# LACTATION CURVES FOR PERFORMANCE ORIENTATED RATIO CALCULATION OF DAIRY COWS

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## ABSTRACT

By computer aided feeding the ratio planning is often based on the estimation of lactation curves by BUREMA and KERKHOF. Analysis on 44 cows (German Fleckvieh cattle) show big differences between the estimation and the real milk yields. By adding an improvement coefficient for different lactation parts a fairly good approximation is reached. With this improved standard lactation factors a more beneficial planning for rations will be possible.

## INTRODUCTION

The optimum result in milk production is reached by input cheapest food resources in the required quantity and quality. But in the planning phase there are two questions open. There is no information at the time of planning about the exact input of roughage and silage and there is a high unsecurity about the further development of lactation.

To reduce this unsecurity it has to be tried to calculate the dry matter intake by multivariant estimation methods for each cow (1,2,6). On the other hand the development of lactation of each cow within the herd was tried to standardize and to take this standard as a guidline. Based on this guidline during the lactation the ratio planning was then changed depending on the measured milk yield per cow. There are some methods for standardized lactation curves (3,4,5,7,8) and it is to examine which of them can give the best estimation for use in connection with the milk yield.

## STANDARD LACTATION CURVES

### WOOD

First standard lactation curves were established by WOOD (1967). They describe the expected milk yields on different performance levels and enable a fairly good estimation after a milking period of about 100 days per cow. With this datas the individual performance of cows is considered very realistic. The calculation is based on (1)

$$Yn = A \times n^{b} \times e^{(-cn)} \qquad (1)$$

with
- $Yn$ = daily milk yield
- $A$ = parameter for curve level
- $b$ = parameter for increase at lactation start
- $c$ = parameter for decrease after yield maximum

or simplified by (2)

$$\ln(Yn) = \ln(A) + b \times \ln(n) - C \times n \qquad (2)$$

To get a good estimation it is importantm that the first daily milk yield resumes from the time not later than six days after calving.

GROENEWOLD

GROENEWOLD (1983) improved this method by analysing 640 Holstein Frisian cows, German Red and White cattles and German Black and Whites especially for the time between calving and the daily maximum milk yield. With the calculated factors a first estimation of the expected lactation is now possible after the first monthly milk recording. Between this state and the yield after 120 days in lactation, the individual lactation curve of each cow is applied to the standard lactation curve.

HUTH

HUTH (1981) analysed more than 12 000 lactations with their means of weekly milk yields. From this material he derived five different parts in a lactation curve in a more describing way. Thus no formula is available for an estimation. Nevertheless, he has included in his results important parameters like biology, genetic and so on.

BUREMA and KERKHOF

In 1979 both authors examined from the milk yields of one Dutch herd a standard lactation curve. It is determined by (3)

$$C = \frac{1}{3} + \left[\frac{132\ B}{(B+1)^2} - 17\right] \frac{A - 1}{(A+5)^2} \qquad (3)$$

with A = number of lactations
C = lactation factor
D = day within lactation

$$B = 0{,}4 + \frac{d}{61}$$

and with the highest milk yield (C = 1) per cow at an age of seven years and 30 lactation days. Based on the very restricted computer resources on a farm at this time no more parameters could be taken into the standard lactation curve.

Comparison

In a comparison of this three main important methods (table I it can be realized that

- WOOD needs too much information for a simplified use on practical farms. In addition to it the determination of lactation curves is possibly too late (after 100 days in milk)
- The improvement by GROENEWOLD is based on only one single herd per breed
- There is no formula by HUTH and therefore no algorithmus
- There is no doubt, that the results BUREMA and KERKHOF received by only two parameters cannot be sufficiently ensured. Important influences like genetic, feeding, months of calving, service time and time between calvings have not been included in this method.

