

COUNTRY: BRAZIL

SESSION: ANIMAL GROWTH AND DEVELOPMENT

EFFICIENCY OF NON-LINEAR MODELS FOR ESTIMATION OF GROWTH CURVE PARAMETERS OF HOLSTEIN-FRIESIAN FEMALES

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ABSTRACT

Estimates of growth curve parameters are important for decision-making in breeding and management programs of dairy cattle. In Brazil little is known about the relative efficiency of non-linear models for estimating growth curve parameters of Holstein-Friesian females, especially for weights at ages older than 24 months. The objective of this study was to compare the relative efficiency of five non-linear models, namely von Bertalanffy, Brody, Gompertz, Logistic and Richards, for estimating weight at maturity (A) and maturing rate (k) of 323 Holstein-Friesian females born from 1993 to 2000 and raised on an intensive dairy cattle production system at Embrapa - Southeast Cattle Center, São Carlos, São Paulo state, Brazil. The data (N = 7,836 body weight records obtained from birth up to ages older than 24 months) were analyzed utilizing the Gauss-Newton iterative method through the Non-Linear Regression (NLIN) procedure of the Statistical Analysis System (SAS) package. The relative efficiency of each non-linear model for estimating weight at maturity and maturing rate was measured as a multiplicative index of the following criteria: convergence percentage, determination coefficient, quality of adjustment and residual mean square. The classification of the models according to the relative efficiency index was: 1) von Bertalanffy = 77.35%; 2) Brody = 33.32%; 3) Logistic = 15.30%; 4) Gompertz = 9.24%; and 5) Richards = 0% (convergence criterion not met). Therefore, the von Bertalanffy non-linear model should be the model of choice for obtaining estimates of weight at maturity and maturing rate in Holstein-Friesian females.

KEYWORDS

Dairy cattle, mature weight, maturing rate.

INTRODUCTION

Estimates of growth curve parameters are important for decision-making in breeding and management programs of dairy cattle. In Brazil little is known about the relative efficiency of non-linear models for estimating growth curve parameters of Holstein-Friesian females, especially for weights measured at ages older than 24 months. The simplest definition of growth was formulated by Seebeck (1968) in which growth is seen as the change in the animal size according to time. Parks (1982) added that the change in size could also be on liveweight or mass according to time or other variable, as an empirical description of growth independent of any

theory. Growth curve parameters (especially weight at maturity and maturing rate) are used to describe the process. There are a few studies in Brazil with the objective of studying non-linear models for estimation of the growth curve parameters of dairy cattle (Kroll, 1990; Freitas et al., 1997; Perotto et al., 1997a,b; McMannus et al., 1998; Bergamasco et al., 2001). However, in most cases only liveweights up to 24 months of age have been used to estimate growth curve parameters. Also there is no consensus about the most efficient model, mainly because the correlation among the estimates have been found to be low. The objective of this study was to compare the relative efficiency of five non-linear models (von Bertalanffy, Brody, Gompertz, Logistic and Richards) for estimating weight at maturity (A) and maturing rate (k) of Holstein-Friesian females utilizing records from birth to ages older than 24 months.

MATERIALS AND METHODS

Liveweight data analyzed in this study were recorded monthly from birth up to time of disposal (death or sale) on Holstein-Friesian females born from 1993 to 2000 in the intensive dairy cattle production system at Embrapa - Southeast Cattle Center, São Carlos, SP, Brazil. In the intensive dairy cattle production system, during the rainy season (October-March) the females are raised on pastures of *Panicum maximum* cv. Tanzânia and *Tobiatã* and *Pennisetum purpureum* cv. Elefante, with rotational grazing, and supplemented with concentrates according to age and stage of production. During the dry season (April-September) females are supplemented with corn silage or sugarcane corrected with urea and concentrates. The data (N = 7,836 body weight records obtained from birth up to ages older than 24 months) were analyzed utilizing the Gauss-Newton iterative method through the Non-Linear Regression (NLIN) procedure of the Statistical Analysis System (SAS, 1995) in order to obtain the estimates of weight at maturity (A) and maturing rate (k) utilizing five non-linear models (Bertalanffy, Brody, Gompertz, Logistic and Richards). Non-linear model equations are given in Table 1. The relative efficiency of each non-linear model for estimating weight at maturity and maturing rate was measured as a multiplicative relative (%) index of the following criteria: convergence percentage, coefficient of determination, quality of mature weight adjustment (percentage of estimates between two standard deviations from the average observed liveweight of mature cows) and residual mean square.

RESULTS AND DISCUSSION

Means for mature weight, maturing rate, convergence percentage, coefficient of determination, quality of adjustment and residual mean square are shown in Table 2. Means for mature weight and maturing rate were estimated only for those females where the convergence criterion was met by the non-linear model. With respect to the convergence criterion the non-linear models ranked as follows: Bertalanffy, Brody, Logistic, Gompertz and Richards. The computational easiness of the Bertalanffy model proportionate an excellent convergence (100%) and quickness of the iterative process (average of 5.04 iterations ranging from 2 to 10). These results are similar to those reported in Brazil by Duarte (1975), Carrijo (1988), Silva (1998) e Silva et al. (2000) with iteration averages varying from 8 to 9. Although with good convergence percentage, the Brody's model had a higher average number of iterations (19.33) and estimated mature weight with values

outside the parametric space; similar results were found by Bergamasco et al. (2001). Both the Logistic and the Gompertz models presented low number of iteration averages (3.08 and 2.87 respectively), but were very poor in terms of convergence percentage. Bergamasco et al. (2001), in contrast to the results obtained in this study, reported higher convergence percentage of the Gompertz model. The estimates of mature weight obtained with the Gompertz and the Logistic models (Table 2) were similar to those reported for Holstein-Friesian females in Brazil by Freitas et al. (1997), McManus et al. (1998) and Bergamasco et al. (2001). The Richards model, with the parametrization adopted in this study, presented a very high computational difficulty which resulted in a null convergence, as has been reported by Oliveira et al. (2000) and Tedeschi et al. (2000) in beef cattle. Perotto et al. (1997a), however, recommended the Richards model for estimating growth curve parameters of crossbred Holstein x Zebu females. For all models in which the convergence criterion was met the coefficient of determination was higher than 99%, result even better than that reported by Freitas et al. (2000). The best quality of mature weight estimates, when the convergence criterion was met, was obtained for the Gompertz and Logistic models (100%), followed by the Bertalanffy and Brody models (Table 2). According to the multiplicative relative index the non-linear models were classified in the following order: 1) Bertalanffy = 77.35%; 2) Brody = 33.32%; 3) Logistic = 15.30%; 4) Gompertz = 9.24%; and 5) Richards = 0.00%.

CONCLUSIONS

From the five non-linear models evaluated in this study, four of them met the convergence criterion for at least 10% of the 323 Holstein-Friesian females. The efficiency of the non-linear models for estimating the growth curve parameters (mature weight and maturing rate) according to the multiplicative relative index was as follows: 1) Bertalanffy = 77.35%; 2) Brody = 33.32%; 3) Logistic = 15.30%; 4) Gompertz = 9.24%; and 5) Richards = 0.00%. Therefore, the Bertalanffy model should be utilized to obtain estimates of the growth curve parameters of Holstein-Friesian females.

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