Prediction of lactation milk yield from test day records using Wood model

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The model parameters, fit statistics and prediction of lactation yield from test day records of different breed groups of Holstein-Friesian breed were estimated after fitting the Wood Model. The model parameters and fit statistics of different breed groups were varied. There was a significant difference among breed groups of Holstein-Friesian cows. According to R2, CV and RootMSE values, the Holstein-Friesian (75%) x Local (25%) blood group showed good fit of Wood model than other breed groups. The predicted highest lactation milk yield (1813.62Kg) was observed for the cow which carries 75% of Holstein-Friesian blood.

Key words: Prediction, Model parameters, Lactation yield and Wood Model.

In Bangladesh, the majority of the dairy cows are zebu type. However, the farmers farm other breeds such as Holstein-Friesian, Jersey and their crossbreds with local and improved local varieties (e.g. Pabna and Red Chittagong Cattle) for milk production. Especially the commercial farmers farm Holstein-Friesian and its crossbreds[2]. Actually there is no well developed recording system in Bangladesh for dairy cattle economic and genetic evaluations but the commercial farmers regularly maintains health and milk production record for their cows.

For designing a suitable breeding and management strategies for dairy cattle, lactation curve act as a valuable tool [3] and [5]. The lactation curve represents the daily milk yields against the time (days in milk) and can provide valuable information about the total milk yield and also the patterns of milk yields from test day or incomplete records. The information on total lactation yields and pattern of lactation are essential for the nutritional and reproductive management of lactating cows [14], [5] and [11].

Wood [13] developed the incomplete gamma function, which comprises three parameters and this model provide the shape of lactation curve and also the total predicted lactation yields and peak yield of the lactation. In this situation, the present study was undertaken with the following objectives.

(i) To estimate the parameters of Wood model

(ii) To predict the lactation milk yields by using Wood model.

MATERIALS AND METHODS

Sources of data: The experimental data was collected at 15 days interval from July 2008 to January 2009 from Homeland dairy farm, Chittagong, Bangladesh. Usually the farmer collects milk from their cows twice daily. So the daily milk yield was estimated by the sum of that and added the two times milking. The cows from which milk is collected by the farmer under this study on three different breed groups of Holstein-Friesian breed, composed of Holstein-Friesian (75%) Local (25%), Holstein-Friesian (67%) Local (33%), Holstein-Friesian (67%) Sahiwal (33%). In this study, 12 test day milk yield records on 90 cows (30 cows in each breed group) were used to predict lactation yields for 180 days in milk in consideration of the age of the cows and calving seasons.

Model: The incomplete gamma function [13], which was used for the estimate of parameters (intercept, curve shape) and predict the total lactation milk yield is given below:

$$Y = a\,x^b\,e^{-cx}$$

Where Y is the milk yield at x days, e is the base of natural logarithms and a, b and c are the parameters of lactation curve which characterized the shape of the curve and which were estimated from the linear regression analysis.

Statistical analysis: At first the incomplete gamma type function was log linear transformation, then the test day milk yield was set as depended variable and days in milk was set as an independent variable. The model was analyzed by the proc GLM of SAS[7] to obtain the model parameters (a, b and c). Along with model parameters the fit statistics, R2 (coefficient of determinant), CV (coefficient of variation) and Root MSE (Root mean square error) was also obtained. The predicted milk yields were observed by using the model parameters with days in milk as independent variables. To obtain the mean value of different model parameters, fit statistics and predicted lactation milk yield and also the least significant difference of the variables, the linear mixed procedure of SAS (PROC LINMIXED; SAS, 2000) was used to the following model.

$$Y_{ijk} = \mu + B_j + e_{ijk}$$

Where Y_{ijk} = the parameter fit statistics and predicted lactation yield

μ = observed mean,

B_j = Effect of the breed groups, and

e_{ijk} = random error distributed as N (o, σ2).

The performance of the model parameters, predicted milk yields fit statistics were compared with 5% level of significance.

Result and Discussion

The result and discussion of this study are described under the following captions:

Model parameters and model performance: The estimated model parameters, fit statistics and predicted lactation milk yield of the Wood model along with their standard error for the different breed groups of Holstein-Friesian are shown in Table 1. From the Table 1, it is seen that there is some variation among the parameters of this model between the genotypes. The values of intercept, the shape of the curves and the placement of the curve of different breed groups were differed. The differences of model parameters were differed due to the differences in breed groups were previously reported by Perochon [4] and [2].

