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Research Paper

Analysis of the rabbit population in Ukraine with the use of Artificial Neural Network

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ABSTRACT
In this study, the use of artificial neural networks (ANN) method was designed to establish an appropriate model for the rabbit population in Ukraine by years and to create predictions. In the development of ANN, the variable of years was used as an input parameter and the variable of the population of rabbits was used as an output parameter. The efficiency of the created model was checked with the statistical processes of Mean Square Error (MSE) and Mean Absolute Error (MAE). The results predict that the number of rabbits will increase in the period of 2020-2025. The ANN model gave good results in making estimations about the animal presence.
KEYWORDS: *Artificial neural network, forecasting, rabbit*

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I. INTRODUCTION

Rabbits, which are mostly bred as experimental animals and for their flesh; are animals that mainly grow and reproduce rapidly, and which turn the herbal wastes (which are not consumed by humans) into high-quality white meat. Rabbits are easy to care for, and they are produced intensively in small areas, and it is a livestock branch where the workforce of all ages can be utilized. Besides the fact that these animals can be produced in intensive conditions, rabbit production activities have also intensified globally in recent years due to the facts like their conformity to family business [1].

Although it is a little difficult in rabbit breeding to precisely classify a breed using a classification made according to yield aspects, the primary goal is meat production. However, the breeds to be preferred must be; early maturating medium breeds such as New Zealand; a combined breed such as Angora rabbit when it is intended to be bred for both meat and wool; and the breeds of chinchilla and rex if it is bred for its fur [2].

Angora Rabbit is a breed mainly bred for its wool in Turkey. According to Nachtsheim, in 1723, they were brought by English sailors to France and England from the countries at the Black Sea region, and they were bred there [3]. Although China is the most important Angora Rabbit wool producer country today, significant quantities of Angora Rabbit wool are also produced in South America and European countries [4].

The threat of hunger, which is inevitable to be encountered in the future, requires effective evaluation of existing food sources, and also requires the search for new food sources [5]. Rabbit is a very beneficial animal for human nutrition and livelihood. Rabbit meat is very tasty and nutritious. It is far more superior to chicken or pork in terms of protein, and its mineral content is almost twice as much as these [6]. Considering the pastures as the mere breeding environment, the possibilities of increasing the population of cattle and sheep are limited. Therefore, it appears that pet production has great potential as an option to meet the meat requirement [7].

According to FAO's 2019 data, there are 299 945 000 rabbits on earth. The countries with the largest rabbit populations in the world are China, the Democratic People's Republic of Korea, Nigeria, Ukraine and Egypt, respectively [8]. In China, where the largest amount of rabbit breeding is carried out in the world, there is a total quantity of 232 695 000, which meets 77.58% of the world rabbit production.

In this study, with the use of the artificial neural network, it is aimed to make modeling and predictions regarding the population of rabbits in Ukraine, which has the fourth-largest rabbit population in the world.

II. MATERIAL AND METHOD

Material

The material of the research is 1992-2019 number of horses values supplied from the Food and Agriculture Organization of the United Nations [8]. The dependent variable was number of rabbits figures while the independent variable was year series. These variables were selected in order to be able to make reasonable estimations with the models to be performed using artificial neural network method.

Method

The artificial neural network is a flexible mathematical model developed by inspiring from the working principles of the human brain [9]. There are three components in the structure of the artificial neural network: neuron, connections and learning algorithm. The neuron is the fundamental processing element of an artificial neural network. According to the number of factors affecting the problem, the neurons in the network receive one or more inputs, and in the number of results expected from the problem, they give outputs. In a common artificial neural network system, the neurons gather in the same direction creates the layers [10].

In an artificial neural network, there are three layers of interconnected nerve cells. These layers are; input layer, output layer and hidden layer. The input layer provides the intake of external data to the artificial neural network. The input layer consists of the parameters that affect the problem and the number of neurons in the input layer is shaped by the number of parameters. The output layer provides the transmission of information to the outside. And the other layer in the model is a hidden layer situated between the input layer and the output layer [11]. Besides that, the other important elements of the artificial neural networks are the functions of addition and activation [12].

The addition function calculates the net input coming inside the cell. The weighted sum function used for the function of addition is formulated as follows.

$$NET = \sum_{i}^{N} G_i A_i$$

Here, G refers to the inputs, A refers to the weights, and N refers to the number of inputs (process elements).

The activation function is a nonlinear mapping function between input and output. One of the most widely used activation functions is the hyperbolic tangent activation function. This function is calculated like follows:

$$F(NET) = \frac{(e^{NET} - e^{-NET)}}{(e^{NET} + e^{-NET})}$$

[13].

