USE OF ARTIFICIAL NEURAL NETWORKS TO ESTIMATE PRODUCTION PARAMETERS OF BROILERS BREEDERS IN THE PRODUCTION PHASE[1]

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ABSTRACT

This paper reports the use of artificial neural networks to estimate performance parameters in production birds belonging to a South Brazilian poultry farm. The method supplies tools for the decisions made by the technical staff to be based in objective, scientific criteria. This method also allows simulations of the consequences related to these decisions, and reports the contribution of each variable to the poultry production parameters under study.

KEYWORDS

Poultry, Management, Production, Broiler Breeders, Artificial Neural Networks and Artificial Intelligence.

INTRODUCTION

Although the poultry industry uses state-of-the-art equipment and up-to-date services, and is responsible for international competitiveness, in Brazil it also generally makes decisions involving all its production parameters based on purely subjective criteria. Such important economic and social activities need objective criteria, based on a scientific approach combined with probabilistic predictions, and so providing support to improve flocks productivity, and also offering better product quality to the foreign and internal markets. Neural networks have been used for many applications: pattern classification and pattern recognition; prediction of financial indices such as currency exchange rates; optimisation of chemical processes; identification of cancerous cells; recognition of chromosomal abnormalities; detection of ventricular fibrillation (Cheng & Titterington, 1994).

Neural networks were inspired in the structure and functioning of biological neurones. Neural networks learn from patterns of interactions, without requiring a priori knowledge of relations between the variables under investigation. An artificial network works like biological neurones, each receiving one or more inputs and transforming the sums of those inputs into an output value that is transferred to other 'neurones', and so on successively. An artificial neural network is a set of processing units (or nodes) that are interconnected by a set of weights (analogous to synaptic connections in the nervous system) that allow both serial and parallel processing of information through the network (Roush *et al*., 1996 and Astion & Wilding, 1992). The neural network 'neurones' may receive excitatory or inhibitory inputs from other 'neurones' (Forsström & Dalton, 1995), and produce an output that is usually a non-linear function of the net input (Astion & Wilding, 1992).

This paper aims to study the use of artificial neural networks to estimate performance parameters - outputs (e.g., feed supplied per female per day, eggs to be laid in the subsequent week, etc.), on the basis of specified variables - inputs (e.g., age, season, temperature, air relative humidity, number of birds, etc.) in production birds belonging to a South Brazilian poultry farm.

It was used a retrospective, longitudinal, analytical and observational approach, in which the models generated are suitable only to evaluate the use of the technique.

MATERIALS AND METHODS

The data used in the mathematical analysis were obtained from 21 broiler breeder flocks' records belonging to a Southern Brazilian poultry farm, which produces broilers from a single genetic line (Cobb), collected over the period between April, 26th 1998 and December, 19th 1999.

Scatter graphs from all the variables were produced, aiming to identify any outliers (biologically impossible data), that once identified were eliminated. The twenty-one flocks produced 990 data lines, from which 301 were eliminated because of inconsistencies in their records.

The data used, therefore, produced just 689 data lines: 552 for the learning set (80%) and 137 for the test set (20%). These data were related to weekly recordings of the following variables:

- Age (ranging between 25 and 66 weeks old);
- Season of the year (1 – Winter: June, 21st to September, 20th; 2 – Autumn: March, 21st to June, 20th; 3 – Spring: September, 21st to December, 20th; 4 – Summer: December, 21st to March, 20th). The seasons were coded according to their light incidence, forcing the software to give more importance to the highest temperatures;
- Temperature (Celsius degrees);
- Air Relative Humidity – ARH (%);
- Number of female birds in the flock;
- Number of male birds in the flock;
- Female's accumulated mortality percentage;
- Male's accumulated mortality percentage;
- Feed supplied per female per day during the week (grams);
- Feed supplied per male per day during the week (grams);
- Total number of eggs laid during the week;
- Percentage of eggs laid (eggs laid in relation to the chickens);
- Total number of hatching eggs produced during the week;
- Fertility (percentage of hatching eggs in relation to eggs laid);
- Eggs set during the week (eggs that really was set into the incubator machine);
- Percentage of eggs set (eggs set in relation to the eggs laid);
- Total number of chicks produced during the week;
- Hatchability.

