Modelling Egg Production of New-Kampong Crossbreed Chicken (KUB) as Promotion of Indigenous Chicken Breeds Using Three Mathematical Methods

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ABSTRACT
The research was conducted to estimating egg number from the new-kampong-crossbreed chicken (KUB) using three mathematical methods. A total one hundred 24-week-old KUB hens were randomly allocated to individual cages. Egg records totalling were divided into eight different ages (weeks); 22-25; 26-29; 29-32; 33-36; 37-40; 41-44; 45-48; 49-52. The result showed that the estimation are optimum at the level 68.0%, 68.0%, 0.62 and $p<0.001$ (Linear); 67.1%, 67.1%, 0.72 and $p<0.001$ (Quadratic). However, in the ANN model, R2, adjusted R2, RMSE and significance level were 71.2%, 72.1%, 0.68 and $p<0.001$. The prediction results weekly using ANN model 4.66 also occurs observed value 4.50. It can be concluded ANN and CRT models appear to predictive than linear and quadratic algorithm. Therefore, it can be promotion to estimation egg number of KUB laying hens in a tropical environment.

Keywords: *Algorithms, Estimation, KUB, Modelling*

1. INTRODUCTION

Indonesia are archipelago country that huge poultry production needed [1]. Egg demand are raised through every year. In other hand, the egg supplied are rely on the laying birds. The government made an imposed ban on the import of live animal species and an imported livestock production consisting of egg and meat product originating from China or transiting into Indonesia territory [2][15]. By this situation, the stakeholders need to develop an alternative rely on the laying bird by developing new-kampong-crossbreed (KUB) chickens as laying purposes.

The KUB chickens are developed by Bogor Animal Research Institute (BARI), which are made for laying purposes. In general, the characteristics of KUB Chickens are as follows: 1) The colour of the feathers is varied, such as chicken in general, 2) Body weight: 1,200 - 1,600 grams / head, 3) Egg weight: 35 - 45 grams / egg, 4) First laying is more early (20 - 22 weeks) and has more resistant to disease since that hens rearing in tropical environment. Thus, KUB chickens are recently introduced into Indonesia region as new breeds. But there is lack of information on the use of statistical regression models to confirmed and predicted egg production in KUB laying birds.

A conventional regional between linear and quadratic models are still high standard error [3]. Artificial Neural Network (ANN) is an architectural and computational computing system inspired by knowledge of nerve cells in the brain. Artificial Neural Network (ANN) is a model that fits how biological neural networks work.

The model can be used for early detection of problems and adjust the production curve of commercial eggs [4]. In other side, the classification regression tree (CRT) is an exploratory method used to see the relationship between response variables and independent variables, which include nominal, ordinal, and continuous variables. According to problem above, the research was conducted to determine the egg using three model mathematical equation.

2. MATERIALS AND METHOD

2.1. Experimental design

The laying hens used in this study were 100 heads, with average age was 24-week-old KUB hens from 22 weeks until 52 weeks.

2.2. Measurement

Eggs were collected daily twice a day at 08; 00 and 16; 00 and weighed. The basal diet was prepared as a single feed and formulated (Table 2). Egg records totalling were divided into eight different ages (weeks); 22-25; 26-29; 30-33; 34-37; 38-41; 42-45; 46-49; 50-53.

The basal diet was analyses in duplicate consisting of dry matter (DM), crude protein (CP), and fat based on proximate analysis [16][17][18].

