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SELECTING HIGH PERFORMANCE RABBITS AT EARLY AGES THROUGH AN STOCHASTIC APPROACH

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ABSTRACT

A stochastic modeling approach was used to detect at early ages during rabbit growth those individuals which will show better performance. The procedure can be helpful for selection purposes or to check if an animal is growing according to its own pattern. The stochastic model can be based on any known rabbit growth curve but its parameters should be historically chosen according to the breed being raised. In this study five New Zealand White females randomly chosen from different litters were weekly weighed from birth to reproduction age (154 days). A Gompertz growth curve showed best fit to the data. Historical information on New Zealand White and average birth weight from present data were used to define the model W_t*=51∗exp(0.113∗(1-exp(-0.026∗t))/0.026), where W_t* is the estimated animal weight in g on day t. The stochastic approach is very powerful as it requires the true weight obtained in the last measurement (W_{t-1}) and provides the expected weight value for age t, $E(W_t)= W_t^*[(W_{t-1})/ (W^*_{t-1})]^{0.8}$. When a rabbit at age t shows real weight $W_t > E(W_t)$ it is an above average animal and can be selected as such. Also, in following the growth of a given animal, when the above inequality shows consistence in sequential ages and then abruptly changes, it is expected that some source (mostly external) affected its growth alerting for intervention.

Key words: growth hazards, stochastic growth model, weight selection.

INTRODUCTION

Studies of animal weight as a function of its age define what is said to be an empirical model, with no mechanistic implications. Under adequate feeding conditions growth follows specific patterns in time depending on the species being considered. When modeling rabbit growth both Gompertz and Von Bertalanfy equations produce a reasonable fit showing coefficients of determination around 0.95. Although this figure could be appealing for linear models, non linear equations require $R^2 \geq 0.98$ to reveal more adequate fit. Therefore a model with R^2=0.95 may indicate areas on the curve where data do not closely match. This is the case for the above mentioned equations, which over and underestimate birth weight (t=0), respectively. Yet, they have been used to describe rabbit growth, for they seem to predict weight fairly well from the seventh day on. Adding a stochastic element to a deterministic growth model was suggested by SANDLAND & MCGILCHRIST (1979) but did not attract enough attention to encourage further development. HENSTRIDGE &TWEEDIE (1984) presented a stochastic growth model which required the previous animal's weight before predicting the next outcome in the growth process measured at fixed time intervals. Due to its conditionality such a recursive model is not always practical when the objective is to predict weight after a long term. This is not the case of following milk production of a dairy cow, when there may be some interest in predicting next week yield based on the week in course (GOODALL & SPREVAK, 1984). Because the stochastic approach considers both the average response of a breed and last yield of one animal, next yield estimate will closely follow its true value. Then considering a known growth pattern, at a certain age if a target animal presents weight higher than its stochastic expectancy, then it will be probably an outstanding animal within its group. The objective of this study was to define the basis of early animal selection through a practical stochastic technique.

MATERIAL AND METHODS

Animals

Five New Zealand White females were randomly chosen from different litters (average size 6), tattooed and kept with litters until weaning (on day 30), when went to individual cages. Weight was recorded weekly from birth to day 154 when animals were headed for reproduction.

Locale and feeding regime

Ihe experiment took place at the Experimental Unit in Igarape, southwestern Brazil, under temperatures ranging from 21 to 28°C. After weaning *ad libitum* feeding was granted by automatic feeder and drinking nipple. Animals were fed a complete pelletized diet with 16% of crude protein, 19% of acid detergent fiber, 1.1% of calcium, 0.8% of phosphorus and 2500 kcal of digestible energy/kg throughout the experiment.

Stochastic model

GOODALL & SPREVAK (1984) suggested the model with multiplicative error W_t=$W^*_t.\varepsilon_t$ where W_t is the true weight at time t, W^*_t is the deterministic component of the model corresponding to a Gompertz equation W^*_t=A exp(B*(1-exp(-Ct))/C) and ε_t is the error element. Hence log W_t=log W^*_t+log ε_t . The term log ε_t can be considered as a function of time forming a time series with a high degree of correlation. If an auto correlation is then included, the value of log ε_t can be modeled as log ε_t = α log ε_t + e_t. This is a first order autoregressive model where e_t is independent and normally distributed with mean zero and $|\alpha|$<1, estimated from any real rabbit data by the least squares procedure. Then $E(W_t)$= W^*_t $[W_{t-1}/ W^*_{t-1}]^{\alpha}$ where $E(W_t)$ is the estimated weight for a given rabbit at age t corrected for stochastic variation.

Setting the standard growth curve

The deterministic component must be numerically defined in order to feed the stochastic process. Under the assumption that growth pattern follows a Gompertz equation, their parameters A, B and C should be provided in advance, either using historical data information or mathematical manipulations. The asymptotic correlation of those parameters are smaller when one of them is C. This means that its value should be the first to be set. Historically C=0.023 to 0.029 (SAMPAIO & FERREIRA,1998), then it is advisable to set c=0.026. New Zealand White females are known to weigh around 51 g at birth and 3600 g at maturity. (RAO *et al*, 1977; NUNES *et al*, 1984 a, b) Then, if A is taken as 51 (even knowing that the Gompertz equation overestimates birth weight), B can be calculated in the equation by seting a known weight for a time t (for example, 3600 g at age 154 days). Due to the prospective nature of the study the equation so obtained does not intend to catch the best fit for a data set which still does not exist. However the stochastic approach is very powerful in correcting eventual distortions caused by proposed standard equation (SAMPAIO, 1988).

