Analysis of longitudinal data of Polled Nellore cattle using nonlinear models

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The most commonly models used to describe animal growth are the Brody, Von Bertalanffy, Logistic and Gompertz functions. The study of growth curves is done mainly through interpretation of parameters such as asymptotic weight, relative growth, absolute, instant and maturation rates, which helps explain animal's growth and development over time, and identify heavier individuals at younger ages. Growth modelling can be used to assist in all production processes stages, such as nutritional management and genetic improvement. So, the aim of this study was to analyze and determine the nonlinear model that best fits growth data of Polled Nellore females raised on pasture in the Cerrado biome. Data used to fit the various models comprised 217 Polled Nellore females, born between 2000 and 2013, belonging to the Embrapa Cerrados, located near Brasília-DF, Brazil. Cattle were weighed from birth to adult age. The following models were fitted to the age and weight data for each sex: Brody: $y_t = A(1-B \exp-kt)$; Von Bertalanffy: $y_t = A(1-B \exp-kt)^3$; Logistic: $y_t = A/(1+B \exp-kt)$; Gompertz: $y_t = A \exp(-B \exp-kt)$; where y_t is body weight at t months old; A is asymptotic mature body weight; B is an integration constant; and k is the maturation rate. For model comparisons, the criteria of mean square, correlation coefficient, mean prediction error, and mean absolute deviation of residuals were used. Based on the model parameter estimates, additional growth parameters were derived, such as relative growth, absolute, instant and maturation rates. Logistic model showed less satisfactory results, while Brody model presented the best adjustments. Therefore, the use of this last model is suggested to describe analyzed herd growing. All models overestimated average birth weight, and underestimated the average weight at adult age. Among all models the one that best adjusted weights to their age was Brody model. Brody model seems to be the most adequate to describe Polled Nellore growth curve, thereby, the curve describe by the model with parameters found in the analysis indicated as an average growth pattern of this breed. Brody model has no inflection point; instant growth rate has shown to always be decreasing starting with a gain around 727 g day^{-1} and was reduced to zero at adult age. In studies which animals have been weighed into adult age, instant growth rate decreases up to where it reached close to zero values when animal maximum growth is achieved. Brody model presented up to two months, the higher relative growth; and maturation rate presented birth average estimative of 0.14% with constant decrease over time. For Brody model, it was observed negative correlation (-0.70) between asymptotic weight and maturity rate. These results indicate that precocious animals have less probability of achieving higher weights into adult age. The negative correlation existing between these parameters indicates that lower growth rates animals reach higher weights at maturity. It was found a pronounced decrease in absolute growth rate in post-weaning phase. So, nutritional strategies should be implemented in order to minimize the smaller weight gain during this phase. The use of growth curves can elucidate factors that influence animal growth at a given age, showing some kind of handling mistake, which can be corrected. So, with this model it is possible to select females to lowest adult weight and are more precocious, which can help to improve the reproductive efficiency of this herd.

Keywords: animal breeding, asymptotic weight, growth curve, maturation rate