2.3. Feed ingredients

Table 1. Composition of the feed ingredients (% air-dry basis)

	DM	CP	CF	Fat
Maize	87	8.2	3.4	7.2
Fish meal	86	34.5	4.5	5.5
Rice bran	88	10	18.2	3.5

Table 2. Ingredient composition of the diet

Ingredients	Basal Diet
Maize	52.1
Soybean meal	21.2
Palm oil	1.00
Rice bran	15.8
Fish meal	6.75
$Caco_3$	0.80
Salt	0.30
Mineral premix	0.05
Methionine	1.00
Lysine	1.00
Total	100
Chemical composition	
Metabolic energy (kcal/kg)	2,902
Crude protein (%)	20.1
Crude fat (%)	5.02
Crude fibre (%)	6.11
Methionine (%)	1.25
Lysine (%)	1.45
Calcium (%)	1.22
Phosphor (%)	0.71

*diet were formulated according to [6]

2.4. Statistical analysis

Data were subjected to descriptive statistic of egg production were calculated based on age. The relationship between egg number and age was established using linear and quadratic regression. The models as follows [12][13].

(1) Linear model: $Y_{ij} = B_0 + B_1X_{ij} + e_{ij}$
(2) Quadratic model: $Y_{ij} = B_0 + B_1X_{ij} + B_2X_{2ij} + s_i + b_i X_{ij} + e_{ij}$

Where Yij = dependent variable (egg number); B0 = overall intercept across all studies (fixed effect); B1 = linear regression coefficient of Y on X (fixed effect); B2 = quadratic regression coefficient of Y on X (fixed effect); Xij = value of the continuous predictor variable (age of birds); si = value of random effect of study i; bi = random effect of study on the regression coefficient of Y on X in study i; and eij = the unexplained residual error.

The data training were at 75% while fitted data at 25%. The model goodness values used are coefficient of determination (R^2) and root mean square error (RMSE). The significance was significant if p <0.05 and if p <0.1 it tended to be significant. Statistical analyzes were performed with software Xlstat Addinsoft Damrémont Paris and neural designer, Barcelona. The optimal age for

egg production were following [3] used classification and regression tree (CRT) as follows:

S^2_e = risk value ÷ S^2_y
Where,
S^2_e = unexplained variation in the number of eggs
S^2_y = variance of the dependent variable
1-S^2_e = explained variation in the number of eggs
Result and Discussion

The mean of egg number production were 2.11, 4.22, 3.22, 3.56, 3.55, 4.32, 3.44, 5.13, 4.33 for ages 22-25; 26-29; 30-33; 34-37; 38-41; 42-45; 46-49; 50-53 weeks old hens, respectively (Table 6). The average weekly egg for combined ages (pooled data) was 4.33. In addition, the lowest mean values were at the beginning of periods 22-25 weeks old hens, while the peak production appeared in the 38-41 weeks.

Table 3. Descriptive characteristic of egg production

Period (week)	Pop. size	Min	Max. Value	Mean Egg Prod.	SEM
22-25	100	2.00	5.00	4.11	0.1
26-29	100	2.00	5.00	4.22	0.3
30-33	100	3.00	5.00	4.22	0.2
34-37	100	3.00	5.00	4.56	0.11
38-41	100	4.00	5.00	4.55	0.33
42-45	100	3.00	5.00	4.32	0.33
46-49	100	2.00	5.00	4.44	0.22
50-53	100	2.00	5.00	4.13	0.26
Total	800	2.00	5.00	4.33	0.02

SEM = standard error mean

The prediction of egg number from age using both linear and quadratic pattern showed corresponding of R^2, adjusted R^2, RMSE, and significance level were 65%, 65%, 0.21, and p<0.001 (linear pattern); 66%, 66%, 0.33 and p<0.001 (quadratic pattern) (table 4).

Table 4. Regression equations of the estimation of egg production number

Model	Population size	R^2	Adjusted R^2	RMSE	P-value
Linear	Y = -2.65 + 0.12X	0.65	0.65	0.21	<0.001
Quadratic	Y = -6.37 + 0.26X - 0.002X^2	0.66	0.66	0.33	<0.001

Y = egg number, X = age, R^2 = coefficient of determination; RMSE= Root mean squares error