The detection of the performance of an ANN model is usually made by Mean Square Error (MSE) and Mean Absolute Error (MAE). MSE is calculated as follows [14].

$$MSE = \frac{\sum_{i=1}^{n}\left(Y_i - \hat{Y}_i\right)^2}{n}$$

And MAE is calculated as follows.

$$MAE = \frac{\sum_{i=1}^{n}\left|Y_i - \hat{Y}_i\right|}{n} = \frac{\sum_{i=1}^{n}|\varepsilon_i|}{n}$$

Here Y_i: Are the observed values of the dependent variable, $\hat{Y}$: Are the estimated values of the dependent variable, and n is the number of observations.

III. FINDINGS AND DISCUSSION

ANN method was used to make a good estimation of the population of rabbits. The quantities of the input, hidden and output layers of ANN were determined as 1-8-1 respectively, and it was applied with Back Propagation Learning using 1000 iterations. The hyperbolic tangent activation function was used. For ANN, MSE = 92384.310 and MAE = 251.356. The residual values, along with the estimated and observed values during ANN application, are given in Table 1.

Table 1. Actual, predicted and residual values (1000)

	Actual	Predicted	Residual
1992	6196.0000	NaN	NaN
1993	6795.0000	6131.6925	663.3075
1994	6891.0000	6553.0991	337.9009
1995	6768.0000	6599.2441	168.7559
1996	6367.0000	6539.1480	-172.1480
1997	5845.0000	6276.2488	-431.2488
1998	5423.0000	5790.0395	-367.0395

1999	5673.0000	5373.3754	299.6246
2000	5600.0000	5614.7124	-14.7124
2001	5557.0000	5541.7347	15.2653
2002	5912.0000	5499.5510	412.4490
2003	6182.0000	5858.1613	323.8387
2004	5367.0000	6119.0747	-752.0747
2005	5219.0000	5323.5354	-104.5354
2006	5436.0000	5201.6186	234.3814
2007	5199.0000	5385.2095	-186.2095
2008	5136.0000	5186.3129	-50.3129
2009	5387.0000	5139.9961	247.0039
2010	5621.0000	5341.1176	279.8824
2011	5355.0000	5562.5711	-207.5711
2012	5643.0000	5313.1062	329.8938
2013	5658.0000	5584.5437	73.4563
2014	5461.0000	5599.6006	-138.6006
2015	5141.0000	5408.2315	-267.2315
2016	5043.0000	5143.5661	-100.5661
2017	4940.0000	5076.9350	-136.9350
2018	4770.0000	5014.4218	-244.4218
2019	4700.0000	4927.2339	-227.2339

The graph of the actual and estimated values as a result of the ANN application is given in Figure 1, and the graph of the residual values is given in Figure 2.

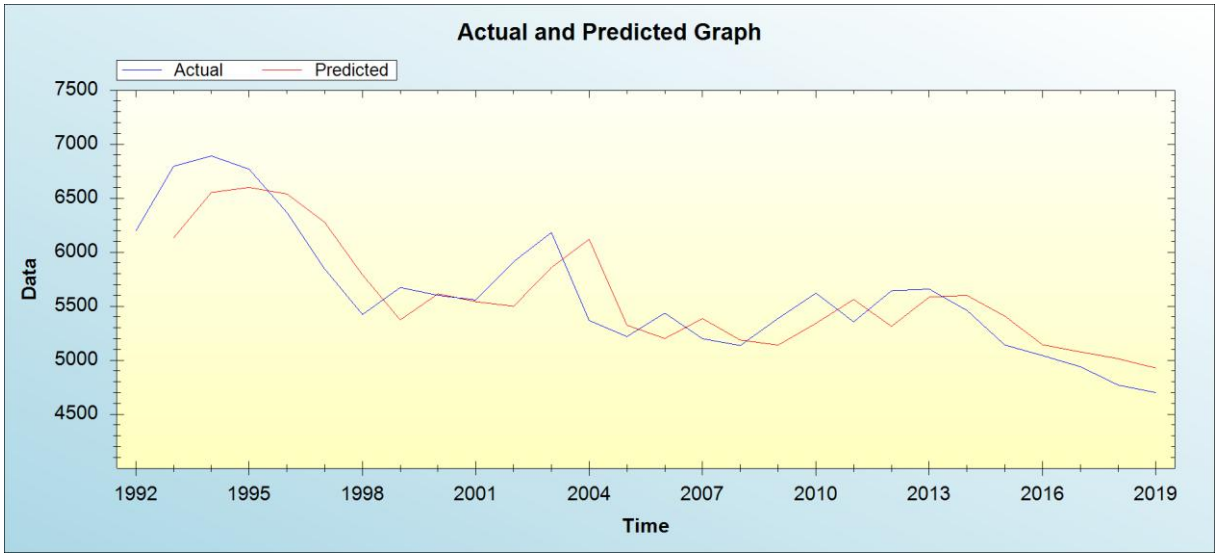

Figure 1. The combined graph of observed and predicted values for number of rabbits