Table 1: Comparison of methods for the estimation of milk yield during the lactation of dairy cows

| author | influences | advantages | disadvantages |
|---|---|---|---|
| WOOD | - level of performance (real performance) | - formula available<br>- calculated from a big data base<br>- simple to use<br>- result is individual for each cow<br>- all milk yield data of a cow are included | - needs very much information<br>- first estimation is possible very late<br>- hardly to fit to the real milk yield through the time of lactation |
| GROENEWOLD | - level of performance<br>- breed<br>- season of calving | - early estimation is possible | - high input on computer resources<br>- database too small |
| HUTH | - level of performance<br>- inter calving time<br>- nutrition<br>- number of lactations<br>- decreasing performance factors like sickness and so on | - very big database<br>- simple values in a table<br>- after first milk recording useable<br>- changing through lactation possible | - no furmula<br>- database concentrated to regional area |
| BUREMA and KERKHOF | - age of cows<br>- performance level | - simple formula<br>- estimation early possible | - data base in only one herd<br>- too little influences |

## ANALYSING AND IMPROVEMENT OF LACTATION CURVES

Looking at the present situation where in some programs the standard lactation curve by BUREMNA and KERKHOF is part of the feeding strategy and of fertility control, it has to be examined in which way this standard can be used on farms without problems.

Data Base

From a practical farm with 44 cows (German Fleckvieh cattle) with an automatic milk measurement equipment 78 lactations could be taken for an analyses after the method by BUREMA and KERKHOF. Within the collected data there has been a loss of 15 % caused by hardware problems, equipment changing and by forgetting the start of data transfer by the farmer himself. After an automated data transfer with a time watch clock the data losses could be reduced to 12 %. In the meantime datalosses have gone down to about 3 to 5 %.

Data Analysis

Based on the standard lactation coefficients from BUREMA and KERKHOF the standard lactation curves for all cows were calculated. Two different calculations were carried out:

Standard lactation curve I had its reference to a maximum milk yield within the first 60 days of lactation and was taken as the mean of the six highest daily milk yields. The calculation afterwards was done in a back- and forward strategy using the standard lactation coefficients from BUREMA and KERKHOF (figure 1)

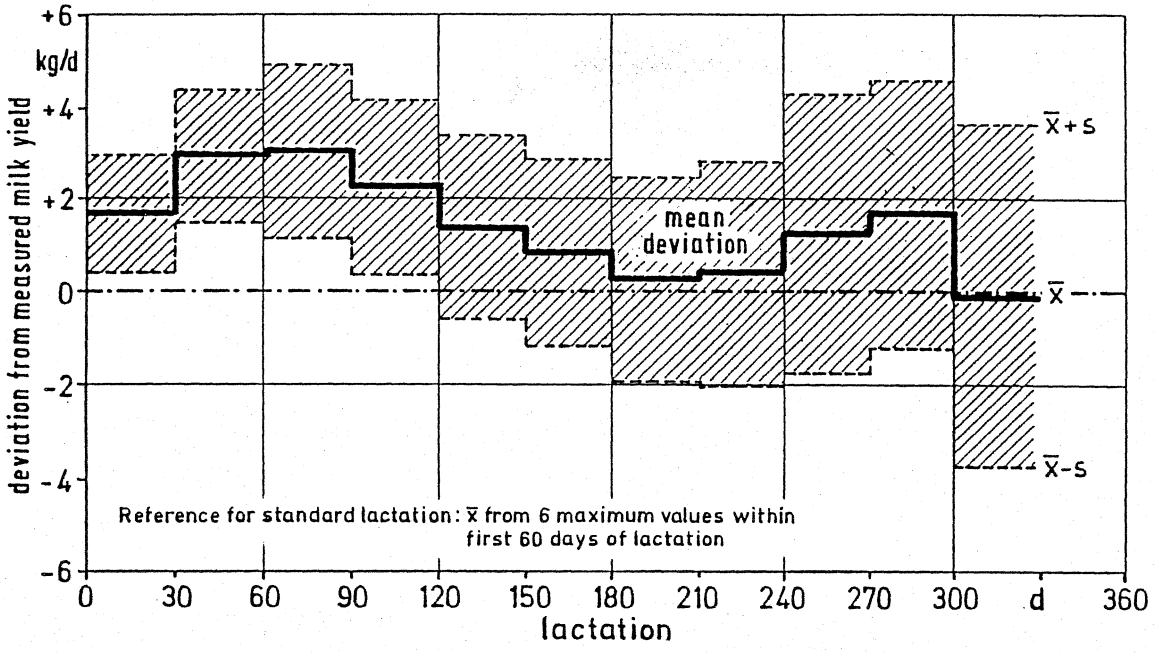


Figure 1: Deviations of standard lactation by BUREMA and KERKHOF from measured milk yields (method I)

