

## **Milk Production Characteristics of Friesian Cows under Conditions of Saudi Arabia: A Comparative Lactation Curve Model Approach**

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**Abstract.** In this paper a comparative lactation curve model analysis is adopted to evaluate the milk production performance of imported Friesian cows under conditions of Saudi Arabia. Two published estimates of Friesians' lactation curve models under UK and Saudi Arabian conditions are thus utilized. The principal lactation characteristics are derived from the respective models and analyzed comparatively. Results have shown that the 305-day lactation and the peak average weekly yields under local conditions are only slightly lower, whereas the attainment of peak weekly yield was found to require relatively longer time than under UK conditions. There has been no evidence of decreased persistency rating, which, in fact is slightly higher under the local conditions. On the whole, this approach has proved to be satisfactory and, with the availability of the required data it can contribute to the assessment of additional important production attributes such as patterns and impacts of seasonal variation.

### **Introduction**

The introduction of temperate, high-yielding, dairy cattle into the tropics and the sub-tropics has been widely adopted as a means of improving the milk production performance in these areas. The Friesian has by far been the most commonly imported breed. In Saudi Arabia, this breed represents around 80% of milk producing cows imported by commercial dairy farms.

There has been some work on evaluating the milk production performance of exotic dairy breeds under arid or semi-arid conditions [1-4] but, few studies have utilized a comparative lactation curve model approach. This is rather surprising since

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this approach has a well established potential in comparative analysis of dairy groups situations [5-7] Presumably, its limited use in assessing the milk production performance of exotic breeds under the local conditions is largely due to the lack of appropriate models for the breeds that are estimated under the specific local conditions. This is particularly true in the case of Saudi Arabia. Recently, however, the first estimates of lactation curve model parameters for Friesian cows imported to Saudi Arabia from UK have been published [8]. With the availability of these estimates, it is now possible to explore the model analysis for assessing the milk production performance of imported cows under conditions of the country.

### Materials and Methods

#### The conceptual framework

An algebraic model of the lactation curve embodies the essential characteristics of lactation [9, pp. 221-225]. This feature, among other uses, has made the lactation curve model approach particularly useful in analysing comparative dairy stock situations [5]. In this paper, this approach was adopted to evaluate milk production performance of Friesian cows imported from UK. Two Friesian lactation curve models: one estimated under UK conditions and the other under those of Saudi Arabia, from the basis of the comparative analysis. Using these two models, the respective principal lactation characteristics are derived and discussed. In this analysis, milk production performance of Friesians under those of Saudi Arabia is evaluated comparatively with respect to: 305-day lactation yield, peak average weekly yield, time to reach peak yield, and persistency.

#### The model

The model most commonly used in the study of lactations is that of Wood [5]. In this model, weekly milk production is related to the stage of lactation by the following gamma-type function:

$$Y_t = At^b e^{-ct} \quad (1)$$

Where  $Y_t$  represents milk yield in the  $t^{\text{th}}$  week of lactation ( $t=1,2,\dots,44$ ).  $A$ ,  $b$ , and  $c$  are the parameters of the model.  $A$  is a general scaling factor associated with average daily yield at the start of lactation, while  $b$  and  $c$  (both less than unity) determine the shape of the lactation curve. The importance of empirical estimates of the model lies in their use in determining the underlying principal lactation characteristics. According to Wood [5], four important lactation characteristics could be derived from the parameters of model (1), namely:

1-Total lactation yield ( $Y_t^*$ ):

$$Y_t^* = A \int_0^{t^*} t^b e^{-ct} dt \quad (1.1)$$

Where  $Y_1^*$  stands for total yield of milk for a lactation season with length  $T^*$  days. This expression could be evaluated, for example, by using the incomplete gamma function tables.

2- Maximum average daily yield ( $Y_{\max}$ ):

$$Y_{\max} = A (b/c)^b e^{-b}. \quad (1.2)$$

3- Time of maximum yield ( $T_{\max}$ ):

$$T_{\max} = b/c \quad (1.3)$$

4- Persistency (s):

$$S = C^{-(b+1)} \quad (1.4)$$

Where persistency is defined as the extent to which peak yield is maintained.

