Lifetime Production Index, what Cows Really can Produce

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Abstract

A lifetime production index (LTP index) was developed, combining lifetime milk yield, fat yield and protein yield using the current Dutch production index (INET) weighing factors. Lifetime production breeding value is derived from existing breeding values for production yields (milk, fat or protein yield), longevity, persistency, rate of maturity and calving interval. The LTP index predicts the bull's genetic merit for daughter lifetime production. The breeding values have been validated by comparing the computed breeding values with realized lifetime production yields. LTP index gives insight in the combination of longevity and production and shows the economic return over a cow's life. LTP index helps the industry in the communication with dairy farmer to show what breeding can do.

Key words: lifetime production, breeding value, LTP index, milk yield, economic value

Introduction

A cow's lifetime production is determined by her milk production and by the number of days she is in milk. To improve the genetic capacity for lifetime production the selection of the right bull is important. To determine a bull's genetic potential for lifetime production, knowledge about the potential for production and longevity is important. Breeding values are already available for both components. However, if one wishes to determine lifetime production in more detail, the rate of maturity, persistency and calving interval play a role as well.

A breeding value for lifetime production yield for bulls can be derived from existing breeding values and information of lactation curves.

The current breeding values for milk, fat and protein shows the farmer the difference in genetic potential of bulls for one 305-day lactation. The lifetime production yield for milk, fat and protein gives a farmer insight in the combination of longevity and production, and show him what daughters of a bull can produce during their whole life. When considering the amount of feed a cow needs during her raising period and her life after first calving, a high production during her whole life gives more insight in the amount of feed per kg milk, fat or protein, than the amount of milk, fat or protein during a lactation. A breeding value for lifetime production yield can support the breeding for more sustainable cows.

The aim of the lifetime production index is to express the genetic potential for lifetime production yields (milk, fat and protein), which in essence is calculated from the breeding values for production and longevity, as well as adjusted for information from the breeding values for rate of maturity, persistency and calving interval.

Method

The breeding value for lifetime production is derived from existing breeding values. Key figures in this index are: production breeding values for milk, fat and protein, rate of maturity, persistency, longevity and calving interval.

The breeding value longevity indicates the average number of production days that its daughters spend in a herd since the first calving, compared to the population. Thus, the breeding value longevity indicates the differences between daughter groups with regard to the number of days that the daughters of a bull are actually in lactation.

The breeding value longevity is used to determine the difference in the percentage of survival per day of life of a bull's daughter

group compared to the population. Each bull has its own survival curve. If the longevity breeding value of a bull is high, then the probability of survival per day of a daughter of this bull is increased. For each bull, survival curves of its daughter group are created for at least eleven lactations.

For the genetic potential for production, the 305-day production breeding values for milk, fat and protein are available. For the first three lactations, the genetic lactation curves for milk, fat and protein yield from the test day model are used, to take into account the differences in genetic potential. Breeding values are available from day 5 through 305. For later lactations lactation curves are based on the shape of the curve in lactation 3, and applying lactation correction factors to adjust the level of production to the production in later lactations. With these lactation correction factors the effect of age on production can be taken into account. Using the genetic lactation curves, differences in persistency and rate of maturity can be taken into account. Currently, in the test day model (milk production breeding value estimation), the breeding value rate of maturity is also determined from the difference in production realized in lactation 3 compared to the production in lactation 1. It is assumed that daughters do not show any further production development after lactation 3 compared to the whole population.

For lactations longer than 305 days, the genetic potential for the days from day 305 and onwards can be predicted using the testday curves by fitting a function to the breeding values of the daily productions.

The average lactation length of a daughter group is derived from the bull's breeding value for calving interval. The average calving interval in the population is currently 418 days. With an average dry period of 60 days, this results in an average length of lactation in the population of 358 days. For each bull, the average calving interval of the daughter group can be determined from this population average and its breeding value for calving interval. Subtracting the dry period from this calving interval result in the average lactation length for a bull's daughter group.

