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PREDICTING EGG WEIGHT FROM AGE AND BODY WEIGHT AT FIRST EGG IN NIGERIA INDIGENOUS AND EXOTIC CHICKENS USING MULTIPLE REGRESSION MODELS

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ABSTRACT

Weight of egg was predicted from age and body weight of hen at first egg from one hundred and fifty hens: 25 White Leghorn, 25 Giri raja, 25 Black Nera, 25 Normal feathered Local, 25 Local x White Leghorn and 25 Giri raja x Local. Multiple regression models: Linear, Exponential, Semi Log and Double Log were used in this study. The highest value of R^2 for White Leghorn was 0.055 (linear model), 0.006 for Giri raja (Linear) and 0.131 for Nera (Exponential). However, higher values for R^2 were observed for the Nigerian local hen, 0.585 (Double Log) and her crosses with Giri raja, 0.612 (Exponential). The lowest standard error for Giri raja x Local cross is in Exponential model which also had the highest R^2 and F value in this research. This same trend was observed for local where Double log regression model had the highest R^2 and F value but the lowest standard error. This shows that egg with could be best estimated with age and body weight of hen at first egg in Local and her crosses with Giri raja.

INTRODUCTION

The Nigeria local chicken has several important features like adaptation to the local environment, broodiness, desired pigmentation and taste (Sonaiya and Olori, 1990). However, because of it small body size and egg, several improvement works have being done to better the qualities of the Nigerian local chicken. The information on mean egg weight and distribution of individual egg weights is essential for determining egg value and the income component of economic models for table egg layer flocks. In systems that separate eggs into weight classes that differ in price, the percentage of eggs in each class must be known in order to determine monetary value (Adams and Bell, 1998).

Studies have established a relationship between egg weight and body weight of hen as well as the age of the hen. Age at first egg was negatively moderately genetically correlated with the first three-month egg production (-0.39) and the annual egg production (-0.36). This favourable trend indicated that selection for earlier age at first egg is likely to be associated with moderate gain in egg production (Khalil *et al*., 2004). Negative estimates of genetic correlations between age at maturity and egg production were also reported by Thakur *et al.* (1989) in India (-0.691) and by Koerhuis and Mckay (1996) in Netherlands (-0.76).

Though various factors are known to affect egg production, there is conflicting reports on the effect of body weight on egg production. For the development of egg production strains, it is necessary to establish the nature of the relationship existing between body weight and egg production parameters (Oke *et al*., 2004). Du Plessis and Erasmus (1972) found that age at sexual maturity showed a constant and significant effect on egg weight in each month of the year, which agrees with the findings in this report. This study therefore tried to see how we can predict the weight of the hen's egg from her weight age first egg and bogy weight at first egg.

MATERIALS AND METHODS

Experimental birds

One hundred and fifty (150) pullets that were used in this experiment were randomly selected from about 500 pullets of the various strains obtained from the Poultry Breeding Unit of the University of Agriculture Abeokuta Teaching and Research Farm. The pure exotic pullets include White Leghorn, Black Nera (control) and the Giriraja. Black Nera was chosen as control for its stability to the environment here in the tropics as a result of its long term use for both meat and egg production. The pure indigenous (normal feathered) local and its crosses with White Leghorn and Giriraja were also obtained. 25 pullets for each of these breed combinations were considered for the study.

All laying chickens were fed layers mash with proximate composition of 16.5% crude protein, 3.5% fats, 3.5% calcium, 6.0% fibre, 0.45% available phosphorus and 2550kcal/kg Metabolizable Energy (M.E) per day needed for optimum egg production. Fresh feed was supplied twice daily, morning and afternoon and the total feed consumed by each strain were recorded. Fresh water was supplied twice daily (morning and afternoon). To keep the layers healthy, they were dewormed every two months with Piperazine®. Vaccination was also done against New castle and Fowl pox diseases. Vitamins were administered as at when due.

Experimental Procedure

At 16 weeks of age, 25 pullets each of the crosses of White Leghorn x Local, Giriraja x Local, White Leghorn, Back Nera, Giriraja and indigenous local were selected and transferred from the Growers pen to the cages in the layers pen. When the pullets started laying, eggs were collected and weighed daily for a period of 125 days.

Data Collection

Data on the following parameters were collected.

1. Age at first egg.
2. Weight of first egg.
3. Body weight at first egg

Data Analysis

The Multiple Regression Model

Y = f (X1, X2, Ui)

Y = Weight of egg

f = f is a function of

X1 = Age of hen at first egg

X2 = Body weight of hen at first egg

Ui = Error term

The study experimented with the linear, exponential, semi-logarithm and double log functions.

The aim was to ensure the choice of an appropriate functional form. The general forms of the equations are as shown below.

