

ABG -20

Fulani Ecotype Chicken Genetic Resource under a Pastured Poultry Management System – 2 – Evaluation for Persistency of Egg Lay

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Abstract

The objectives of this study were to describe egg-laying rate, evaluate the persistency of egg lay, and to characterise the laying patterns in Fulani ecotype hens (FEH) using non-linear models. Data on weekly egg production records of 83 laying hens up to 45 weeks of lay were used for this analysis. Four non-linear models including Gamma, Logistic-curvilinear, Compartmental, Narushin-Takma were fitted to describe the egg-laying rate, while the Grossman model was fitted to evaluate the persistency of egg lay. Goodness-of-fit criteria used included adjusted R^2 (adj. R^2), mean square error (MSE), and Akaike Information Criterion (AIC). The difference between the goodness-of-fit criterion (adj. R^2) was small for all models for egg laying rate. However, based on the AIC and R^2 values, Gamma and Narushin-Takma models presented the best fit. It was observed that the FEH could maintain constant egg production at weeks 9 to 11, and 39 to 41. In characterizing the laying patterns, FEH recorded double peaks at early and late laying periods. Overall, the data suggest that FEH are not persistent layers.

Keywords: Ecotype, Fulani, models, non-linear, persistency

Introduction

Raising chickens for eggs offers a means of solving problems of animal protein shortage especially in the rural areas of many African countries (Sonaiya *et al.*, 1999). To achieve this, the focus is on all traits related to laying rate and persistency of egg lay of hens (Bradford, 2016). Persistent hens can maintain a level of constant egg production at their peak (Grossman *et al.*, 2000). Persistency of egg lay is observed after the peak of production, usually from the 8th to 9th week of egg production in commercial layers (North and Bell, 1990). Persistency of egg lay has mathematically been described using non-linear models (Grossman *et al.*, 2000). These models fit egg production and curve parameters with biological interpretations, and capture rate of increase in egg lay prior to and/or decrease from the peak of egg-lay, week of peak production, as well as duration of persistent egg production and rate of decline from peak of production. This makes it possible to establish parameters and descriptors that fully capture egg production patterns in laying hens (Poomkasemsak *et al.*, 2015).

The objectives of this study were to describe the egg-laying rate, evaluate the persistency of egg lay, and characterise the laying patterns in Fulani ecotype hens using non-linear models.

Materials and Methods

Data on 83 laying (Fulani ecotype hens or FEH) were used for the study. The hens were vaccinated against Newcastle disease, tagged and raised for forty-five weeks at the Pastured Poultry Unit, Teaching and Research Farm, Obafemi Awolowo University Ile-Ife, Osun State Nigeria. They were fed layers' mash diet containing 18% CP and 2,900Kcal/Kg of Metabolizable energy (ME) for the period of the experiment. Four hens were removed from the flock due to mortality.

Four non-linear models including Gamma, Logistic-curvilinear, Compartmental, Narushin-Takma were fitted to describe the egg-laying rate (Otwindowska-Mindur *et al.*, 2016). A persistency model was fitted to evaluate the persistency of lay following Grossman *et al.* (2000). Model parameters were obtained using the NLIN Procedure of SAS[®] to generate egg production curves for NFEC. The laying period was divided into 9 sub-phases, based on five weeks interval making up each sub-phase.

All analyses were carried out using non-linear (NLIN) procedures of SAS[®] Version 9.4. The most appropriate model for egg laying performance characteristics was evaluated using model goodness-of-fit tests, including adjusted coefficient of determination, mean squared error and Akaike Information Criterion (Kaps and Lamberson, 2004).

Results and Discussion

The Gamma model (Table 1) presented the initial production rate a as 24.61, the rate of increase to the peak b as 1.25, and the rate of decrease c was at 0.14. The Compartmental model gave an initial production rate of 6274.5 which surpassed the maximum egg number obtainable from the flock of hens. The Logistic-curvilinear model presented b as a negative rate of production decrease ($b = -0.97$). Two of the models (Gamma and Compartmental) showed good plots at the peak of production for the hens (Figure I). These models showed sustained egg production from the 9th to the 11th week of production. The Narushin-Takma model, showed predicted plots close to the observed records, till about 18th week of production. With the goodness-of-fit criterion (adj. R^2 and AIC), showing close values across the models, Gamma and Narushin-Takma models were thus selected as the best fit.

