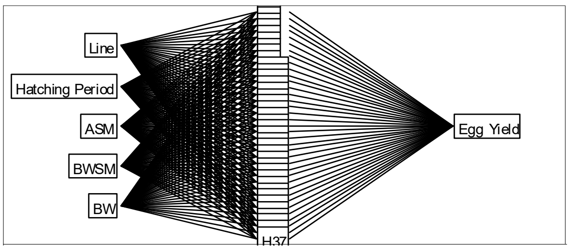


**Figure 1.** Studied model for egg yield
***Şekil 1.*** *Yumurta verimi için model çalışması*

**3. Results and Discussion**

Performance criteria of ANN models for training and test sets were summarized in Table 1. The neural net modeling performance results for egg yield (response variable) from hatching period, line, BW, ASM and BWSM (input variables) show good fit (Table 1).

The $R^2$ value of ANN model for training set reached 0.80 and for test set was reached 0.82. The ANN model for the test set gave higher $R^2$ values than training set. Moreover, the ANN models were similar at RMSE values (0.45). MAD values had also similar pattern with RMSE values (Table 1). The importance of this findings explained that ANN properly learned the relationship between the input and output parameters for predicting egg production.

**Table 1.** Performance criteria results for neural net modeling
***Çizelge 1.*** *Yapay sinir modellemesi için performans kriteri sonuçları*

| Data set | SSE | SSE Scaled | $R^2$ | MAD | RMSE |
|---|---|---|---|---|---|
| Training | 49076.64 | 286.76 | 0.80 | 4.817 | 0.448 |
| Test | 14836.22 | 90.14 | 0.82 | 3.353 | 0.447 |

Ghazanfari et al. (2011), Savegnago et al. (2011) and Faridi et al. (2013), reported higher $R^2$ values and lower RMSE than our findings. Ahmadi and Golian (2008) reported $R^2$=0.99 for first and second cycle egg yields but higher RMSE values for the first (0.54) and the second cycles (0.69) than our results. Cruz et al., (2013) obtained the higher results than our reports with $R^2$ (0.29-0.87) while the MSE decreased.

These observations are in agreement with the results that ANN method alternative and sufficient method for the estimation of future egg production. Actual versus predicted plots for training (a) and test (b) data set were given in Figure 2.

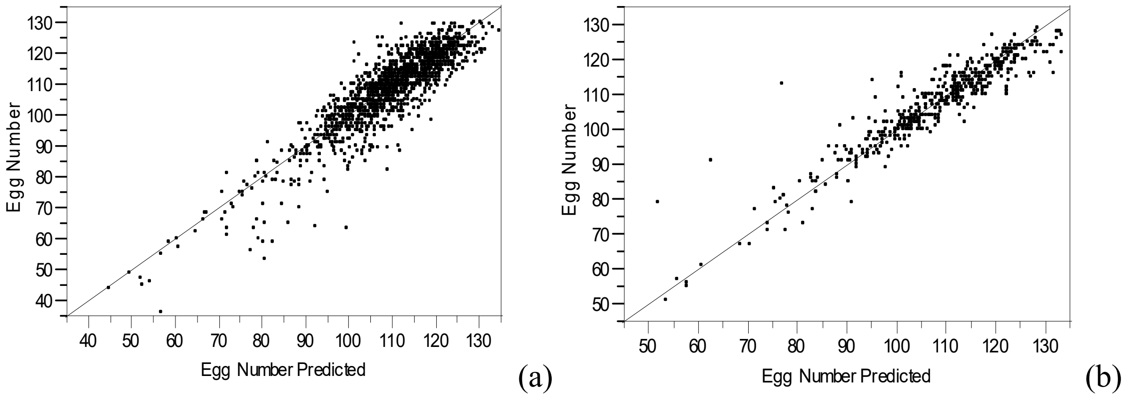


**Figure 2.** Actual by predicted plot for training (a) and test (b) data sets

***Şekil 2.*** *Eğitim (a) ve test (b) veri setleri için gerçek değerlerle tahmin değerlerinin grafiği*

## 4. Conclusions

The present study was conducted to predict egg yield of laying chickens by using ANN model. ANN model which was examined are performed in this paper had higher prediction accuracy between actual and predicted data. Although, test set have higher $R^2$ values than training set they both have acceptably high values. in ANN model. Therefore it can be said that, ANN models were one of the powerful tools to prediction of egg yield. Besides, ANN models could be used as an alternative tool to predict yield from early part of egg yield as a selection criterion to improve to rest of the egg production period.

