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Effect of farms on growth pattern of crossbred cattle

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Researchers in the field of behavioural 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 etc rests. Growth models are used to predict growth rates and change in the shape of the organism. Comparison of nonlinear models for weight age data in cattle has been done under homoscedasticity Brown *et al.* (1972), Brown *et al.* (1976), Alessandra *et al.* (2002), Kolluru *et al.* (2003). Lambe *et al.* (2006), also studied different growth models in lambs. Various nonlinear models are available for comparing the growth pattern of cattle, but comparison of growth pattern is needed to find most appropriate model

In this paper, comparison of performance of different breeds maintained at different farms has been done on the basis of non-linear models under homoscedastic error variance condition and heteroscedastic error condition on the data of same breed for different farms.

Data used in the study were collected from Dehradun, Agra and Bareilly farms for Friesian × Sahiwal × Hariana breed, from birth to 36 months of age. The data for cattle in case of Friesian × Sahiwal breeds was collected for Agra and Dehradun farms for comparing the growth pattern of cattle among farms. Following models are fitted for comparing the performance of double cross and triple cross cattle.

1. Logistic model

$$X_t = \beta/(1+\beta_{2e}^{-\beta_3^t})$$

2. Gompertz model

$$X_t = \beta_1 \exp(1\beta_{2e}^{-\beta_3^t})$$

3. Richards model

$$X_t = \beta_1 \exp(1+\beta_{2e}^{-\beta_3^t})^{1/\beta 4}$$

4. Von Bertalanffy Model

$$X_t = \beta_1/(1+\beta_{2e}^{-\beta_3^t})^3$$

5. Brody Model

$$X_t = \beta_1/(1+\beta_2 e^{-\beta_3^t})$$

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Where X_t is weight of cattle at time t, 1-Asymptotic weight, 2-Scaling parameter, ?3 -Rate of maturity, 4-Inflection parameter.

For testing for homogeneity of variances at different farm the Bartlett's test has been used, and it was found with the test result that there is a variability between the farms.

Measure of model adequacy

To determine the adequacy of the models, statistical measure, RMSE which is $\sqrt{\text{MSE}}$, is considered for judging the goodness of fit of the model. It is given by

$$\text{Root mean squared error (RMSE)} = \left[\sum_{i=1}^{n} \frac{Y_1 - \hat{Y}i}{n-p}\right]^{1/2} ;$$

n = number of observations, p = number of parameters in the model.

RESULTS AND DISCUSSION

From Table 1, 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 gives good prediction for birth and maturity weight, so Gompertz model is the 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.

RMSE (4.4825) values is least in Richards model observed from Table 2 and it also shows that prediction for birth weight and maturity weight is good. Therefore Richard is the best fitted model for F×S breed at Dehradun Station followed by Gompertz model as this model over estimates the weight at birth and gives good prediction of weight at maturity. Table 1 also indicates high RMSE for Von Bertalanffy model than Gompertz model. Asymptotic weight (619.80) is maximum for Richards model followed by Gompertz (382.5) and Von Bertalanffy models. Growth rate (0.1534) is the highest for Brody and Logistic models and the least (0.0207) for Richards model.

Table 1. Station-wise parameter estimates by different models under homoscedastic error structure