Linear Function

Y = âo+ â1X1 + â2X2 + Ui

Exponential Function

Ln Y=âo+ â1X1+ â2X2+ Ui

Semi- logarithm Function

Y = Lnâo+â1LnX1+â2LnX2+Ui

Double-log Function

LnY = Lnâo+â1LnX1+â2LnX2+Ui

Where,

Y = Weight of egg

f = f is a function of

X1 = Age of hen at first egg

X2 = Body weight of hen at first egg

Ui = Error term

âo = Constant term

âi to â2 = Regression coefficients to be estimated

RESULTS

The values of coefficient of multiple determinations, the standard error of the estimated parameter, statistical test of the F-ratio and the significance of the coefficient of the explanatory variables for the different strains of hen and the different models used are shown in Tables 1 - 6.

Based on the sign of the constant (B0) the semi log function had negative values for White leghorn while others had positive values. The significance of the coefficient of the explanatory variable with respect to their values was tested using student t-test at one and five percent level of significance. In White Leghorn, none of the variables was significant except the value for constant under exponential function which was significant at 1%. This same trend was observed for Giri raja and Nera. However, for White Leghorn x Local cross, the constant was significant at 5% for linear and double log functions respectively but was significant at 1% for exponential function. Semi log was not significant. For Nera x Local cross, values were significant for constant and X1 (age at first egg) in all the regression models used all at 5% except for exponential and double log models for constant that were significant at 1%. However, the reverse was observed for the local hen were age at first egg was not significant for any of the regression models used but body weight at first egg was significant at 1% for all the regression models used. Constant was only significant for Exponential and Double Log at 1% and 5% respectively.

The value of the Coefficient of Multiple Determination (R^2) is also used to determine the lead equation. The higher the value of R^2, the better the “goodness of fit” of the regression plane to the sample observations. The values of the R^2 for all the three (3) exotic breeds used in this study were generally low for all the regression models used. The highest value of R^2 for White Leghorn was 0.055 (linear model), 0.006 for Giri raja (Linear) and 0.131 for Nera (Exponential). However, higher values for R^2 were observed for the Nigerian local hen and her crosses. In White Leghorn x Local cross, the highest R^2 value was 0.060 (Exponential), 0.612 for Giri raja x local cross (Exponential) and 0.585 (Double Log) for Local. The standard error of the estimated parameter was considered. The form with the smallest standard error was given priority and for strains of fowl with higher R^2 (Giri raja x Local cross and Local). The lowest standard error for Giri raja x Local cross is in Exponential model which also had the highest R^2 and F value in this research. This same trend was observed for local where Double log regression model had the highest R^2 and F value but the lowest standard error.

DISCUSSION

The higher values of R2 peculiar to the Nigerian local hen and her crosses with the Giri raja could be attributed to her several important features like adaptation to the local environment as reported by Sonaiya and Olori (1990). These results gives us better information on mean egg weight and distribution of individual egg weights is essential for determining egg value and the income component of economic models for table egg layer flocks as explained by Adams and

Bell (1998). These models will also help in predicting the weight of eggs from the weight and age at first egg to enable farmers keep the exact type of hens either for heavy of light weight eggs as the need may be. The relationship established by these models between egg weight and body weight of hen as well as the age of the hen are in line with reports of Khalil *et al*. (2004), Thakur *et al* (1989) and Koerhuis and Mckay (1996). Du Plessis and Erasmus (1972) found that age at sexual maturity showed a constant and significant effect on egg weight in each month of the year, which agrees with the findings in this report.

CONCLUSION

The results of this study has shown the possibility of predicting the weight of the egg of a hen from both the age at first egg and the body weight at first egg of that hen. The results of this predictions are more reliable with the Nigerian normal feathered chicken and her crosses with Nera but very poor with the exotic hens. All four regression models are good but exponential model is best in Nera x Local cross while Double Log is best for the Nigerian normal feathered local chicken.

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Table 1: Summary of regression analyses for White Leghorn

Functional forms	Dependent variables	Constant	Coefficient of independent variable X1	X2	R^2	Standard error	F - value
Linear Y	Y	13.190	0.076	6.476	0.055	5.152	0.646
t-value		(0.787)	(0.487)	(0.464)			
Exponential	LnY	2.846***	0.002	0.208	0.039	0.200	0.441
t-value		(4.366)	(0.403)	(0.383)			
Semi Log	Y	-15.317	9.192	8.323	0.050	5.167	0.575
t-value		(-0.149)	(0.429)	(0.467)			
Double Log	LnY	1.929	0.296	0.263	0.034	0.200	0.387
t-value		(0.482)	(0.355)	(0.380)			