Three fit statistics (R2, CV and RootMSE) values were used to evaluate the model performance with different blood groups of Holstein-Friesian breed. The smaller value of RootMSE was considered to be superior but for R2 and CV, the bigger values indicated the superiority of the blood groups of Holstein-Friesian breed in case of Wood model. Table 1 indicated that the R2 and CV values of Holstein-Friesian (75%) Local (25%) is higher than Holstein-Friesian (75%) Sahiwal (25%) breed group, which indicated Wood curve was good fit with the breed group of Holstein-Friesian (75%) X Local (25%). Furthermore, the RootMSE value of Friesian (75%) Local (25%) indicated its best fit with Wood model. Model fitness statistics varied between breed groups of Holstein-Friesian breed. The differences of lactation curve traits can be differed with genetic group[4], [2] and [2] and also their fitting ability[10] and [12]..

Shape of the curve: The shape of lactation curve of different breed groups after fitting the Wood curve are shown in the figure 1. From the figure it was seen that the shape of the curves varies with the variation of breed groups of Holstein-Friesian and also with the variation of model parameters. Variation in the shape of lactation curve has been reported by Ramírez-Valverde[6] and Khan[2] in tropical system of dairy farming. However, the most common shape being a rapid increase after calving to a peak a few weeks later followed by a gradual decline until the cows is dried off.

Table 1: The estimated model parameters, fit statistics and the predicted milk yield of Wood model for different blood group of Holstein-Friesian

Traits	Breed groups		
	H (67%) × L (33%)	H (75%) × L (25%)	H (67%) × S (33%)
a	2.39± 0.21	2.18±0.71	2.04±0.67
b	0.05±0.21	0.14±0.21	0.16±0.21
c	-0.001±0.21	-0.002±0.21	-0.002±0.21
R^2	0.59ª±0.07	0.79ª±0.06	0.76ª±0.09
CV	9.59ª±2.91	13.67ª±3.27	9.20ª±3.73
RootMSE	0.9ª±0.21	0.53ª±0.21	0.18ª±0.21
PLY (kg)	1544.35ª±0.16	1813.62ª±0.16	1703.28ª±0.17

Legends: a= Intercept, b= Shape of the curve, c=Placement of the curve RootMSE= root mean square error, PLY= Predicted milk yield CV=Coefficient of variation.

H × L = Holstein-Friesian × Local and H × S = Holstein-Friesian × Sahiwal

The differences of x and y was 5% significant differences

Lactation Yields: From the Table 1, it was seen that there were variation in predicted lactation milk yields among the different breed groups of Holstein-Friesian breed. Highest predicted lactation yield was obtained for the cows which carry 75% of Holstein-Friesian breed. The lactation milk yield of Holstein-Friesian breed were differed with the differences of breed groups was reported by Talukder[9] and Hossain[1].

Figure 1: The shape of lacttaion curve of different breed groups of Holstein-Friesian breed after fitting Wood model
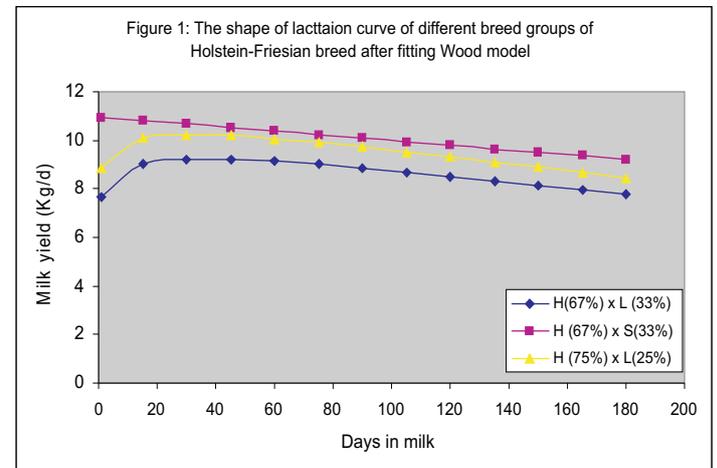
From the above study it seen that the model parameters and model performance of Holstein-Friesian × local showed better fit and produced higher predicted lactation yield than other breed groups. Such study could be useful for the scientist for further research on genetic improvement programme of dairy cattle under different management systems.

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