Standard lactation curve II had its reference on the mean from the first three milk yields after calving. Its calculation then was done in a forward strategy by using the standard lactation coefficients from BUREMA and KERKHOF (fig.2).

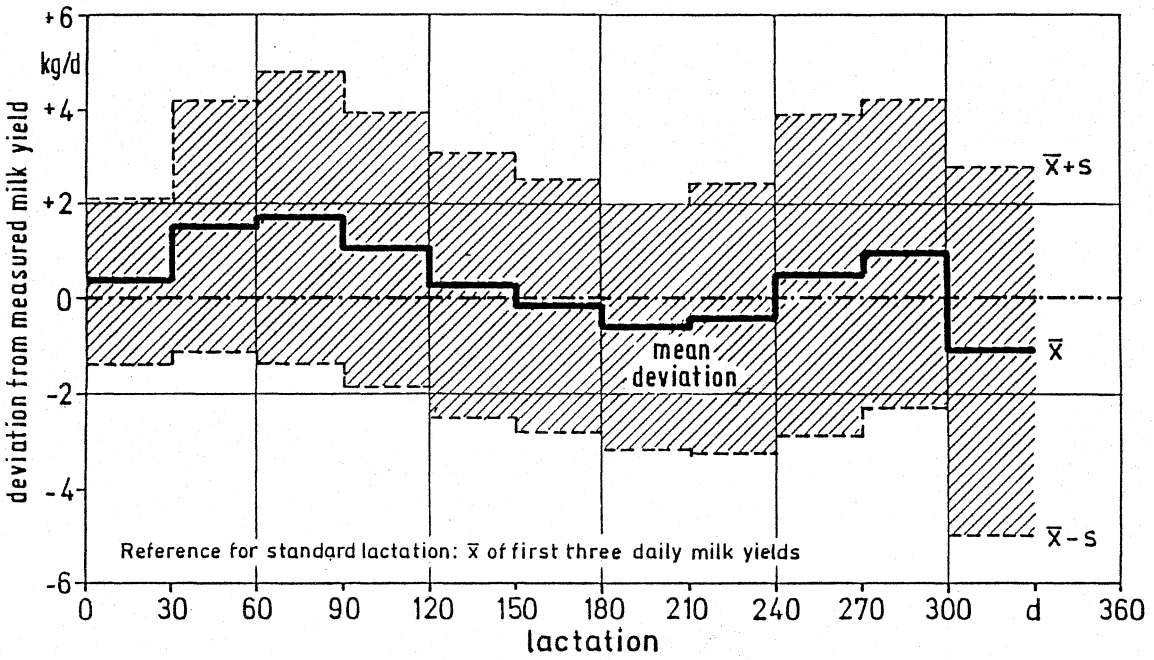


Figure 2: Deviations of standard lactation by BUREMA and KERKHOF from measured milk yields (method II)

By analysing the lactation datas from cows with one to five lactations, the deviations shown in table 2 were found. It can be seen, that with increasing lactations the standard deviation of the deviations is also increasing. Also it can be realized, that within the first half of lactations the standard lactation coefficients from BUREMA and KERKHOF over-estimates the real milk yield, whereas in the second half an under-estimation is kept.