model	Parameter	Bareilly	Agra		Dehradun	
		F×S×H	F×S×H	F×S	F×S×H	F×S
Logistic	ß1	340.3000	339.5000	410.5000	327.8000	354.4000
		(16.5271)	(14.1131)	(13.6002)	(17.2990)	(15.6193)
	ß2	6.6046	6.9597	6.9597	8.5121	6.6555
		(0.9968)	(0.9061)	x(0.8657	(1.9712)	(0.8399)
	ß3	0.0404	0.1614	0.1623	0.1949	0.1534
		(0.0043)	(0.0147)	0.0114)	(0.0262)	(0.0142)
	RMSE	19.2179	16.1711	15.0360	24.3640	16.7320
Gompertz	ß1	368.0000	367.3000	446.1000	349.2000	382.5000
		(17.2467)	(13.6603)	(12.8978)	(23.9764)	(15.7104)
	ß2	2.3180	2.3697	2.5350	2.5636	2.3190
		(0.1215)	(0.0978)	(0.0807)	(0.2814)	(0.0966)
	ß3	0.0974	0.0967	0.0951	0.1156	0.0927
		(.00905)	(0.0070)	0.0051)	(0.0176)	(0.0072)
	RMSE	13.5646	10.4996	9.3217	23.9571	11.3109
Richards	ß1	619.9000	536.3000	526.3000	343.2000	619.8000
		(171.0000)	(59.7119)	(41.1868)	(32.9774)	(101.6000)
	ß2	–0.9849	619.8000	–0.8693	0.6171	–0.9811
		(0.0171)	(0.0165)	(0.0772)	(3.2792)	(0.0127)
	ß3	0.0195	0.0275	0.0503	0.1304	0.0207
		(0.0118)	(0.0072)	(0.0112)	(0.0680	(0.0074)
	ß4	–1.2270	–1.0838	–0.6752	0.1937	–1.1862
		(0.1840)	(0.1103)	(0.1589)	(0.8430)	(0.1165)
	RMSE	7.19420	4.2206	6.8825	24.8196	4.4825
Brody	ß1	340.3000	339.5000	410.5000	327.8000	354.4000
		(16.5270)	(14.1131)	(13.6002)	(17.29900	(15.6193)
	ß2	–6.6046	–6.9597	–8.0829	–8.5121	–6.6555
		(0.9968)	(0.9061)	(0.8657)	(1.9712)	(0.8399)
	ß3	0.1614	0.1614	0.1623	0.1949	0.1534
		(0.0175)	(0.0147)	(0.0114)	(0.0262)	(0.0142)
	RMSE	19.2179	16.1710	15.0360	24.3640	16.7320
Von-Bertalanffy	ß1	355.4000	354.6000	429.4000	339.5000	369.5000
		(16.7750)	(13.7857)	(12.9894)	(20.5903)	(15.5772)
	ß2	–1.0792	–1.1132	–1.2214	–1.2482	–1.0815
		(0.0864)	(0.0733)	(0.0634)	(0.1825)	(0.0703)
	ß3	0.1185	0.1180	0.1173	0.1412	0.1128
		(.1185)	(0.0093)	(0.0069)	(0.0200)	(0.0093)
	RMSE	15.6515	12.6185	11.3303	23.9349	13.3384

Figures in brackets indicate standard errors.

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

It is observed from Table 1 that F×S×H breed growth is maximum at Dehradun farm and minimum at Bareilly farm under homoscedastic error condition using nonlinear models. Maturity weight is found maximum at Dehradun farm and minimum at Bareilly farm.

Table 1 revealed that growth rate is found better at Agra farm than Dehradun farm for F×S breed under homoscedastic error condition using nonlinear models and maturity weight is also found to be better at Agra farm than at Dehradun farm.

RMSE is least for Dehradun farm for F×S×H breed for logistic model Table 2 and Growth rate is found better for Bareilly farm. The maturity weight is found to be maximum at Dehradun farm and minimum at Agra farm when models

Table 2. Station-wise parameter estimates by different model under heteroscedastic error structure

Model	Parameter	Bareilly	Agra		Dehradun	
		F×S×H	F×S×H	F×S	F×S×H	F×S
Logistic	ß1	287.9250	285.6676	343.9066	303.6285	289.2903
		(2.3784)	(2.7842)	(4.0048)	(2.7840)	(3.3954)
	ß2	8.9420	9.2417	10.4364	9.7401	8.8038
		(0.1056)	(0.1272)	(0.1656)	(0.1208)	(0.1473)
	ß3	0.2643	0.2618	0.2531	0.2409	0.2659
		(0.0028)	(0.0032)	(0.0034)	(0.0025)	(0.0040)
	RMSE	0.1320	0.1427	0.1534	0.1346	0.1571
Gompertz	ß1	318.6515	315.6594	315.6594	337.3123	318.0417
		(1.1803)	(1.4062)	(1.4062)	(2.4365)	(1.8383)
	ß2	2.4832	2.5214	2.5214	2.5720	2.4744
		(0.0042)	(0.0051)	(0.0510)	(0.0079)	(0.0067)
	ß3	0.1361	0.1354	0.1354	0.1236	0.1394
		(0.0006)	(0.0008)	(0.0008)	(0.0011)	(0.0011)
	RMSE	0.0778	0.0851	0.0851	0.1040	0.0981

are fitted under heteroscedastic error condition.

F×S breed growth rate is found (Table 2) to be better at Dehradun farm than at Agra farm. The maturity weight is also found to be better at Agra farm than at Dehradun farm under heteroscedastic error condition.

SUMMARY

Different sigmoidal nonlinear growth models are fitted in growth data of double cross Friesian×Sahiwal and triple cross Friesian × Sahiwal × Hariana breed at different farms. It is found that growth rate of Friesian×Sahiwal× Hariana breed under homoscedastic and heteroscedastic error condition is found maximum at Bareilly farm and minimum at Dehradun farm. Maturity weight is maximum at Dehradun farm and minimum at Agra farm. For Friesian × Sahiwal breed maturity weight is better at Agra farm than Dehradun farm. Growth rate is better at Dehradun farm than at Agra farm.

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