# ANALYSIS OF REPRODUCTIVE FACTORS IN HANOVERIAN WARMBLOOD POPULATION

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## SUMMARY

The reproduction parameters, such as number of mares mated per sire, foaling rate, reproductive life and generation interval, were analysed. The records from the years 1978 to 1991 were obtained from the Hanoverian stud-book. In this period 189.006 matings were registered. They resulted 109.105 foalings, wherein the foals born in 1992 were considered. 45.4 % stallions were mated with less than 10 mares. On an average, the stallions were kept for 4.0 years for breeding and mated with 30 mares (s= 35) per season. The mean value of stallions mated with less then 10 mares per year was 41.9 %. The average foaling rate was 57.7 %. The foaling rate per year increased with increased artificial insemination practise. In 1990 more than 61 % foalings were observed. The reproductive life of the mares born in 1977 was analysed. The average reproductive life of such mares was 4.6 years with 2.7 foals born within the span of 14 years. The generation intervals for dam-daughter, dam-son, sire-daughter and sire-son were $L_{dd}$= 9.1, $L_{ds}$= 9.2, $L_{sd}$= 10.7 and $L_{ss}$= 10.7 years for each respective path (s= 4.2-4.8). In the period between the years 1979 to 1992, the generation interval continuously increased from 8.8 to 9.6 years in case of mares.

## INTRODUCTION

The selection response realisable in a defined period of time depends directly on selection intensity, accuracy of breeding values, genetic variance and generation interval. While short-term influence on the genetic variance of a population is very small, the other parameters can be affected more efficiently by breeders. The accuracy of estimating breeding values depends on the used method, but even more on the quantity of offspring per sire, i.e. the number of mares mated per sire. In the same way, the practical selection intensity depends on available number of offspring which is determined by foaling rate and fertility of broodmares and sires. The generation interval finally is under breeders control by determining age at first mating and reproductive life.
Using data from Hanoverian Warmblood population, the number of mares mated per sire, foaling rate, reproductive life and generation interval were analysed exemplary (UPHAUS, 1993).

## MATERIAL AND METHODS

The analysed parameters of reproduction based on data from Hanoverian stud-book, recorded in the years 1978 to 1991. In this span 189.006 matings were registered. They resulted 109.105 foalings out of which a total number of 267 pairs of twins were identified. Every year, on an average 0.2-0.3 % of all foaling mares bore twins. A total number of 54.555 colts (50.1 %) faced 54.354 fillies (49.9 %) while 196 foalings were registered without recording sex.
The mating distribution approached peak in the month of April, May and June. In this quarter 73 % of all matings were carried out. The months March and July, indicating 12.8 % and 9.2 % matings respectively, can be considered as beginning and end of the breeding season. The rest of the matings were distributed equally over the remaining month of the year.
It was observed during the analysed period that every year 1-2 % of all matings were conducted using frozen semen for insemination. The inseminations with fresh semen were negligible till mid eighties. At that time natural insemination was widely practised. This changed rapidly from the year 1986 where 6 % of all matings occurred using fresh semen. In 1990, insemination with fresh semen was already used in 36.5 % of all mares to be mated. More mares were inseminated artificially (53.7 %) than natural in the year 1991. More over, the portion of artificial inseminations exceeded 80 % level in Hanoverian Warmblood population during last year (WILKENS, 1994).

## RESULTS AND DISCUSSION

### Matings per sire

During the analysed 14 breeding years 188.865 matings were carried out by 1593 different stallions (in 141 registered matings the sire codes were not properly recorded). Thus on an average 119 matings were performed per sire. The standard deviation of s= 223 indicates a large variance. While one sire bred more than 2000 and 16 sires more than 1000 mares each, 45.4 % of all serving stallions (n= 724) mated less than 10 mares in the observed 14 years. If sire and year are considered as one unit, 6395 different sire*year combinations can be generated. These combinations and the total number of 1593 overall used sires indicate the stallions were kept for 4.0 years for breeding. Further it reveals, the stallions were mated on an average with 30 mares (s= 35) per season. A continuous growing number of serving sires (from 392 in 1981 to 564 in 1991) can be observed along with more proportional increase in fraction of stallions mating extremely less (< 10) and a great many (> 150) mares per season. This is due to the growing number of private owned stallions in the hanoverian breeding area during the last few years. On the other hand, the increasing use of artificial insemination practise since 1987 made it possible that often demanded sires mated more than 150 mares per season.