#### Data and estimation

Our estimates of the parameters of model (1) for Friesian cows under the conditions of Saudi Arabia [8] are the only available records. They are based on lactation data from the University Farm of King Saud University in Riyadh, Saudi Arabia. The corresponding estimates under UK conditions are from Goodall and McFurray [10]. These corresponding estimates are based on lactation data from the Agricultural Research Institute of Northern Ireland at Hillsborough.

The usual practice in estimating model (1) has been to linearize through logarithmic transformation to give:

$$\log_e Y_t = \log_e A + b \log_e t - ct \quad (2)$$

which is then fitted by ordinary least-square (OLS) methods to obtain estimates of the parameters. Cobby and Le Du [11] have commented that OLS may sometimes result in a poor fit to the data.

They, therefore, suggested estimating model (1) directly by non-linear least-square methods; or, when this is not possible, they proposed estimating model (2) using weighted least-square methods. However, as Wood [6] has commented, this refinement would only be necessary in cases of relatively large dispersion in milk yield values.

Both of the two lactation curve model estimates used in this study are obtained by applying ordinary least-square methods to model (2).

### Results and Discussion

Table 1 shows the estimates of the mean parameters of the lactation curve model for Friesians under Saudi Arabian and UK conditions. As shown by the table, parameter estimates in the former case are, more or less, similar to the respective estimates under UK conditions. The estimate of parameter (A), which is associated with starting lactation yield, is slightly higher under the UK conditions.

Table 1. Mean parameters of the model  $Y_i = At^b e^{-ct}$ ; Estimates of Friesians under Saudi Arabian and UK conditions

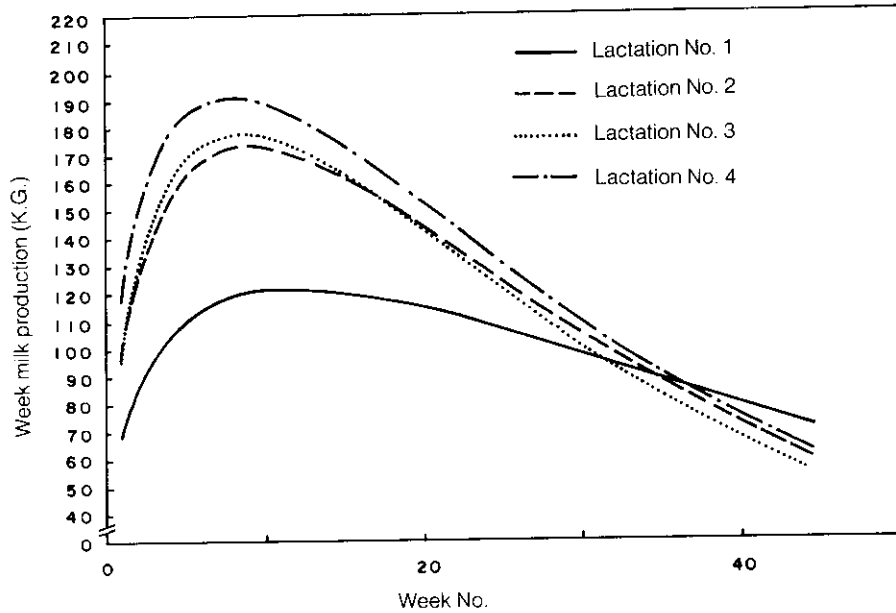
Model parameter		Under Saudi Arabian conditions				Under UK conditions			
		Lactation number				Lactation number			
		1	2	3	4	1	2	3	4
log	A	4.241	4.591	4.616	4.811	4.447	4.73	4.890	4.831
	b	0.381	0.466	0.482	0.405	0.430	0.380	0.390	0.430
	c	0.031	0.051	0.055	0.050	0.046	0.050	0.056	0.053

Source: Estimates under Saudi Arabian conditions are from Mohammed and Al-Hamoudi [8], and under UK conditions are from Godall and McMurray [10].