Table 2: Mean deviation and standard deviation of standard lactation curve I and standard lactation curve II for lactation 1 to 5

| | n | age | standard lactation curve I dev.(kg) | I s(kg) | II def.(kg) | II s(kg) |
|---|---|---|---|---|---|---|
| total herd | 78 | 4.7 | 1.39 | 2.36 | .38 | 2.90 |
| 1. lactation | 14 | 2.8 | .90 | 1.62 | -0.16 | 3.17 |
| 2. " | 23 | 4.0 | 1.43 | 2.68 | 0.09 | 3.35 |
| 3. " | 21 | 5.0 | 1.58 | 1.96 | 0.84 | 2.21 |
| 4. " | 14 | 6.0 | 1.37 | 2.24 | 0.83 | 2.47 |
| 5. " | 4 | 6.8 | 1.67 | 2.29 | 0.37 | 2.08 |

Improvement of Standard Lactation Coefficients

Based on this deviations by more than 4 kg milk per cow and day (figure 3) an improvement of the standard lactation curve from BUREMNA and KERKHOF was tried.

By adding a multiplication factor with the shape in (4)

$$C = \left\{ \frac{1}{3} + \left[ \frac{132\ B}{(B+1)^2} - 17 \right] \frac{A-1}{(A+5)^2} \right\} \quad ( X + 1 ) \ ; \qquad (4)$$

this deviations between estimation and real milk yield could be reduced to a minimum near zero percent. Different factors along the lactations have been used (shown in table 3). These factors include different parameters like time in lactation, calving season and others, explained by HUTH.

Table 3: Coefficients for an improved standard lactation curve based on BUREMA and KERKHOF

| days in lactation (d) | improvement coefficient x |
|---|---|
| 0 - 12 | 0.0192 d |
| 13 - 30 | 0.0 |
| 31 - 60 | 0.000144 $d^2$ - 0.0173 d + 0.25 |
| 61 - 200 | 0.001143 d - 0.1986 |
| 201 - 240 | -0.00075 d - 0.18 |
| 241 - 295 | 0.000224 $d^2$ - 0.1187 d + 15.59 |
| 296 - 305 | 0.7 |

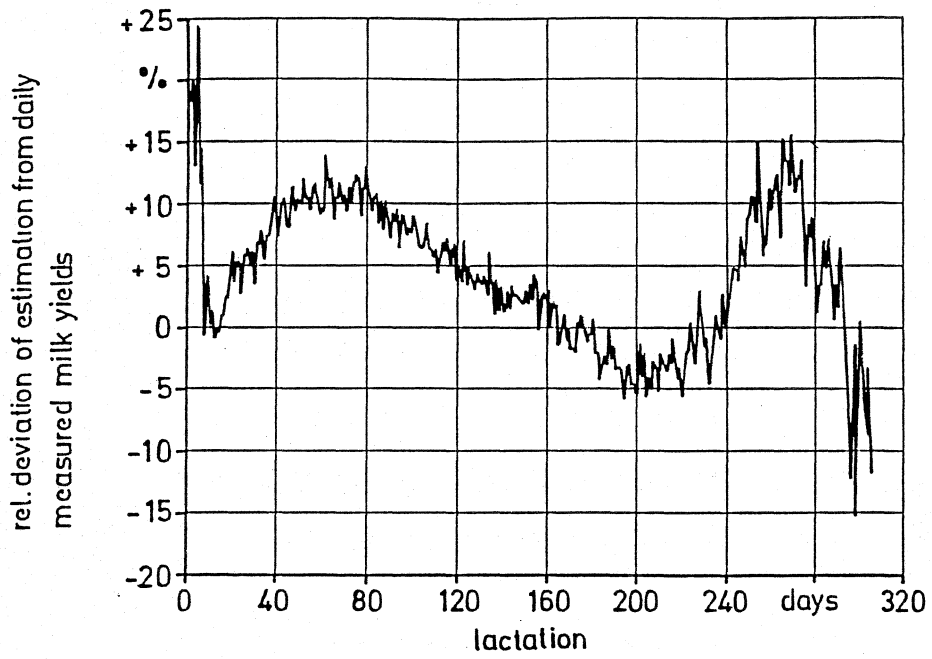


Figure 3: Relativ daily deviations of estimated milk yield by BUREMA and KERKHOF from the measured milk yields depending on days in lactation (44 German Fleckvieh cattle, 78 lactations)

