Growth pattern in cattle double and tripple crosses at Dehradun farm

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Amrit Paul
Indian Agricultural Statistics Research Institute

Lalmohan Bhar
Indian Agricultural Statistics Research Institute

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Growth pattern in double and tripple crosses cattle at Dehradun farm

SURENDRA SINGH[1], A K PAUL[2] and L M BHAR[3]

Indian Agricultural Statistical Research Institute, New Delhi 110 012 India

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Researchers in the field of behavioral and life sciences often come across with the studies on growth. Growth studies are very important for the livestock production because growth is the foundation on which the other forms of production such as milk, meat, wool rests.

Growth models are used to predict rates and change in the shape of the organism. The economic importance of rate of maturing, rate of gain, mature size and related characters can be determined by growth models. Comparison of nonlinear models for weight age data in cattle has been done under homoscedsticity (Brown *et al.* 1972). Brown *et al.* (1976), Alessandra *et al.* (2002), Kolluru *et al.* (2003) Lambe *et al.* (2006), also studied the different growth models in lamb. Various nonlinear models are available, but comparison of models is needed to find most appropriate model. In the present investigation 5 sigmoidal models are taken for comparing the growth pattern for double-cross and triple-cross cattle; these are Logistic and Gompertz Richards, Brody and Von Bertallanffy.

Data used in the study were collected from Dehradun farm for Friesian × Sahiwal and Friesian×Sahiwal×Hariana breed. Data collected for 40 cattle from birth to 36 month of age of Friesian × Sahiwal breed and 35 cattle for Friesian × Sahiwal × Hariana breed, for comparing the growth pattern among double-cross and triple-cross cattle. Following models are fitted for comparing the performance of double-cross and triple-cross cattle.

1. Logistic Model $X_t = \beta_1/(1+\beta_{2}e^{\beta_3 t})$

2. Gompertz model $X_t = \beta_1 \exp(-\beta_{2}e^{-\beta_3 t})$

3. Richards model $X_t = \beta_1/(1+\beta_{2}e^{\beta_3 t})^{1/\beta_4}$

4. von Bertalanffy Model $X_t = \beta_1/(1-\beta_2 e^{-\beta_3 t})^3$

5. Brody Model $X_t = \beta_1/(1-\beta_2 e^{-\beta_3 t})$

X_t is dependent variable (weight), it is weight of the cattle at age t month; β_1, asymptotic weight; β_2, scaling parameter; β_3, rate of maturity; β_4, inflection parameter.

To determine the adequacy of the models, a statistical measure, viz. the coefficient of determination (R^2) is used. It is expressed as R^2 = 1–(residual sum of squares/total sum of squares), where residual sum of squares is $\sum_{i=1}^{n}(y_i - \hat{y}_i)^2$

Total sum of squares is $\left[\sum_{i=1}^{n}\frac{(y_i-\hat{y}_i)^2}{n-p}\right]^{1/2}$, and Y_i and $\hat{y}_i$ are observed and predicted value of dependent variable (weight)

Another measure, i.e. RMSE which is $\sqrt{MSE}$, is considered for judging the goodness of fit of the model. It is given by

Root mean squared error (RMSE)= $\left[\sum_{i=1}^{n}\frac{(y_i-\hat{y}_i)^2}{n-p}\right]^{1/2}$; n, number of observations, p, number of parameters in the model

RMSE (4.4825) values is least in case of Richards model observed from Table 1, and it also shows that prediction for

Table 1. Parameter estimate of different models under homoscedastic error variance for the Friesian × Sahiwal breed at Dehradun farm

Parameter	Logistic	Gompertz	Richards	Brody	Von Bertalanffy
ß1	354.4000	382.5000	619.8000	354.4000	369.5000
	(15.6193)	(15.7104)	(101.6000)	(15.6193)	(15.5772)
ß2	6.6555	2.3190	-0.9811	-6.6555	-1.0815
	(0.8399)	(0.0966)	(0.0127)	(0.8399)	(0.0703)
ß3	0.1534	0.0927	0.0207	0.1534	0.1128
	(0.0142)	(0.0072)	(0.0074)	(0.0142)	(0.0093)
ß4	–	–	-1.1862	–	–
			(0.1165)		
Goodness-of-fit statistics					
R^2	0.9803	0.9910	0.9986	0.9803	0.9875
MSE	279.9608	127.9378	20.0933	279.9608	177.9144
RMSE	16.7320	11.3109	4.4825	16.7320	13.3384
Prediction at birth	>	>	√	>	>
Prediction at maturity	√	√	√	√	√

Note: > and √ denote over and correct prediction, respectively. Figures in the brackets indicate standard errors.

Present address: [1-3]Senior Scientist.

Table 2. Parameter estimate of different models under homoscedastic error variance for the Friesian×Sahiwal×Hariana breed at Dehradun farm

Parameter	Logistic	Gompertz	Richards	Brody	Von Bertalanffy
ß1	327.8000 (17.2990)	349.2000 (23.9764)	343.2000 (32.9774)	327.8000 (17.2990)	339.5000 (20.5903)
ß2	8.5121 (1.9712)	2.5636 (0.2814)	0.6171 (3.2792)	-8.5121 (1.9712)	-1.2482 (0.1825)
ß3	0.1949 (0.0262)	0.1156 (0.0176)	0.1304 (0.0680)	0.1949 (0.0262)	0.1412 (0.0200)
ß4	–	–	0.1937 (0.8430)	–	–
Goodness-of-fit statistics					
R^2	0.9606	0.9619	0.9620	0.9606	0.9620
MSE	593.6078	573.9470	616.0128	593.6078	572.8819
RMSE	24.3640	23.9571	24.8196	24.3640	23.9349
Prediction at birth	>	√	√	√	>
Prediction at maturity	√	√	√	√	√

Note: > and √ denote over and correct prediction, respectively. Figures in the brackets indicate standard errors.

birth weight and maturity weight is good. Keeping these points in consideration Richard is best fitted model for F×S breed at Dehrudun Station followed by Gompertz model as this model over estimates the weight at birth and gives good prediction of weight at maturity. RMSE (13.3384) is more for Von Bertalanffy model than Gompertz model. Asymptotic weight (6.19.80) is maximum for Richards model followed by Gompertz (382.5) and Von Bertalanffy models. Growth rate (0.1534) is highest for Brody and Logistic models and the least (0.0207) for Richards model.

From Table 2, it is evident that RMSE (23.9349) is least for Von Bertalanffy model, but RMSE (23.9597) for Gompertz model is very close to this value and Gompertz model give good prediction for birth and maturity weight, so Gompertz model is best fitted model for F×S×H breed at Dehradun farm. Asymptotic weight (349.2) is maximum for Gompertz model followed by Richards model (343.2), Growth rate (0.1949) is maximum for logistic model.

By above results it is found that maturity weight is more for F×S breed than F×S×H breed, growth rate of F×S×H breed is better than F×S breed.

SUMMARY

Different sigmoidal nonlinear growth models are fitted in growth data of double cross Friesian×Sahiwal and triple cross Friesian×Sahiwal×Hariana breed at Dehradun station. In double crossbred Richards model gives better fit over other models whereas in triple cross Gompertz model is the best fit model. Growth rate is high in triple crossbred than double cross. Maturity weight was more in double-cross than triple-cross. Goodness-of-fit statistics shows better performance in double-cross compared to tripple-cross.

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