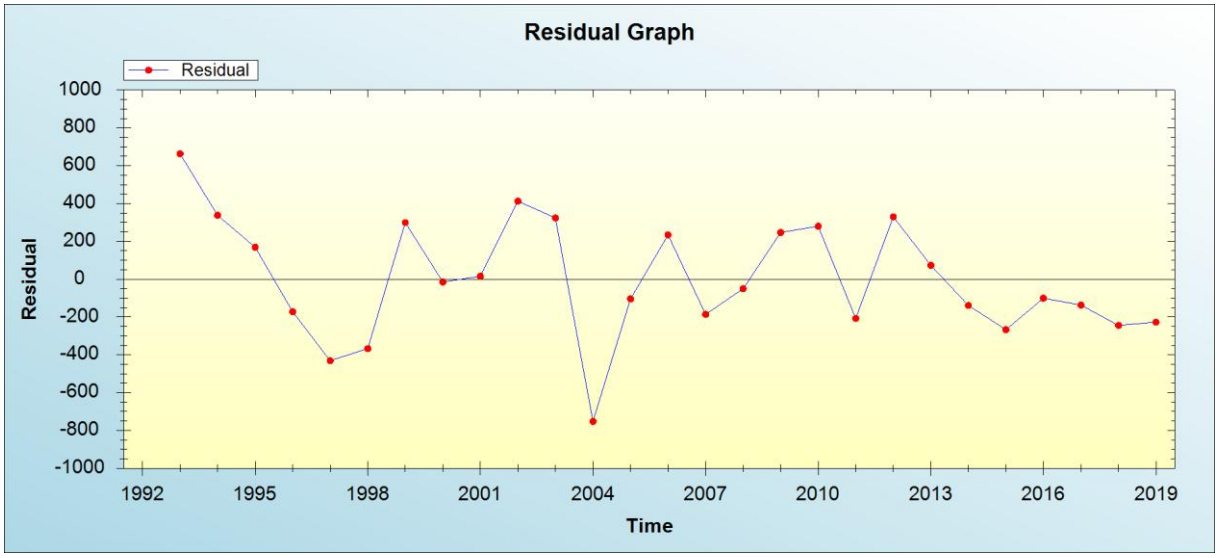

Figure 2. Graph of residual values

In Figure 3, the joint graph of observed and residual values was monitored, and it was seen that the residual and observed values were independently and randomly distributed. This demonstrates that the important hypotheses of the model are met.