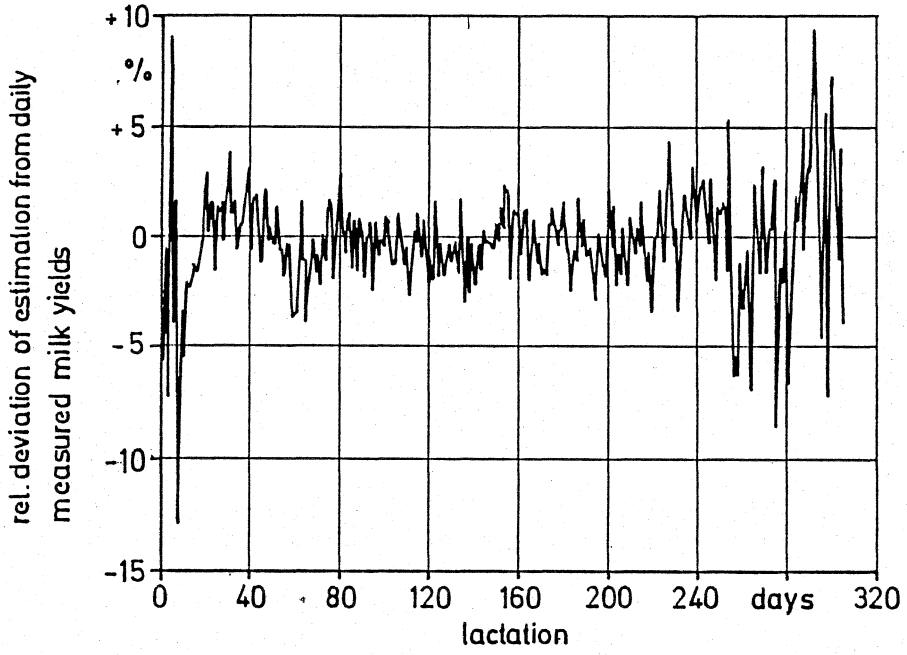


Figure 4: Relativ daily deviations of estimated milk yields with improved estimation method from the measured milk yields depending on days in lactation (44 German Fleckvieh cattle, 78 lactations)

Calculated lactation curves from a lot of cows give a very good fitting to the standard lactation coefficient (figure 4 to 6). Thus a much better estimation is possible and a more beneficial feeding strategy can be realized.

