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Original Research Article

MODELING AND ALGORITHM DEVELOPMENT FOR RED SHEEP

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Abstract: Modeling animal growth and production data can be helpful in understanding the pattern of growth and production for different species of animals. Further this can help in evolving strategies to address low productivity and augment production as well. Analysis of longitudinal growth data of Madhya Pradesh red sheep using Linear Mixed Effects (LME) model indicates that the conditional quadratic model with heterogeneous AR (1) error covariance structure is good with the covariates, dam's weight at lambing and gender of lamb showing marked influence on the growth parameters. Season of birth is found to be significant only for growth rate and not for the intercept. Among the ANN models developed for the longitudinal growth data of Madhya Pradesh red sheep, ANN (Artificial Neural Effects) model using Multilayer Perceptron (MLP) architecture is found to perform better when compared to the ANN model based on RBF architecture. Further, when the ANN model based on MLP architecture is compared with the best LME model, it is found that ANN model based on MLP architecture is better than the LME model based on the reliability coefficient concluding that ANN can be considered as an useful alternative modeling technique for longitudinal growth data of Madhya Pradesh red sheep with better predictive ability.

Key-words: Non-linear Model, Body Weight, Growth Factor,

Introduction: The word "Non-Linear Programming" was first introduce by Albert W. Tucker [1] and Hourshell D [2] in the summer of 1950 at the Second Berkeley Symposium on Mathematical Statistics and Probability, held at Berkeley, California. They gave a discipline the title 'Non-linear Programming', which were presently available in conference measures and for the original time the name 'Non-Linear Programming' - the title Kuhn and Tucker [2] prefer for their paper-appeared in the mathematical journalism [Kuhn and Tucker 1950 [3]. In their paper Kuhn and Tucker introduce a non-linear programming difficulty and proved Kuhn-Tucker theorem which gives needed

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circumstances for the survival of a best solution to a non-linear programming problem. Kuhn and Tucker were not the primary to establish this theorem. William Karush [4] was the primary one to establish the similar theorem in 1939 in his master's theory from the University of Chicago and second was the Frit John [5] who derivative the same result in a paper published in 1948 in an dissertation collection for Richard Courant's [6] 60th birthday. John and Karush [7] work has not been measured by the mathematician at that moment, it was Kuhn and Tucker whose workings has been conventional by the mathematicians at that time.

Growth is an important attribute of organisms. Growth has been defined as an irreversible, correlated and coordinated add to in mass of the corpse in an exact period of time. Expansion model relate the standard weight of dissimilar organisms as a purpose of their era [12-14]. So; in present study,

Materials and Methods: The Madhya Pradesh red sheep, which were selected for these studies, are an original breed of Bhopal and Sehore districts of Madhya Pradesh state and are being maintained underneath the AICRP for sheep development. Data on review body weight calculated of 1,523 sheep from origin to 2 years of age born during the years 2016 to 2018 along with sex of lamb, season of birth, dam weight at lambing, year of birth and average daily weight gain (in grams) during the periods 0-3, 3-6, 6-9 and 9-12 months is collected to characterize the whole increase profile. Weaning of lambs is done at three months of age.

Madhya Pradesh red sheep are maintained under semi-intensive system of management. In addition to grazing, rams are fed concentrate @ 300 grams/day and ewes are fed concentrate @ 250 grams/day. Lambs are provided concentrate feed (creep feed) @ 100 grams/day. Monthly weight of sheep is recorded using a digital weighing scale with an accuracy of 100 grams. System of housing used for the sheep is pen and run with a spacing of 15-20 sq. ft./ animal.

A nonlinear regression model is one in which at least one of the parameters appears nonlinearly and even after transformation remains nonlinear. Estimation of nonlinear model parameters cannot be done by the conventional principle of least squares as the partial differential of the residual sum of square with respect to at least one of the parameter will be a function of that parameter. This is because when a model is nonlinear in the parameters, so are the normal equations. Consequently, it is impossible to obtain a closed form solution to the least squares estimate of the parameters by solving the normal equations. So we need to use iterative methods to minimize sum of squared errors for estimating the parameters.

In this work, goodness of fit of the models was assessed using Mean Absolute Error (MAE), Mean Squared Error (MSE) and Akaike Information Criterion (AIC) along with Coefficients of determination (R^2 values) as given below.

$$R^2 = 1 - \frac{\sum (y - \hat{y})^2}{\sum (y - \bar{y})^2}$$

$$MAE = \frac{\sum |(y - \hat{y})|}{n}$$

$$MSE = \frac{\sum (y - \hat{y})^2}{(n - p)}$$

$$AIC = n \log_e (MSE) + 2p$$

Where p is the number of parameters in a model. A good model will have a very high value of R2 and very low values of MAE, MSE and AIC.

Body Weight:

The fixed effects model used for the analysis is

$Y_{ijklm} = \mu + S_i + G_j + D_k + T_l + \varepsilon_{ijklm}$

Where *Yijklm* is the adjusted monthly weight of the m^{th} lamb,

μ is the overall mean,

Si is the fixed effect of the i^{th} season (*i*=main, off),

Gj is the j^{th} gender (j = female, male),

Dk is the k^{th} weight group of the dam at lambing (k=<25, 25-29.99, 30-34.99, ≥ 35 kg),
Tl is the *lth* time period (*l*=1996-2000, 2001-05, 2006-10) and ε_{ijklm} is the error attributed to the m^{th} lamb

Average Daily Gain

The fixed effects model used for the analysis is

$$Y_{ijklm} = \mu + S_i + G_j + D_k + T_l + \varepsilon_{ijklm}$$

Where *Yijklm* is the adjusted average daily weight gain of the m^{th} lamb,
μ is the overall mean,
Si is the fixed effect of the i^{th} season (*i*=main, off),
Gj is the j^{th} gender (*j* = female, male),
Dk is the *kth* weight group of the dam at lambing (k=<25, 25-29.99, 30-34.99, ≥ 35 kg),
Tl is the *lth* time period (*l*=1996-2000, 2001-05, 2006-10) and *εijklm* is the error attributed to the m^{th} lamb.

Results and Discussion: Out of 1,424 sheep, 1,224 (85.96%) are born during main season and the rest during off season. As regards sex of the lamb, there are 703 (49.37%) females and 721 (50.63%) males. More males are born in off season (55.5%) than in the main season (49.8%). Regarding weight of dam at lambing, 157 (11%) are born to dams less than 25 kg, 638 (44.8%) to dams weighing between 25-29.99 kg, 511 (35.9%) to dams weighing between 30- 34.99 kg and 118 (8.3%) to dams weighing more than 35 kg. With regard to the year of birth, 279 (19.6%) were born during 2016-2018, 634 (44.5%) during 2015-2017 and 511 (35.9%) during 2017-2018. In the present study, the type of all births is single and no twinning is observed.

Conclusion: In conclusion, it is possible to show improvement in 12M body weight which comes from the fact that this trait is highly heritable and at the same time genetically correlated to 3M weight. The findings suggest that by selecting potential animals early based on 3M weight, a significant genetic improvement in the 12M body weight in Madras Red sheep can be brought about.

Modeling the longitudinal growth data of Madhya Pradesh red sheep, it is found that the conditional quadratic model with heterogeneous AR1 error covariance structure is found to be more appropriate for describing the growth profile of Madhya Pradesh red sheep.

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