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Full Length Research Paper

Selecting for higher growth in rabbit raised in the rainforest zone of Nigeria using stochastic approach

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Five hundred and fifty four weekly body weight records of mixed strains of Dutch and New Zealand White rabbits were analysed to model the growth of rabbits using the stochastic approach for improved breeding. The weekly body weights were collected from 2 weeks to 22 weeks of age when the rabbits were sexually matured. The result of stochastic modeling approach on the data gave a deterministic equation of W*t=29.4exp(0.809*(1-exp(-0.007*t))/0.007) as against a standard deterministic equation of W*t=51exp(0.113*(1-exp(-0.026*t))/0.026) obtained from historical information on New Zealand White rabbit. The stochastic model showed that all rabbits used in the study were poor performance animals whose growth can however be manipulated at week 7 and week 4 and 9 for heavy and light females respectively for improved growth.

Key words: Selecting higher growth, stochastic approach, rabbits.

INTRODUCTION

Rabbit production, though not popular in Nigeria, however holds the key to cheap and sustainable animal protein source. Availability of rabbit meat will depend on rabbit growth. The lifetime inter-relation between an individual's inherent impulses to grow and mature in all body parts and the environment in which the impulses are expressed can be expressed with growth models. Improvements in the ability to model growth processes as a sigmoidal function have allowed the detection of differential growth responses to a variety of stimuli (Leberg et al., 1989). In the literature, many models that describe the growth response of animals in general are presented (Brody, 1945; Fitzhugh, 1976; Parks, 1982; Moore, 1985). Many of the models are mechanistic, which are excellent for gaining insight, transfer of scientific knowledge and for simulation of processes (Aerts et al., 2003).

Besides mechanistic models, empirical models have been used to describe animal weight as a function of its age. Sandland and McGilchist (1979) added the stochastic element to a deterministic growth model though did not attract enough attention to encourage further development. However, if selection is to be targeted at selecting outstanding animals within a group, the stochastic approach will be more appropriate since it considers both the average response of a breed and the last growth value of an animal. With the stochastic approach, animal's that present weight higher than its stochastic expectancy will be probably an outstanding animal within its group (Sampaio et al., 2004). The objective of this study therefore was to model rabbit growth to obtain information for selecting improved growth performance through a practical stochastic technique.

MATERIALS AND METHODS

Location

The experiment was carried out at the rabbit experimental unit of the University of Benin Farm Project, Benin City, Nigeria. The University is located on latitude 6° and 30'N of the equator and longitude 5° 40' and 6°E of the Greenwich meridian in the rainforest zone with average temperature of 27.6°C, annual rainfall of 2162 mm and mean relative humidity of 72.5%.

Animals and management

The animals used were litters from mixed strains of crosses of New Zealand White of different colour shadings. The foundation population consists of 40 females and 10 males with average age of 5 months purchased from private rabbit farmers in Northern

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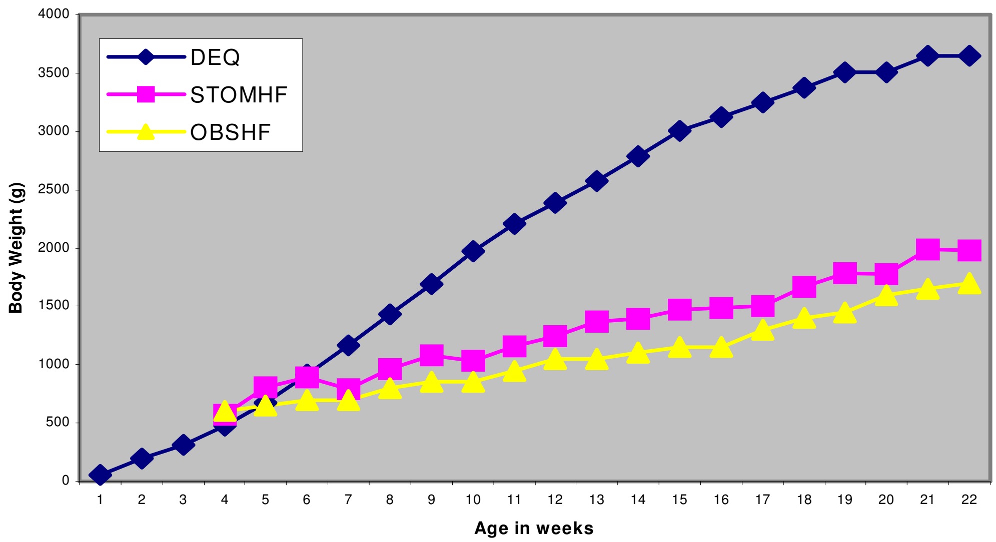