The temperature and air relative humidity were not measured in the chicken house, but were obtained from the Ministry of Agriculture's 8th Meteorological District, located in the neighbouring town of Bento Gonçalves - RS, Brazil (4 kilometres far way from the farm).

In order to obtain the artificial neural networks, the software NeuroShell 2® version 4.0™ (Ward Systems Group®) was used. A backpropagation architecture (Ward Network), with supervised feed forward networks with 3 hidden layers and different activation functions was used to produce the artificial neural networks (Figure 1). The input layer (slab 1) used a linear scale function [-1, 1]. The first hidden layer, slab 2, used a Gaussian function. The second hidden layer, slab 3, used a hyperbolic tangent function and the third hidden layer, slab 4, used a Gaussian complement function. The output layer (slab 5) used an activation logistic function (sigmoid logistic). The links among neurones were adjusted for learning and momentum rates in 0,1 and the initial weights were between +0,3 and -0,3.

The training data set was partitioned into a learning set (80% - 552 lines) and a randomly chosen test set (20% - 137 lines). After an input pattern was presented to the first layer of neurones, it was then propagated through each succeeding layer, until an output was generated. This output pattern was compared to the actual output, and an error signal was calculated for each output. This error signal was transmitted backwards across the neural network (backpropagation). The connection weights were thereby updated, in order to decrease the error in network. As learning proceeded, the error between the input and output decreased and the neural network "learned" the pattern of data (Forsström & Dalton, 1995).

In fact, there was the possibility to build 34,468 different models, but embracing all the possible logical combinations, it would take more than 4 years to complete the experiment execution, working 8 hours per day just for it (15 minutes per model). So, the approach was to use the veterinary knowledge to choose the variables (inputs) that could have influence on the outputs we wanted to predict and test then.

The artificial neural networks models generated were compared and selected as the best, based on their largest determination coefficient, (R2), lowest Mean Square Error (MSE), as well as on an uniform scatter in the residual plots.

RESULTS AND DISCUSSION

With the data available, it was possible to build and test 248 models for 16 output variables.

As an example, it was built 15 models to predict the output "Eggs to be laid in the subsequent week". The chosen model (best) to be used in the worksheet for the simulation was calculated by the model number 15, because it reported the lowest MSE and the largest R^2, and also because this net presented an uniform scatter in the residual plots.

The contributions in percentage of the different inputs used to estimate the outputs is of importance in understanding what is interfering with the variable to be predicted.

The final results of an artificial neural network model chosen can be put in Excel® software worksheets, which are showed in Figures 2, 3 and 4. These

three worksheets are interconnected, so the information typed in the first worksheet (Figure 2) is used in the subsequent worksheets (Figures 3 and 4).
From the 990 data lines, 301 had to be eliminated because of inconsistent recordings. Besides that, it is important to say that relevant data for the modelling, such as: pharmacological treatments, feed formulation, vaccinations, laboratory monitoring, management techniques, necropsy findings, houses' inner temperature, etc. were not systematically recorded by the company in any of the flocks studied. For this reason, these elements could not be aggregated to the models.
The recording mistakes, and the lack of important data suggest that, in the present form of breeders production management, the company's previous data are not being adequately analysed.
Outputs and inputs combinations were done using veterinary knowledge and time available. It is obvious that other combinations could have been used, but it depends on the answers required.
We believe that the generated models can only be used effectively by the poultry company where the study was done. In a further study, a prospective field work should be performed, to test the validity of the models generated.

CONCLUSION

It is possible to explain the performance parameters from breeder birds in a poultry farm, through the use of artificial neural networks. The method allows the decision making by the technical staff for the different production flocks to be based in scientifically obtained, objective criteria. Besides that, this method allows the simulation of consequences concerned to these decisions, also supplying the contribution percentage from each variable to the poultry production parameters under study.