***: Indicate significance at 1% level
**: Indicates significance at 5% level
X1 = Age of hen at first egg
X2 = Body weight of hen at first egg

Table 2: Summary of regression analyses for Giri raja

Functional forms	Dependent variables	Constant	Coefficient of independent variable X1	X2	R^2	Standard error	F - value
Linear Y	Y	28.942	0.032	1.236	0.006	5.925	0.290
t-value		(0.880)	(0.150)	(0.106)			
Exponential	LnY	3.414**	0.001	0.018	0.004	0.165	0.200
t-value		(3.723)	(0.148)	(0.056)			
Semi Log	Y	12.614	4.377	2.542	0.005	5.929	0.023
t-value		(0.077)	(0.130)	(0.099)			
Double Log	LnY	2.969	0.118	0.036	0.003	0.165	0.015
t-value		(0.650)	(0.126)	(0.050)			

***: Indicate significance at 1% level
**: Indicates significance at 5% level
X1 = Age of hen at first egg
X2 = Body weight of hen at first egg

Table 3: Summary of regression analyses for Black Nera

Functional forms	Dependent variables	Constant	Coefficient of independent variable X1	X2	R^2	Standard error	F - value
Linear Y	Y	63.325	0.004	-12.431	0.106	5.492	1.307
t-value		(2.010)	(0.029)	(-1.489)			
Exponential	LnY	4.312***	0.000	-0.283	0.131	0.106	1.658
t-value		(7.047)	(-0.162)	(-1.743)			
Semi Log	Y	50.809	0.209	-15.722	0.097	5.520	1.183
t-value		(0.378)	(0.008)	(-1.418)			
Double Log	LnY	4.433	-0.092	-0.360	0.121	0.107	1.514
t-value		(1.698)	(-0.185)	(-1.669)			

***: Indicate significance at 1% level
**: Indicates significance at 5% level
X1 = Age of hen at first egg
X2 = Body weight of hen at first egg

Table 4: Summary of regression analyses for White Leghorn x Local cross

Functional forms	Dependent variables	Constant	Coefficient of independent variable X1	X2	R^2	Standard error	F - value
Linear Y	Y	57.272**	-0.106	-1.736	0.056	3.672	0.649
t-value		(3.274)	(-1.083)	(-0.294)			
Exponential	LnY	4.096***	-0.002	-0.049	0.046	0.927	0.526
t-value		(9.270)	(-0.993)	(-0.328)			
Semi Log	Y	116.055	-15.254	-1.935	0.060	3.663	0.707
t-value		(1.741)	(-1.126)	(-0.315)			
Double Log	LnY	5.452**	-0.354	-0.054	0.050	0.092	0.574
t-value		(3.236)	(-1.034)	(-0.347)			

***: Indicate significance at 1% level
**: Indicates significance at 5% level
X1 = Age of hen at first egg
X2 = Body weight of hen at first egg

Table 5: Summary of regression analyses for Giri raja x Local cross

Functional forms	Dependent variables	Constant	Coefficient of independent variable X1	X2	R^2	Standard error	F - value
Linear Y	Y	28.416**	0.059**	-0.051	0.577	2.729	4.784
t-value		(3.498)	(2.967)	(-0.009)			
Exponential	LnY	3.362***	0.002**	-0.001	0.612	0.071	5.526
t-value		(15.709)	(3.187)	(-0.006)			
Semi Log	Y	20.030**	3.475**	0.473	0.462	3.080	3.005
t-value		(2.777)	(2.351)	(0.051)			
Double Log	LnY	3.120***	0.100**	0.013	0.501	0.081	3.521
t-value		(16.337)	(2.546)	(0.052)			

***: Indicate significance at 1% level

**: Indicates significance at 5% level
X1 = Age of hen at first egg
X2 = Body weight of hen at first egg

Table 6: Summary of regression analyses for Local

Functional forms	Dependent variables	Constant	Coefficient of independent variable X1	X2	R^2	Standard error	F - value
Linear Y	Y	17.669	0.001	23.006***	0.563	3.473	12.232
t-value		(1.379)	(0.012)	(4.876)			
Exponential	LnY	3.129***	-9.3E-005	0.587***	0.570	0.087	12.586
t-value		(9.726)	(-0.040)	(4.954)			
Semi Log	Y	35.618	1.120	21.994***	0.576	3.420	12.907
t-value		(0.571)	(0.088)	(5.005)			
Double Log	LnY	3.655**	0.011	0.562***	0.585	0.085	13.392
t-value		(2.339)	(0.035)	(5.107)			

***: Indicate significance at 1% level
**: Indicates significance at 5% level
X1 = Age of hen at first egg
X2 = Body weight of hen at first egg