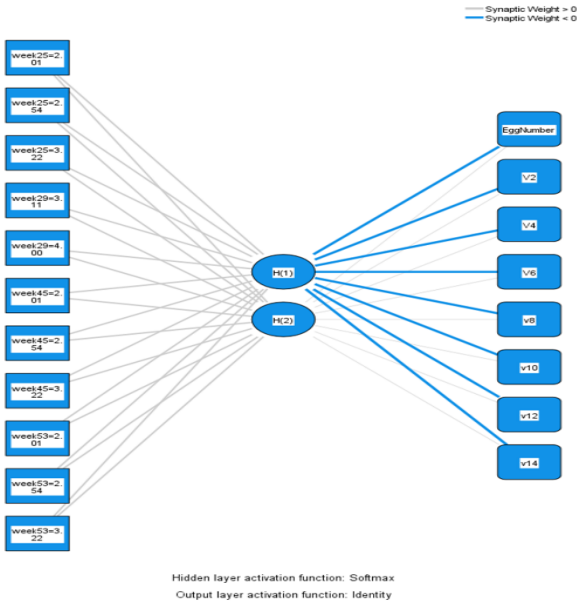
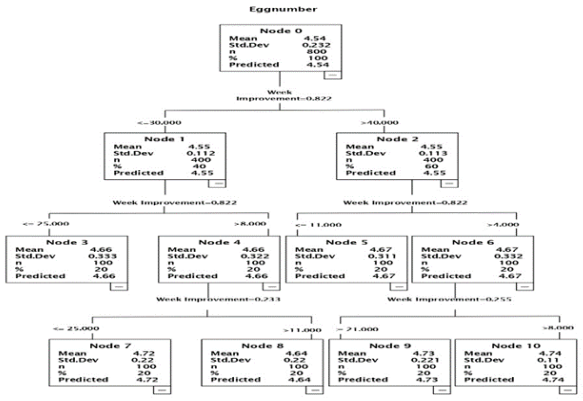


Figure 1. Representative of three layered artificial neural network. Weighed sum (22-25; 26-29; 30-33; 34-37; 38-41; 42-45; 46-49; 50-53 weeks old hens).

Table 5. Descriptive statistics of actual and predicted egg number using artificial neural network.

Model	Sample size	Min value	Max value	Mean	P-value
Observed	800	2.00	5.00	4.56	0.003
ANN	800	2.01	4.00	3.65	0.003



ANN= Artificial neural network predicted

Figure 2. Regression tree using artificial neural network as prediction model.

The number appeared enough and reliable in estimated the egg production [4]. The egg production of the KUB chicken are fitted in 66.0% (Linear) and 67.0% (Quadratic). Thus, the method are reliable in predicting egg number. Reported by [11] their optimal age appeared at 63 weeks. In addition, reported from [5] using linear regression showed value at 0.35.

The artificial neural network showed great contribution among of ages 38-41 and 42-45 weeks to egg number prediction. The result show greater result since the grey line less than zero and the number of robustness to tolerate error mean. Thus, artificial neural network better compared the conventional model both linear and quadratic pattern. The pattern of [5] showed similar also with the result of these studies to predict the egg number production (22-36 week) with R2 value of 0.71. In contrast reported from [7] the prediction reached until upper level about 88% and rapidly increased at that phase.

The result analyses from CART showed that the optimal produce eggs production started at 38 weeks and the peaks were 43 weeks. This means that the KUB chicken hens productive and higher reproductive cycle at that weeks. Reported from [4][14] from it study showed that optimal egg production using CART were at 48 weeks of age. Thus, ANN model above, an indication that the CRT model fitted well. However, [9] fitted lay eggs from 34.5 to 54.5 weeks of egg production and stable at 54.5 weeks. [11] Have reported the external cycle lengths longer or shorter than 24 h can be accommodated when such an approach is used. When the ovulation curves of individuals in the flock are integrated, the characteristic laying curve is faithfully reproduced.

3. CONCLUSION

ANN and CRT models appear to predictive than linear and quadratic algorithm. It can be promotion to estimation egg number of KUB laying hens in a tropical environment.

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