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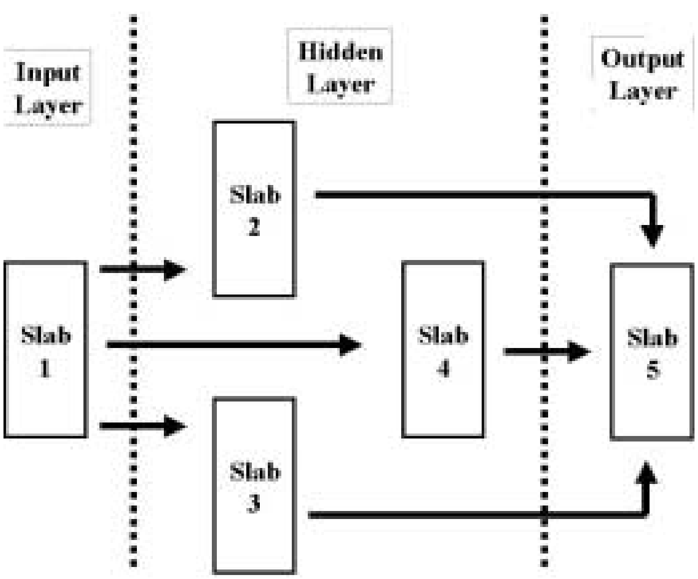

Figure 1
Artificial neural network backpropagation architecture used in the experiment.

Legend: **Input**: is a variable that a network uses to make a classification or prediction; **Layer**: is a grouping of slabs; **Link**: is the connection between the slabs or groups of neurones in a network; **Neurone**: is a basic building block of simulated neural networks which processes a number of input values to produce an output value; **Output**: is the value or values the network is trying to predict; **Slab**: is a group of neurones.

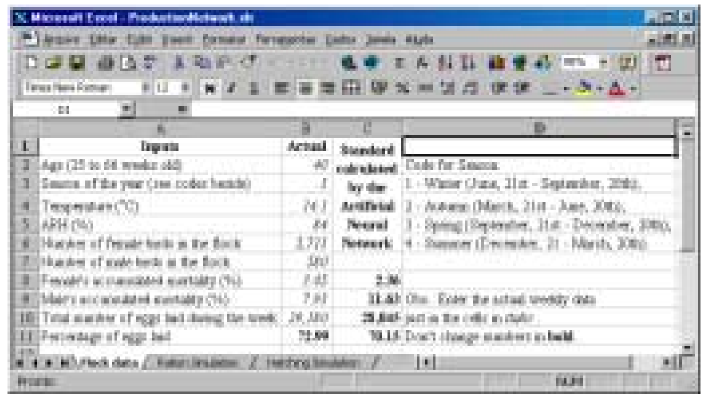

Figure 2
Electronic worksheet to verify the flocks' performance.

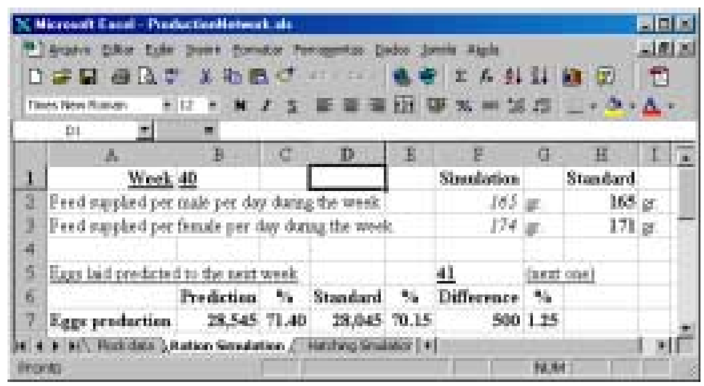

Figure 3
Electronic worksheet for simulating the subsequent week's eggs laying, according to the feed supplied per day to the females during the week.

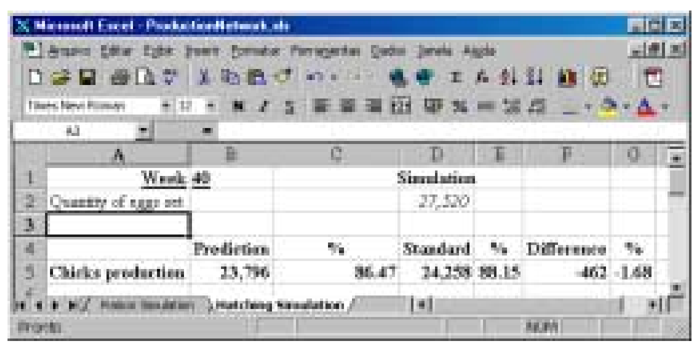

Figure 4
Electronic worksheet for the simulation of the number of chicks hatched from a given number of eggs set.