The length of lactation is bull-dependent, but the dry period is an assumed constant for every bull (60 days).

Based on a bulls' survival curve, lactation curves as well as the lactation length, the genetic potential for the milk, fat and protein produced per day during the whole lifetime for female offspring is determined. The result of the summation of all daily productions is a breeding value for lifetime production for milk, fat and protein.

For bulls without any known genetic lactation curves, because they have no daughters in milk production in the Netherlands and Flanders, the average population lactation curve is used. Based on this population-lactation curve and the breeding value for production, the genetic potential per day is determined. This situation applies to both bulls tested abroad and genomic bulls.

The lifetime production index that is published for bulls is based on the lifetime production breeding values for milk, fat and protein, weighted with the weights -0.3, 2.2 and 5.0 respectively. These weights are the same as used in the current INET (Dutch production index). The weights are based on prices for milk, fat and protein minus the feed cost. The lifetime production index indicates a cow's lifetime yield for milk, fat and protein, all expressed in euros.

Demonstration of calculation on three bulls

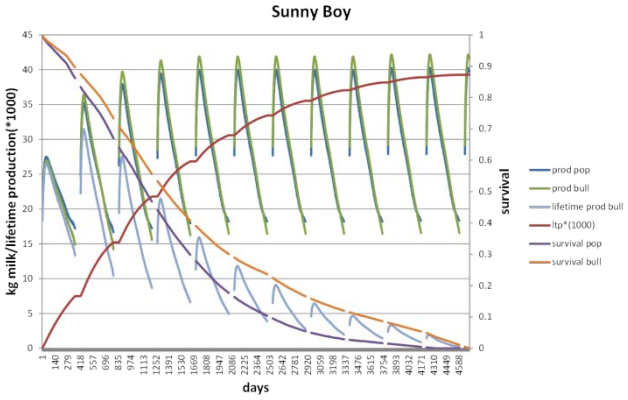
To show what the calculation for the lifetime production breeding values look like for individual bulls, lactation curves for milk yield and survival curves of three bulls are shown; Skalsumer Sunny Boy, Etazon Addison and Beverlake Louson. Their breeding values used for the figures 1 to 3 are shown in table 1.

Table 1. Breeding values for milk (kg), longevity (days), persistency (pers), rate of maturity (rom) and calving interval (ci) for Skalsumer Sunny Boy, Etazon Addison and Beverlake Louson to compute lifetime production index. (pers, rom and ci are relative breeding values with mean of 100 and standard deviation of 4.Values above 100 mean, more persistent, higher rate of maturity (cows produce relative more in later lactations than as heifer), and shorter calving interval.

Bull	milk	long	pers	rom	ci
Sunny Boy	54	373	99	108	99
Addison	1937	193	107	100	95
Louson	424	-254	107	103	95

Results for Skalsumer Sunny Boy are shown in figure 1. The green lactation curves represent the milk production of the daughters. The lactation curves for the population are in dark blue. The higher rate of maturity (EBV of 108) is reflected in the lactation curves of later lactations being above the population lactation curves. The positive longevity breeding value of 373 days is represented as a survival curve (colour orange) being higher than the population survival curve. The milk yield daughters are able to produce is then expressed as the multiplication of the survival rate per day times the production on the same day, resulting in light blue lactation curves. By summation of these daily milk yields over the whole life the red curve is derived. This red curve is an asymptotic curve showing the life time milk yield. In the case of Skalsumer Sunny Boy this lifetime production is about 39,000 kg.

Figure 1. Lactation curves for milk yield, survival curves and lifetime milk production curve for Skalsumer Sunny Boy daughters.



For Etazon Addison the milk yield production for the daughters are shown in figure 2. Due to the high breeding value of 1937 kg of milk the lactation curves for the daughters are way above the population curves. But the lactation curves are also longer than the average population curves, due to the low breeding value for calving interval (=long calving interval). The positive breeding value for longevity results in a survival curve for the daughters above the population survival curve. The light blue curves show then the realized milk yield by the daughters as function of the lactation curve and survival rate per day. The summation of these realized daily yields results in the red asymptotic curve showing a lifetime milk production of about 42,000 kg.