On the other hand, multilayer and multineuron structures are needed in using artificial neural networks to solve complex problems. Although this is a disadvantage when using neural networks, but today high performance fast computer systems with more accelerated CPUs, GPUs and developing computer technology overcome his problem.

## References

Ahmadi H, Golian A (2008). Neural network model for egg production curve. Journal of Animal and Veterinary Advances, 7:1168-1170.

Amraei S, Mehdizadeh S A, Salari S (2017). Broiler weight estimation based on machine vision and artificial neural network. Britsh Poutry Science, 58(2): 200-205.

Cruz V A R, Savegnago R P, Schmidt G S, Ledur M C, Munari D P (2013). Neural networks on predict breeding values of egg production using phenotypic information. 10th World Congress of Genetics Applied to Livestock Production Proceedings.

Faridi A, France J, Golian A (2013). Neural network models for predicting early egg weight in broiler breeder hens. Journal of Applied Poultry Research, 22:1-8.

Fausett L (1994). Fundamentals of Neural Networks: Architectures, Algorithms and Applications, USA, Prentice Hall.

Felipe V P, Silva M A, Valente B D, Rosa G J (2015). Using multiple regression, Bayesian networks and artificial neural networks for prediction of total egg production in European quails based on earlier expressed phenotypes. Poultry Science, 94(4):772-80.

Ghazanfari S, Nobari K, Tahmoorespur, M (2011). Prediction of egg production using artificial neural network. Iranian Journal of Animal Science, 1(1): 11-16.

Gianola D, Okut H, Weigel K A, Rosa G J M (2011). Predicting complex quantitative traits with Bayesian neural networks: a case study with Jersey cows and wheat. BMC Genetics, 12:87.

Lin H, Zhao J, Sun L, Chen Q, Zhou F (2011). Freshness measurement of eggs using near infrared (NIR) spectroscopy and multivariate data analysis. Innovative Food Science & Emerging Technologies, 12(2): 182-186.

Mehdizadeh S A, Minae S, Hancock N H, Torshizi M A K (2014) An intelligent system for egg quality classification based on visible-infrared transmittance spectroscopy. Information Processing in Agriculture, 1(2): 105-114.

Savegnago R P, Nunes B N, Caetano S L, Ferraudo A S, Schimidt G S, Ledur M C, Munari D P (2011). Comparison of logistic and neural network models to fit the egg production curve of White Leghorn hens. Poultry Science, 90:2174-2188.

Sefat M Y, Borgaee A M, Beheshti B, Bakhoda H (2014). Application of Artificial Neural Network (ANN) for Modelling the Economic Efficiency of Broiler Production Units. Indian Journal of Science & Technology, 7(11):1820-1826.

Semsarian S, Nasab M P E, Zarehdaran S, Dehghani A A (2013). Prediction of the weight and number of eggs in Mazandaran native fowl using artificial neural network.

International Journal of Advanced Biological and Biomedical Research, 5:532-537.
Tijen W F (1982). Yumurta sektöründe uygulamalı tavuk ıslahı. Uluslar arası Bilimsel Tavukçuluk Kongresi, 53-71, Ankara.
Ünver Y, Oğuz İ, Akbaş Y (2000). Yumurtacı Damızlıklarda Kısmi Yumurta Verim Kayıtlarına Ait Parametre Tahminleri. Ege Üniversitesi Fen Bilimleri Enstitüsü Yüksek Lisans Tezi.
Zhang Z, Wang Y, Fan G, Harrington P B (2007). A comparative study of multilayer perceptron neural networks for the identification of rhubarb samples. Phytochem. Anal. 18:109–114.