Selecting high performance rabbits

Many causes can disrupt an expected growth pattern. External causes are denounced by abrupt change when growth is observed sequentially. If this happens with an animal, the stochastic process tries to redirect its growth towards the natural trend. The animal may recover and catch the expected potential weight. Genetic causes cannot be corrected. The stochastic process adjusts animal weight for eventual fluctuations, but actual weight is generally higher than its stochastic estimate when the animal is an above average individual. So whenever at an age t the animal shows weight $W_t > E(W_t)$, it is a high performance rabbit in terms of growth. Litter size effect can disturb the process during lactation time, therefore, this sort of growth capacity test should be performed only after eventual weaning stress is overcome.

RESULTS AND DISCUSSION

Birth weights varied from 50 to 53 g and averaged 51 g so the value of A should be taken as 51. If historically C is 0.026 and adult weight for a New Zealand White female ready for reproduction is around 3600 g (at age 154 days), then B can be calculated from the Gompertz equation and should be 0.113. Therefore the standard equation used as deterministic component was W^*_t=51exp(0.113*(1-exp(-0.026$*$t))/0.026). To apply the stochastic model $E(W_t)= W^*_t\ [W_{t-1}/\ W^*_{t-1}]^{\alpha}$ the value of α was calculated based on historical data and was set to 0.8 (ranging from 0.7 to 0.9 and in actual data set α=0.77). Figure 1 shows the standard Gompertz equation, the observed weights for two females (namely the heaviest and lightest females at 154 days), and their stochastic growth curves. Notice that female H (heaviest) always presented actual weight higher than expected by its stochastic estimate so that at 42 days it could have been selected as a high performance individual. The standard Gompertz equation does not represent the average growth response of all five studied animals, but defines the growth pattern to the stochastic algorithm. So this equation should not be taken as a critical line separating rabbits with high and low performance. What really counts is the relative position of the real weight with respect to the stochastic response curve for a given rabbit at age t. If a Gompertz equation was estimated from actual data the best fit would correspond to the model W^*_t=61.6exp(0.110*(1-exp(-0.0266$*$t))/0.0266), but this would only be known at the end of the trial. In fact the main interest is to anticipate technical information at age t before the animal reaches maturity.

Female L (lightest in Figure 1) in its turn can be taken as a low performance individual when its growth is checked until maturity. However, after weaning (30 days) and free of competition it showed a compensatory growth affecting its classification for, from day 35 to 49, its real weight was higher than its stochastic estimate, $W_t>E(W_t)$. At 56 days however it resumed its true classification. The effects of compensatory growth and weaning stress, (as slightly present in female H at day 35) are controlled by the process only after some time. Results suggest waiting 21 days after weaning.

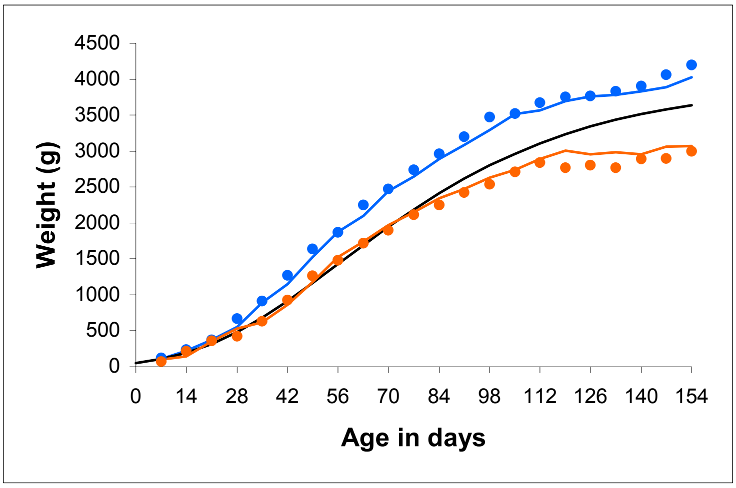

Figure 1. New Zealand White female weights as a function of age in days: standard Gompertz equation (⁄), stochastic model for female H (⁄) and L (⁄) and observed weights of female H (•) and L (•).

Actual data should provide good selection basis from day 56 on (weaning at 30 days plus 21 days of adaptation). Female H weighed 1640 g at 49 days and 1876 g at 56 days. For the same female W*49=1167.1 g and W*56=1428.8 are estimated according to the standard Gompertz equation W*t=51exp(0.113*(1-exp(-0.026$*$t))/0.026). Then the stochastic figure for E(W*56) is 1428.8[1640/1167.1]0.8 =1875.7 g which is nearly the observed weight, 1876 g. Experimenter should decide according to his perception based not only on the difference Wt -E(Wt) but also in its absolute value. Female H at 56 days would be selected as a high performance individual despite the negligible difference Wt -E(Wt) (which could have been even negative). In case of doubt it may be necessary to check the previous or the next age point. Due to the scale in Figure 1 distances do not reflect real differences in weight which go from zero to 238 g.

Animals meant for reproduction deserve constant attention during their growth, not only by checking their classification but also by detecting in due time any disruption in their growth trend. Take female L as an example. Observe its growth from 77 to 112 days showing a nearly linear pattern (Figure 1). Between 112 and 119 days something must have happened so that at day 119 it weighed 2770 g, much less than expected by the stochastic algorithm. As W_{112}=2840 g, W^*_{112}=2892.4 g and W^*_{119}=3232.5, its stochastic estimate of next weight $E(W_{119})$ is then $3232.5[2840/2892.4]^{0.8}=3007.6$. It can also be observed that female L never recovered its former growth trend. Experimenter intervention should have been triggered at day 119 if the stochastic approach were available.

CONCLUSIONS

When dealing with elite animals meant for reproduction stochastic modeling can be a powerful tool for selecting and checking growth patterns of rabbits. High performance individuals in terms of weight can be spotted as soon as 21 days after weaning. Disturbances in the growth pattern can be detected in due time allowing prompt experimenter intervention.

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