Since almost half of the sires are mated with less than 10 mares in their whole service period and, on an average, 41.9 % of sires are bred with less than 10 mares per season, there is much selection response to be gained on the male side. More intensive selection in sires will result more selection response. Further more, the selected sires will produce more offspring in a shorter period of time. This will lead to more accurate estimated breeding values and again increase selection response.

### Foaling rate

Foaling rate is a conventionally used parameter to describe fertility performance in horses. In this evaluation, the foaling rate was defined as the percentage of foaling mares from all mares mated in the previous breeding season. In the span of 1981 to 1987 the foaling rate increased slightly from 54.6 % to 56.7 %, but advanced more rapidly since 1988. So far, it showed a peak in 1991 with 61.4 %. This above average growing rates can be due to intensified use of artificial insemination practise since 1986. The improved veterinary care in the scope of artificial inseminations, specially the increasing number of heat detections by ovary palpation, must be considered as the most important effects on the observed progress. A comparison between artificial and natural insemination practise on basis of uncorrected data support this argument. Artificial inseminations with fresh semen indicated higher foaling rate (59.4 %) than the natural inseminations (55.7 %). Whereas, the application of frozen semen was less successful (32.5 %) and therefore only used in a small number of mares.

WILKENS (1989) analysed the reproductive performance of Holsteiner Warmblood mares and estimated 51 % of average foaling rate for the period 1978 to 1986. He attributed the comparatively less foaling rate to loss of data while merging different data sets. KLEMETSDAL and JOHNSON (1989) observed a foaling rate of 61.6 % in Norwegian trotters which is quite similar to that one found in the Hanoverian population. In the West German Thoroughbred breed a compulsory pregnancy diagnosis is carried out every autumn. Since more than four decades, veterinarians are able to ascertain fertility rates of 70 % and higher (MERKT et al., 1993). This fertility rate is not absolutely identical with the above defined foaling rate. But it indicates, optimum management and veterinary care in the scope of a comprehensive control system can bring distinct improvements in reproductive performance. Likewise some warmblood studs are able to gain above average foaling rates, if compared with the breed average (OSTER and PAUFLER, 1990). This requires a very good management including intensive collaboration with the veterinarians. By allowing the stallions to run at liberty together with the mares, the breeders of Icelandic toelter horses are able to get live foals from more than 80 % of all mated mares (HUGASON et al., 1985).

### Reproductive life

The average reproductive life of Hanoverian mares with number of foals and length of breaks between breeding years was analysed. All mares borne in 1977 were used exemplary for evaluation. In the period between 1979 to 1991 a total number of 2715 mares of the referred age class were used for breeding. Altogether 12.431 matings were registered and thus the average reproductive life was 4.6 years with 2.7 born foals per mare. Conspicuously 23.8 % of the considered mares did not give birth to any foal. Whereas, only one offspring born per mare was

observed in 21.9 % cases and in 14.5 % cases two offsprings born per mare were observed (table 1). Only 198 mares (7.3 %) were bred each season. Half of the broodmares (52.3 %) were not used for breeding purposes for more than three years, and a quarter (24.4 %) of them performed only one breeding year. These results are in good conformity with findings published by WILKENS (1989) from Holsteiner Warmblood population. KLEMETSDAL (1993) found a mean reproductive life of 5.57 years among Norwegian trotter mares.

Tab.1. Reproductive life (breeding years till 1991 and foalings till 1992) of mares borne in 1977

| breeding year | no | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mares | n | 664 | 423 | 335 | 241 | 154 | 153 | 133 | 91 | 110 | 106 | 107 | 196 | 2 | 2715 |
| | % | 24.4 | 15.6 | 12.3 | 8.9 | 5.7 | 5.6 | 4.9 | 3.4 | 4.1 | 3.9 | 3.9 | 7.2 | 0.1 | 100 |

| foaling | no | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mares | n | 647 | 595 | 394 | 249 | 206 | 133 | 139 | 123 | 73 | 67 | 54 | 24 | 11 | 2715 |
| | % | 23.8 | 21.9 | 14.5 | 9.2 | 7.6 | 4.9 | 5.1 | 4.5 | 2.7 | 2.5 | 2.0 | 0.9 | 0.4 | 100 |

If only mares with more than one breeding year are taken into account (n= 2051) by considering second and further matings (n= 9716), then it is observed 88.1 % matings were carried out in successive breeding years. Whereas, a portion of 6.9 % matings was carried out with a preceding breeding break of one year and 2 % matings reveal, the break lasted two years. Thus longer intervals without breeding are limited to exceptional cases.