Figure 1. Body weight of female rabbits as a function of age: Standard Gompertz equation (DEG), stochastic model for heaviest female (STOMLF) and observed weight of heaviest female (OBSLF).

Nigeria. The rabbits were housed in individual hutches with separate feeders and drinkers. The house is typically of concrete floor and metallic roof. It has open-sided wire mesh with dwarf wall made of zinc to ensure adequate ventilation. Each rabbit was provided with a metallic feeder hung at a reasonable height to prevent feed spillage and weighted clay bowls for water. Daily observation of the rabbits and other routine management practices were carefully carried out. All animals were given the same management and environment.

Data collection

544 individual weekly body weights of rabbit kittens from 2 weeks to 22 weeks of age were obtained using a weighing balance of 10 kg capacity with 0.01 kg accuracy.

Mathematical modeling

Many of the models proposed in the literature to model animal growth have wide range of equations that describe animal growth as a function of time (age) by making use of nonlinear regression equations (Parks, 1982). Of these empirical models, the Gompertz equation was found to be most suitable for describing growth (output), but not inputs such as feed consumption or feed composition. Gompertz model is represented as:

$W = A\exp(-b \exp(-kt))e^{be-kt}$ (Fitzhugh, 1976)

Where, W is the weight at time t (kg); A is mature weight (kg); b is a scaling parameter; k is a function of the ratio of maximum growth rate to mature size (1/d); t is time in weeks. Since the objective of the study was aimed towards better growth performance and because many causes can disrupt an expected growth pattern of an animal, the stochastic process as suggested by Sampaio et al. (2004) was used since it tries to redirect animal's growth towards the natural trend. The stochastic process only adjusts animal's weight for eventual fluctuations, since genetic causes cannot be corrected. The stochastic model as suggested by Goodall and Sprevak (1984) is a model with multiplicative error

$W_t = W^x_t \, . \, e_t$

Where, Wt is the true weight at time t, W^x_t is the deterministic component of the model corresponding to a Gompertz equation. W^x_t = A exp (B*(1-exp(-ct))/C and e_t is the error element. Hence log W_t = log W^x_t + log e_t. The term log e_t can be considered as a function of time forming a time series with a high degree of consideration. If an auto correlation is then included, the value of log e_t can be modeled as log e_t =∝log e_t + e_t. This is a first order autoregressive model where e_t is independent and normally distributed with mean zero and I∝I <1. Then

$E(W_t) = W^x_t \; [W_{t-1} / W^x_{t-1}]^{\propto}$.

Where, $E(W_t)$ is the estimated weight for a given rabbit at age t corrected for stochastic variation. Estimated weights for 2 animals (the heaviest and the lightest female at age 22 weeks) were then obtained for comparison with actual weight.

Statistical analysis

The nonlinear Gompertz equation was fitted using an iterative least squares algorithm. The parameters A, B and C of the deterministic equation and α of stochastic model used for this study were obtained from historical data information (Rao et al., 1977). The parameters were fitted into the stochastic model to obtain estimated weight. Body weights at different ages were generated using JMP start statistical (Sall et al., 2005).