Table 1: Estimate of model parameters (a, b, c, d, e, f, g) for curves fitted to egg-lay for Fulani ecotype chickens

Model	Parameters							Goodness of Fit		
	a	b	c	d	e	f	g	Adj. R^2	AIC	
G	24.61	1.25	0.14					0.896	178.964	
C	6274.50	0.1087	0.1140					0.894	179.472	
L-C	8.64	-0.97	0.09	0.40				0.878	183.945	
N-T	62.23	-	10121.3	-8004.0	-22.10	1362.00	-65.99	0.898	181.568	
		1433.80								
		Persistency Model								
Model	Peak	tp	P	s						
Parameters	-179.6	-17.18	47.28	-15.71				0.695	69.069	

a: the initial production; b: the rate of increase to the peak/ production decrease (L-C); c: the rate of decrease from the peak/reciprocal indicator of the variation in week of first egg production (L-C); d: mean week of egg production at sexual maturity; e: the scale parameter; f: the rate of decrease of egg laying; g: an indicator of variation in sexual maturity. In the persistency model, Peak: The production rate at the peak of production; tp: the production period in week; P: the number of weeks for constant egg production; s: the rate of decline from the week of production; G: Gamma C: Compartmental L-C: Logistic-curvilinear N-T: Narushin-Takma

The persistency model showed irregularities and negative parameter estimates (Table 1), suggesting that it might not be suitable for FEH. The fitted plot (Figure II), suggested that FEH are not persistent layers, ostensibly due to occasional interruptions of egg lay with broodiness. In contrast, the curve of a persistent layer is characterised by the level of observed flatness, depicted by a constant level of production at the peak of lay, (Grossman *et al.*, 2000), compared to a curve that declines rapidly after the peak of egg production.