**Generation interval**

In horse breeding, replacement of the parents by selected offspring is a continuous process. The progenies are mated as soon as they are mature while most of the parents are still used for breeding. When generations overlap this way, FALCONER (1981) suggested to calculate the generation interval as the average age of the parents at the birth of their selected offspring. Since much more female progenies are selected than male, the generation intervals of different paths must be distinguished. Deviating from FALCONER (1981), in a first step of this study all progenies were considered to estimate generation intervals. For dams and sires respectively, an overall data set, each including 107.290 pairs of parent-offspring observations, was analysed. Records with missing information, such as sex of the foal and year of birth of dam or sire, were rejected from analysis (table 2).

Tab.2. Generation intervals in Hanoverian Warmblood population based on matings in the period 1979 to 1992

| path | | number observations n | generation intervals years | standard deviation s |
|---|---|---|---|---|
| dam-daughter | $L_{dd}$ | 53.547 | 9.1 | 4.2 |
| dam-son | $L_{ds}$ | 53.743 | 9.2 | 4.2 |
| sire-daughter | $L_{sd}$ | 53.547 | 10.7 | 4.8 |
| sire-son | $L_{ss}$ | 53.743 | 10.7 | 4.7 |
| dam-offspring | $L_{do}$ | 107.290 | 9.1 | 4.2 |
| sire-offspring | $L_{so}$ | 107.290 | 10.7 | 4.7 |
| parents-offspring | $L_{po}$ | 214.580 | 9.9 | 4.5 |

The average generation interval between parents and offspring ($L_{po}$) was 9.9 years for the period between 1979 to 1992, with a standard deviation of 4.5 years. On the female side, the generation interval ($L_{do}$= 9.1) was 1.6 years shorter than on the male side ($L_{so}$= 10.7). The average age of dams at birth of their female offspring was

9.1 years and 9.2 years in case of male offspring. Sires averaged 10.7 years of age at birth of both, their male and female progenies. The generation interval was more variable to the male side (s= 4.8) than the female side (s= 4.2). If the definition of FALCONER (1981)is strictly followed, then only progenies with their own breeding activities are considered. Thus data has to be reduced to 18.345 dams and 1079 licensed sires. These selected progenies in fact replaced their parents. The generation intervals, estimated by evaluating this data, showed negligible deviation from the above mentioned intervals.

On the female side, the generation intervals increased continuously from 8.8 to 9.6 years in the period between 1979 to 1992. A similar trend was observed on the male side. The sires of all progenies born in 1980 averaged 10.4 years of age. Till 1990 the generation intervals increased at 11.1 years, then declined slightly in the next two years at a level of 10.9 and 10.8 years. With respect to the selection response per unit of time, this development is unsatisfactory. It indicates inefficient breeding in the Hanoverian Warmblood population since more than ten years, provided the other parameters of selection response remained unchanged. In spite of the short average reproductive life of 4.6 years, the generation interval is longer than nine years in case of mares. This is to a large extend due to the more age at first mating of considerable part of mares. 52.5 % dams were younger than six years, but 21.7 % were older than nine years at birth of their first foal. Likewise, 47.5 % sires were ageing ten years and older at time of birth of their first offspring. Thus reducing the portion of parents which are comparatively old at start of reproductive life is an appropriate way to increase selection response.

OJALA (1982) reviewed literature and found average generation intervals of 11.4 years for the male and 10.4 years for the female side in different horse populations. According to this review, the generation interval seems to be one to two years longer on the male side than on the female. This is in good conformity with the observations in the Hanoverian population. KLEMETSDAL (1993) however, reported a generation interval for the path sire-offspring of 10.94 years and 11.16 years for the path dam-offspring in Norwegian trotters. Likewise, HUGASON et al. (1985) estimated a shorter interval for sires ($L_{so}$= 8.65) than for dams ($L_{do}$= 11.40) in Icelandic toelter horses. They attribute this to the quite intensive use of young colts for breeding.

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