Result of Beverlake Louson is shown in figure 3. With his negative breeding value for longevity the survival curve for his daughters are below the population survival curve. The result is that his lifetime milk production yield is about 24,000 kg.

Figure 2. Lactation curves for milk yield, survival curves and lifetime milk production curve for Etazon Addison daughters.

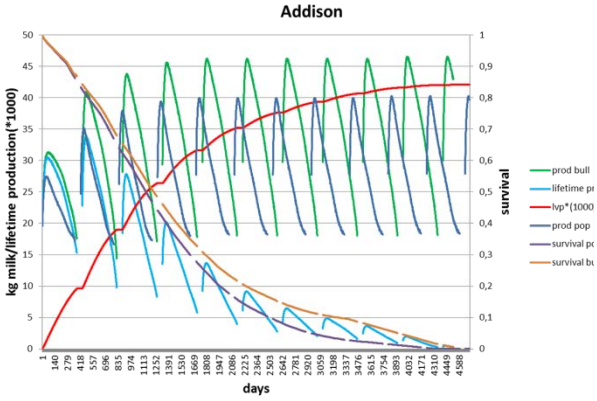
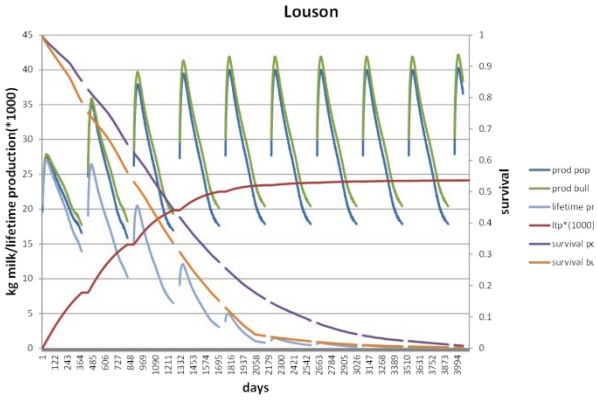


Figure 3. Lactation curves for milk yield, survival curves and lifetime milk production curve for Beverlake Louson daughters.

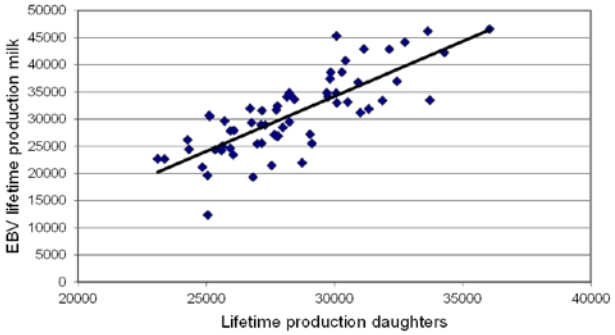


Validation

To validate the lifetime production breeding values, the lifetime milk production breeding values of bulls were compared with realized lifetime production of daughters. A group of Black&White Holstein Friesian bulls were selected having at least 1000 culled daughters which could have been at least 10 years old and the bulls' breeding value of longevity was based on at least 150 culled daughters. The realized lifetime production for milk of the daughters was compared with the breeding value for lifetime milk production.

The correlation between the breeding value and realized lifetime milk production was 0.79. The slope of the regression of the realized lifetime milk production on the lifetime breeding value was 2.02, an expected value as half of the bulls' genes are expressed in his daughters' performances (see also figure 4).

Figure 4. Realized lifetime milk production of daughters and bulls' breeding value for lifetime milk production (n=62).



Conclusions

- Breeding value for lifetime production can be computed using existing breeding values
- Lifetime production for milk, fat and protein are combined in a lifetime production index (LTP) using the current INET (Dutch production index) factors.
- LTP index show what a farmer can earn during a cows' lifetime and gives insight in the combination of longevity and production
- LTP index helps industry in communication with dairy farmer to show what breeding can do.