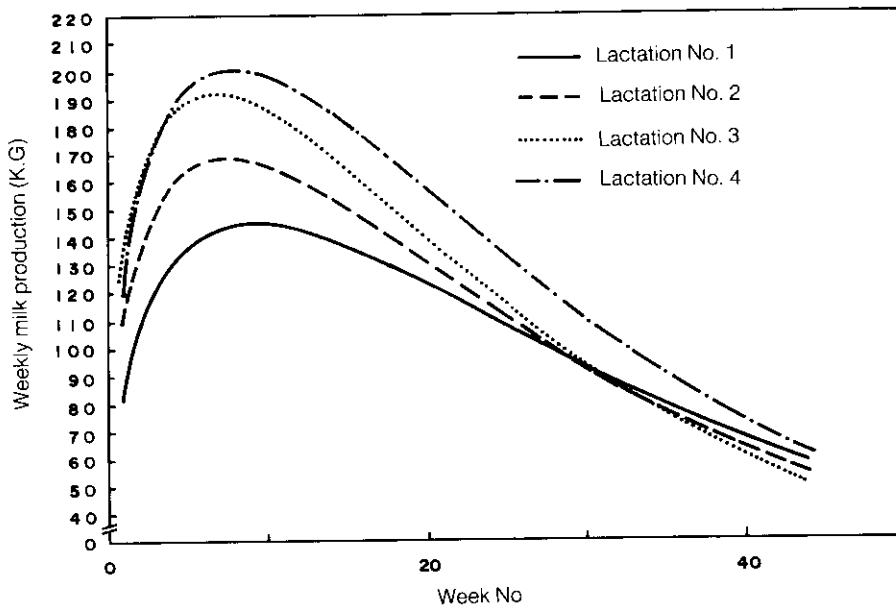
The estimates of parameters b&c, which influence the shape of the lactation curve, do not show great variations between the two conditions. Under both conditions, the changes in parameters' estimates with parity, especially the increase in (A), confirm to the established norm. The graphical representation of the mean parameter value for the friesians' lactation under Saudi Arabian and UK conditions are shown in Figs. 1 and 2, respectively. As could be seen from the figures, the general shape and pattern of Friesian lactation curves under the two conditions are essentially similar. However, it could also be observed from the figures that production levels in the respective parity groups are comparatively lower under Saudi conditions.

A more detailed insight into differences in production levels and patterns is obtained from analysis of comparative lactation characteristics. The estimates of the principal lactation characteristics, by parity group, for Friesians under Saudi Arabia UK conditions, are given in Table 2. Estimates are derived on the basis of the mean respective parameter values (as given in Table 1), employing equations (1.1) through (1.4).

The estimates of 305-day yield and peak average weekly yield for Friesians under condition of Saudi Arabia confirm closely to corresponding recent estimates provided by Salah *et al.* [4]. As seen from Table 2, the 305-day and the peak average weekly yields are slightly lower under Saudi conditions in comparison to UK. Lactation number two, however, is an exception where both attributes are slightly higher under local conditions. On average of all parity groups, Friesian milk production under the local, relative to the UK, conditions, is lower by 1% and 5% with respect to the 305-day yield and average weekly peak yield, respectively. This finding is



**Fig. 1: Friesian lactation curve under S.A. conditions**  
 Source: Constructed from the respective parameters in Table 1.



**Fig. 2: Friesian lactation curve under U.K. conditions**  
 Source: Constructed from the respective parameters in Table 1.

**Table 2.** Friesians' comparative lactation characteristics

Lactation characteristic	Under Saudi Arabian conditions				Under UK conditions			
	Lactation number				Lactation number			
	1	2	3	4	1	2	3	4
305-day yield (kg)	4469	5457	5412	5884	4724	5111	5479	6060
Peak average weekly yield (kg)	123.4	173.4	184.3	191.2	145.2	168.6	191.9	200.6
Time to reach yield (weeks)	12.3	9.1	9.5	8.1	9.4	7.6	7.0	8.1
Persistency	121	78	74	67	82	62	55	67

Source: Estimates using Equations (1.1) through (1.4) on the basis of the respective mean parameter values as given in Table 1.

rather remarkable, considering the harsh climatological environment (especially the hot summer) which prevails in the Riyadh area.