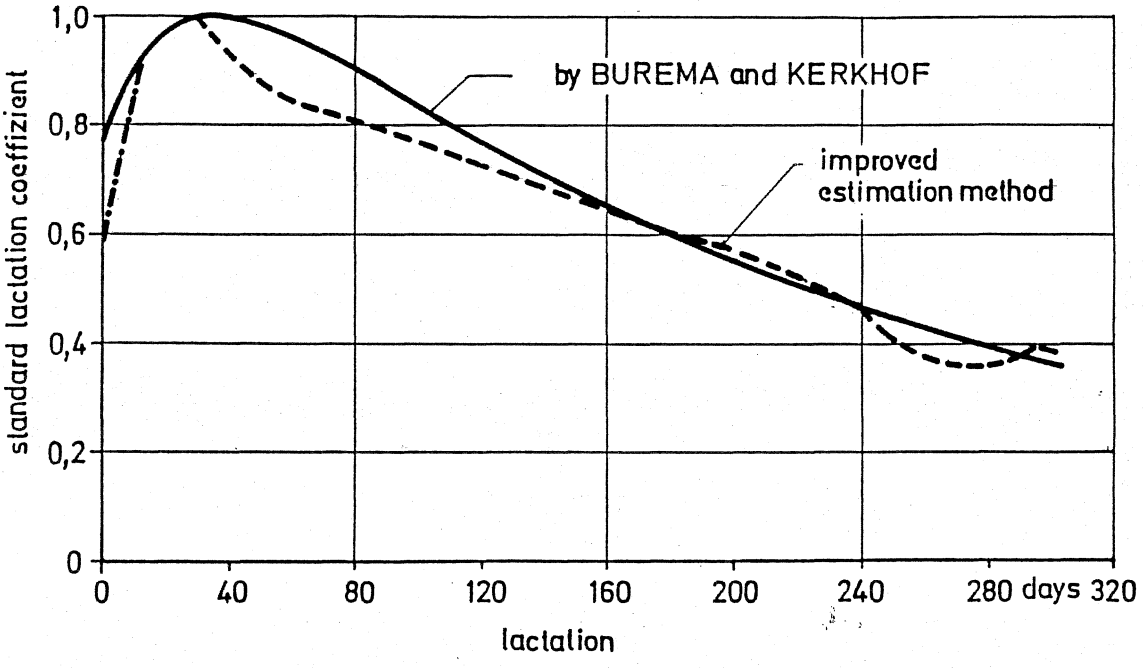


Figure 5: Standard lactation curve by BUREMA and KERKHOF and improved standard lactation curve

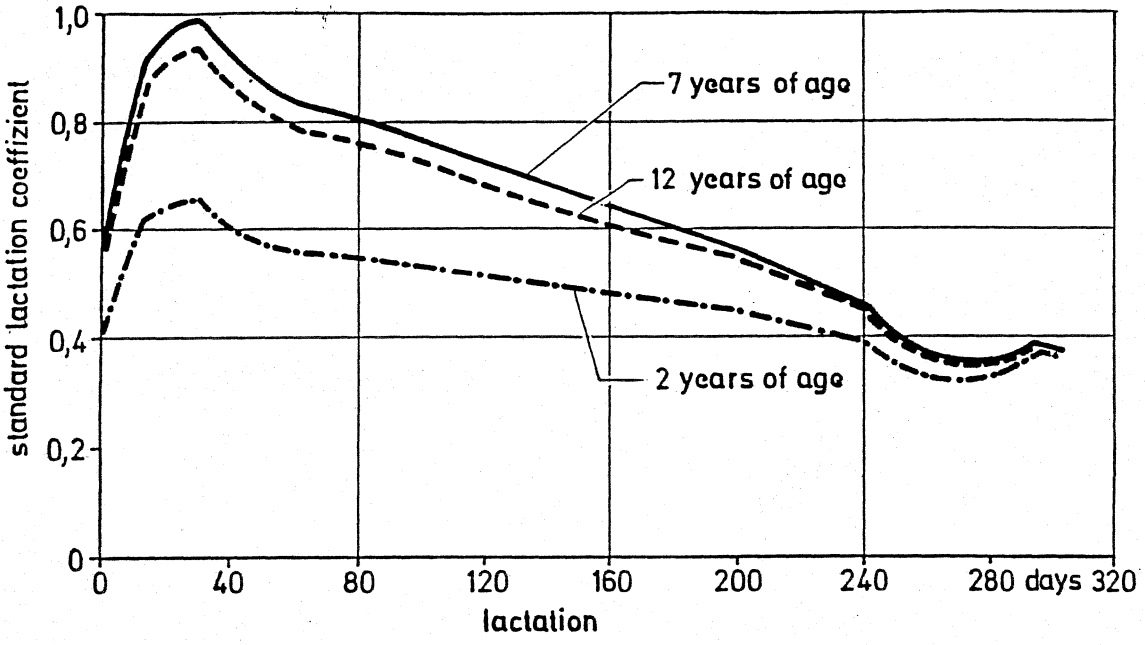


Figure 6: Improved standard lactation curves by BUREMA and KERKHOF for different years of age

## CONCLUSION

The standard lactation curve by BUREMA and KERKHOF shows a very strong deviation from the real milk yields on practical farms. By adding a coefficient of improvement to the formula a real good fitting to the daily milk yields is possible. These coefficients include different parameters on a different lactation stage.

For use on practical farms the following steps can be useful:

1. As a first strategy the analized improvement coefficients should be taken
2. After complete lactations of an individual herd these coefficients can be improved by recalculations
3. In a teach-in method after each lactation the recalculation can be repeated so that special lactation curves for each farm and each cow can be developed.

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