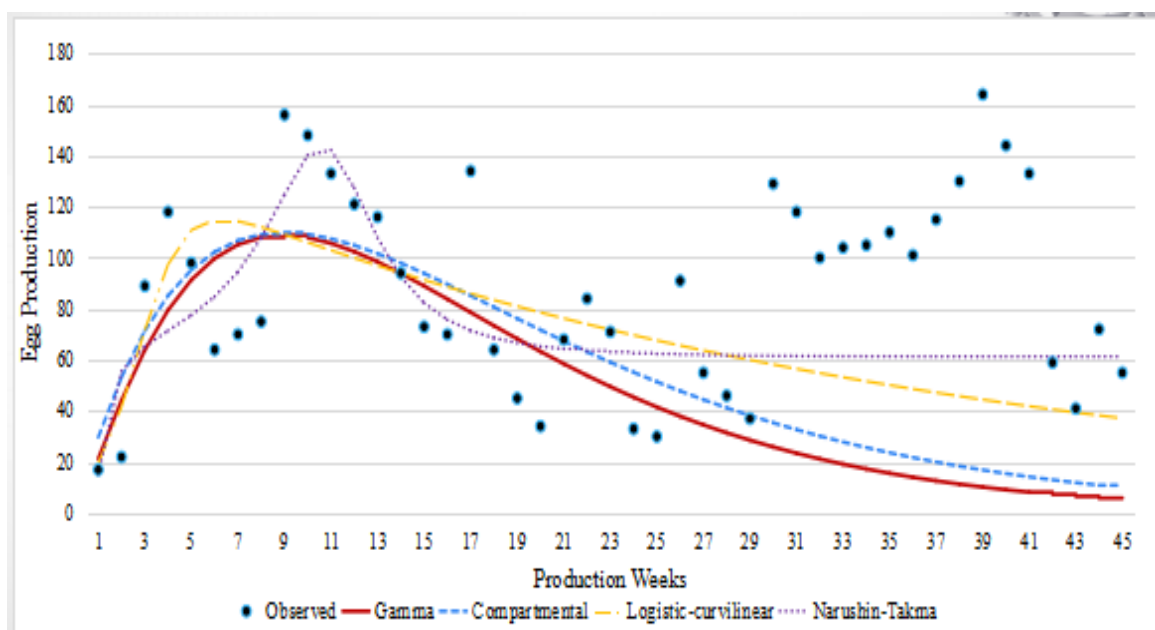


Fig. I: Observed and predicted weekly egg production of Fulani ecotype hens

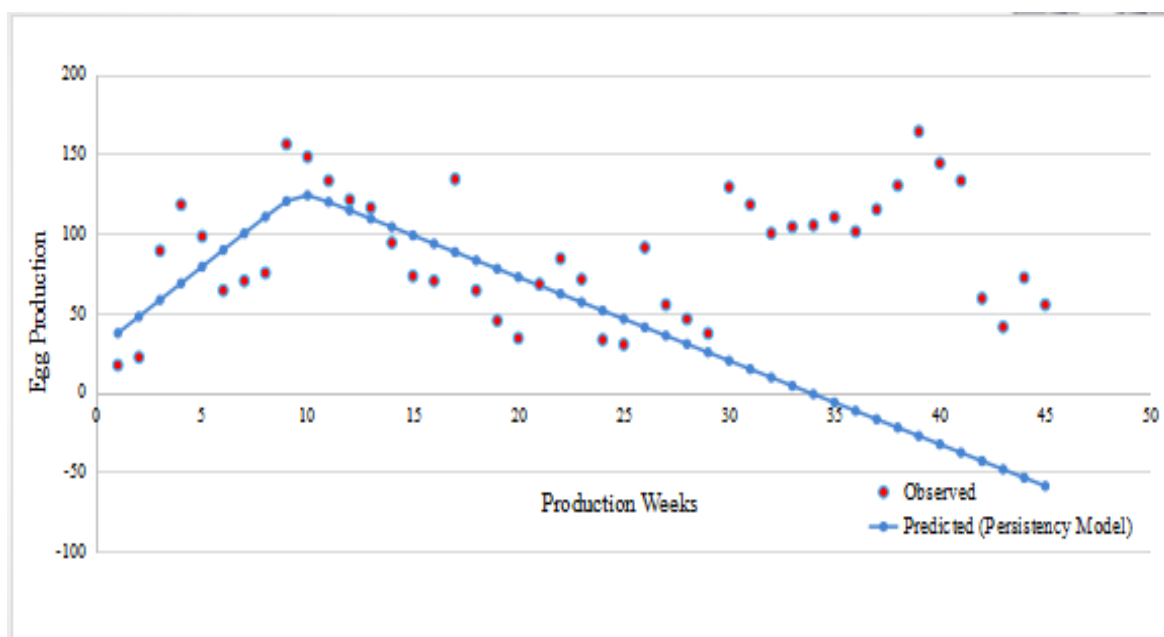


Fig. II: Observed and predicted weekly egg production of Fulani ecotype chickens based on the Persistency model (Grossman *et al.*, 2000)

Table 2: Estimate of model parameters for persistency model fitted to egg hen-day egg production for Fulani ecotype chickens by phase of lay

Phase	Parameters (Persistency Model)				Goodness of fit	
	Peak	tp	P	s	AIC	MSE
1	164.7	26	3	17	21.98	81.94
2	52.23	36.23	443.7	0.44	11.66	10.39
3	24.75	212.1	-176.4	4.5	37.69	1898.5
4	12.88	211.3	-2460.1	5.83	51.65	30947
5	10.62	211.2	-8.778E8	2.06	40.15	3099.3
6	-0.35	2.21	-9.73E15	0.65	15.76	23.62
7	-2.67	75.16	-9.39E21	0.55	22.18	85.22
8	-32.9	136.6	-3E28	0.09	14.69	19.07
9	-9.19	-13.45	-3.02E31	-0.33	21.09	68.48

Peak = peak production level (% egg / hen-day); tp = age of hens, in weeks, at the peak; s = rate of production decrease after the peak (eggs/hen-day decrease per week); P = number of weeks during which a constant egg production level is maintained after the peak.

Estimates of model parameters to characterize the laying pattern of FEH are presented in Table 3. This output showed that the HDEP for the FEH reduces the age of production progresses. Also, parameter (P) which represents the number of weeks wherein a constant egg production was attained, was 3 weeks. The parameter (tp), which is the estimated week of peak production was at 26 weeks. Finally, parameter (s), which is the rate of decline from peak production was fastest in the first phase of lay, with an estimate of 17. Until now, there has been no report of the modelling for egg production and persistency of egg-lay for FEH.

Conclusion

The Gamma and Narushin-Takma models gave the best fit models for the egg-laying rate. From the curves, it was observed that the Fulani ecotype chicken can maintain sustained egg production at weeks 9 to 11 and weeks 39 to 41. The persistency model was not very suitable due to occasional interruptions in egg lay attributable to broodiness. The highest production rate (peak) was observed in the first and phases of lay. However, this phase also presented the highest rate of decrease in egg production ($s=17$), suggesting that the FEH might not be persistent layers.

Acknowledgements

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