Available evidence supports that “good management and feeding could overcome some of the hot summer influence on milk production” [4]. Considering the attribute of the time to reach peak weekly yield, Friesians took a relatively longer time under Saudi Arabia in comparison to those of the UK. As for persistency ratings of Friesian lactations, they showed a slight increase in case of Saudi Arabia in comparison to UK conditions. This finding, which is also rather remarkable, is again in line with Salah *et al.* [4] who concluded that “the importation of Friesian breed from a temperate to an arid or semiarid environment does not affect its lactation persistence, although it decreases its lactation yield”.

The comparative lactation curve model analysis adopted in this study, could be extended to include other important comparative production attributes. Chief among these, are variations in milk production attributed to variation in month of calving and to seasonal variation. Data used in the present study was inadequate for such analysis. However, the lactation curve model approach, is quite appropriate for handling these effects [12].

### Conclusions

The focus of this paper was on exploring the potential of comparative lactation curve model approach in assessing milk production performance of Friesian cows imported into Saudi Arabia. The approach is applied to a comparative analysis of four principal lactation characteristics of the breed under conditions of the Kingdom versus U.K. Results show that the 305-day yield and the peak average weekly yield are slightly lower under local conditions compared to the UK. With respect to the time to reach peak weekly yield, it was relatively longer under local conditions in

comparison to those of the UK. As for lactation persistence, the results indicated a slightly higher value under local conditions compared to UK conditions. These results are in general conformity with recent findings of others. In the face of this rather remarkable performance of Friesians under the harsh local environment, we share the speculations that good management and feeding could overcome some of the hot summer influence on milk production.

Overall, the comparative lactation curve model approach adopted in this study proved to be appropriate. With the availability of the required additional data, this approach could be extended to include assessment of other, comparative production attributes such as patterns and impacts of seasonal variation.

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## خصائص إنتاج الحليب لأبقار الفريزيان تحت ظروف المملكة العربية السعودية : تحليل مقارن لأنموذج منحنى الإدرار

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ملخص البحث . ركز هذا البحث على استخدام التحليل المقارن لأنموذج منحنى الإدرار وذلك لتقويم أداء الإنتاج لأبقار الفريزيان المستوردة تحت ظروف المملكة العربية السعودية . استخدمت تقديرات معاملات أنموذج الإدرار تحت ظروف كل من المملكة المتحدة والمملكة العربية السعودية من نتائج لأبحاث منشورة باستخدام هذه التقديرات تم استخلاص خصائص الإدرار الرئيسة تحت ظروف كل من البلدين وأخضعت للتحليل المقارن . أظهرت النتائج أن دورة إنتاج الحليب لـ ٣٠٥ يوم ومستوى أعلى إدرار أسبوعي كانتا أقل قليلاً، بصورة مقارنة، تحت ظروف المملكة العربية السعودية .

بالنسبة للوقت اللازم لتحقيق أعلى مستوى إدرار أسبوعي فإن الفترات كانت أطول، بالمقارنة، في حالة المملكة العربية السعودية . كما أظهرت النتائج أنه بالنسبة لخاصية المثابرة على الإنتاج فإن المعدلات كانت، بصورة مقارنة أعلى قليلاً في حالة المملكة العربية السعودية . عموماً كان أسلوب التحليل المقارن لأنموذج منحنى الإدرار مناسباً لأغراض التقويم ويتوافر البيانات المطلوبة يمكن أن يساهم هذا الأسلوب في تقويم خصائص إنتاج أخرى مهمة مثل أنماط وتأثير التغيرات الموسمية .

\* حالياً : صندوق التنمية الصناعية السعودي، الرياض، المملكة العربية السعودية.