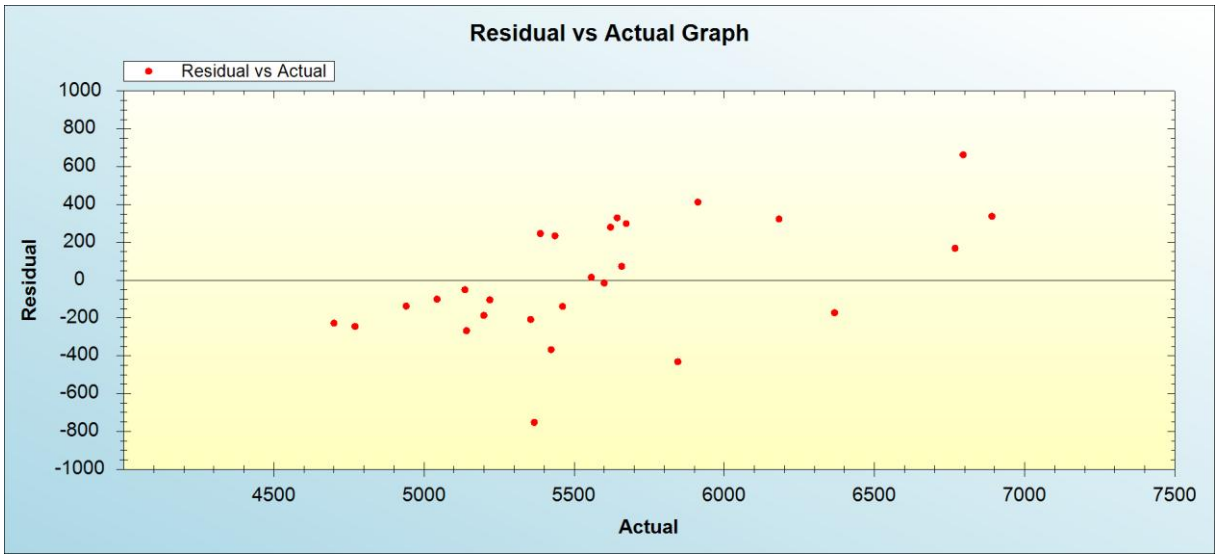

Figure 3. Joint graph of actual and residual values

The forecast for the population of rabbits for the period 2020-2025 is given in Table 2 and Figure 4.

Table 2. Number of rabbits forecasting according to ANN method

Years	Forecasting
2020	4 896 672
2021	4 990 364
2022	5 044 039
2023	5 077 605
2024	5 099 659
2025	5 114 599

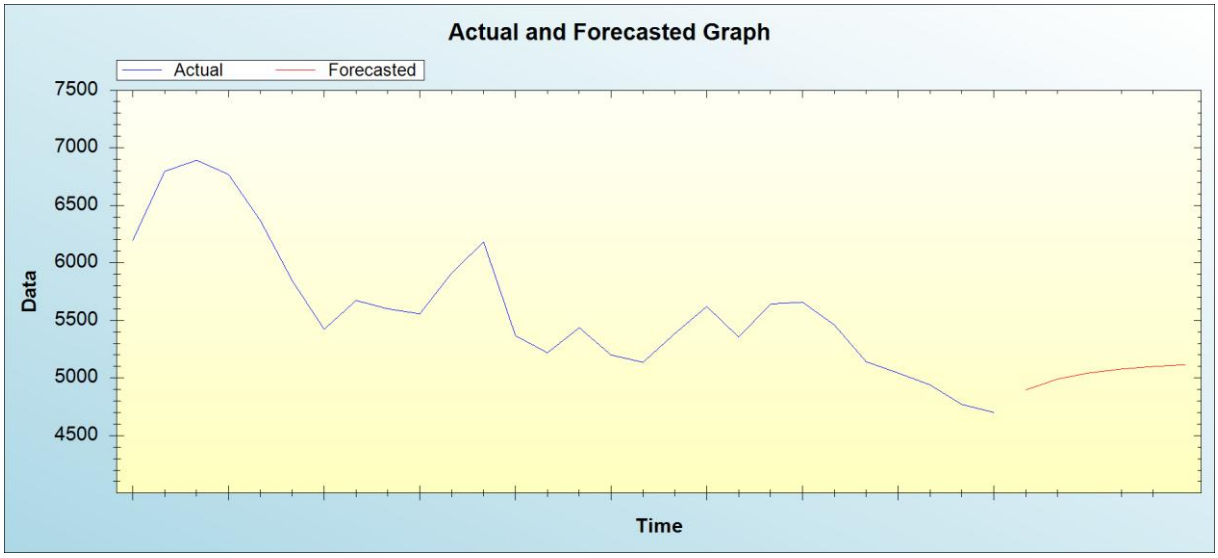

Figure 4. The joint graph of observed and estimated values

In a study, the effects of environmental temperature on viability, growth, body temperature and blood values were investigated in rabbits. Survival rate was higher in K (28.57%) under 30°C but it was better in New Zealand White (43.18%) under 10°C. While the body weights were 1680 and 1387.5 g under 30°C, those weights were 1237.37 and 994.29 g in 10°C room for New Zealand White and Californian, respectively. Body temperature has been effected by ambient temperature especially in New Zealand White. Under 10°C, the count of erythrocyte (4 548 420/mm3), reticulocyte (17 737/mm3), hematocrit value (35.89%) were found higher than 30°C (4 300 000/mm3; 16 100/mm3 and 34.40%) for New Zealand White [15]. Regarding forecasting in livestock, the number of pigs [16], mules [17], camels [18], donkeys [19] and horses [20] was studied and predicted.

IV. CONCLUSION

In this study, the population of rabbits in Ukraine was modeled with the application of an artificial neural network. The years as the input variables were (1992-2019), 1 independent variable was used, and the population of rabbits was used as the output variable. In the coming stage, the training, testing and verification processes of the network were carried out and the estimation process was carried out. Regarding the prediction in terms of the population of rabbits: It is predicted that this population, which was 4 700 000 in 2019, will increase by 8.82% and will reach 5 114 599 in 2025. In short, there will be an increase in the population of rabbits within the 2020-2025 period.

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