RESULTS AND DISCUSSION

Selecting for higher growth

The standard equation obtained for the deterministic component was W*t=51exp(0.113*(1-exp(-0.026*t))/0.026). Values obtained for the standard equation used as the deterministic components, stochastic growth curve and observed weights for the heaviest and lightest female at age 22 weeks are depicted in Figures 1 and 2 respectively. Gompertz equation parameters

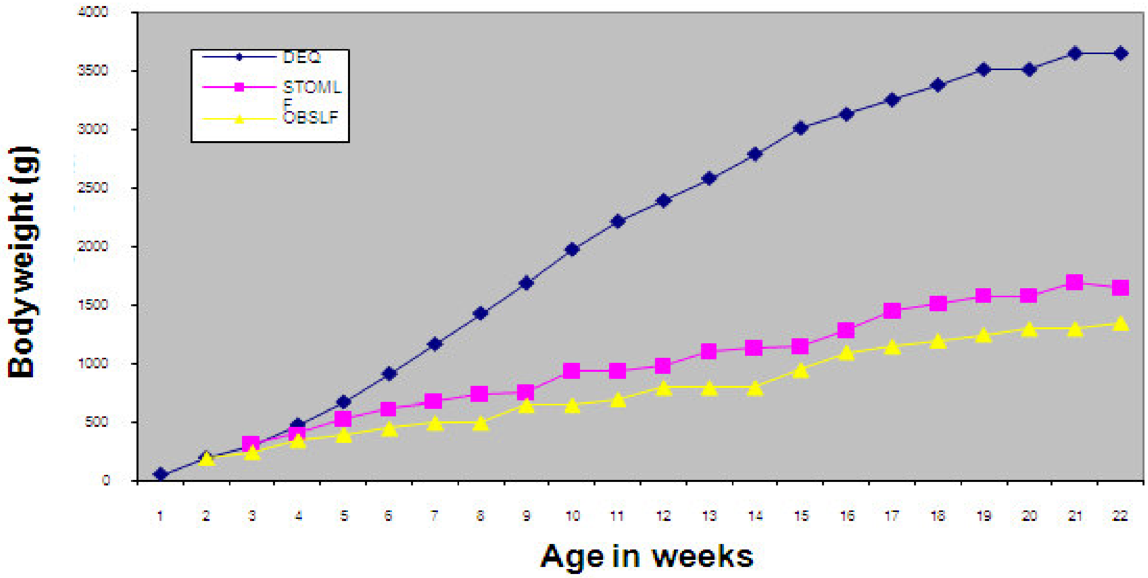

Figure 2. Body weight of female rabbits as a function of age: Standard Gompertz equation (DEG), stochastic model for lightest female (STOMLF) and observed weight of lightest female (OBSLF).

estimated from actual data was W*t=29.4 exp(0.809*(1-exp(-0.007*t))/0.007). Such equation can only be generated at maturity but if selection is to be done early in life, we need technical information at early age before the animal reaches maturity which was the purpose for this study. The female that weighed heaviest at sexual maturity that could have been presumed to be a good performance animal technically is not, as none of the observed weight value was higher than the stochastic value except only at age 4 weeks when the values were close (Figure 1). An animal is regarded as high performance individual when Wt > E(Wt). At week 7 the animal performance was fairly close to its stochastic value giving the impression that it could be a good performance individual but thereafter reversed to its true performance and was consistently lower with difference of between 159 and 341 grams. The lightest female at sexual maturity had value that was close to its stochastic value at ages 4 and 9 weeks. However, the differences in values between the stochastic and observed weights range from 272.51 to 329.69 g (Figure 2). Ages were observed, weights that were close to stochastic weights suggested that the animals may have had compensatory growth which could have affected their classification but they could not sustain it and therefore remained classified as poor performance individuals.

However, the results of this study therefore suggest that though the heaviest and lightest female at sexual maturity were generally poor performance individuals, attempt at manipulating their growth at week 4, 7 and 9 for the heavy and light females respectively will improve their growth. The results further suggest that rabbits would respond to selection better at 7 and 9 weeks of age. Hassan (2004) also made similar observation when he reported that New Zealand white rabbits responded to selection better at 8 weeks of age where percentages of the rabbits that possess positive values were higher. Similarly, Iraqi (2008) concluded that since the estimate of heritability was higher for body weight at 8 weeks than other ages as well as obtaining the highest genetic correlation between 8 and 12 weeks, selection will be more effective at 8 weeks of age to improve post weaning growth traits in Gabali rabbits.

Conclusion

It can therefore be concluded that though rabbit populaion used in this study had stochastic values higher than their observed weights, thus indicating poorer performance, considerable potential for improvement can be achieved at age 7 or 9 weeks through their selection.

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