

## REPRODUCTIVE CAPACITY OF MONTBELIARD CATTLE BREED, REARED IN BULGARIA

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### *Abstract*

*The aim of the present study is to ascertain the reproductive capacity of the cows of the Montbeliard cattle breed during the adaptation period in the initial stage of the breed introduction in Bulgaria. The study involves 1,222 cows, which is relatively new in Bulgaria, reared in 16 farms. In our country rearing conditions, the Montbeliards reach average first calving age of  $31.6 \pm 0.19$  months. It is observed that the cows born in Bulgaria have calved earlier when compared to those born in France- respectively  $30.9 \pm 0.32$  and  $32.7 \pm 0.38$ . The farm, father, year and month of birth have a significant effect on the age of first calving. The average duration of the calving interval of the animals examined is  $453 \pm 20$  days. We have ascertained that of all factors considered, the farm, year and month of calving have the biggest influence on the calving interval. The rank correlation of the farms in terms of duration of the calving interval and the first calving age is positive and high enough ( $+0.618$ ).*

**Key words:** *calving, lactation, Montbeliard, reproduction.*

### INTRODUCTION

The French selection is characterized by its traditionalism and quite high conservatism. Therefore, the selection indexes of the dairy cattle breeds are similar (Launay, 2014) and have not change within ten years. In 2012, however, this happened with the shift to paying more attention to the functional traits, especially those related to longevity. Furthermore, two new priorities- cows fertility and udder health have been introduced, while the milk productivity relative share has been decreased (Govignon-Gion et al., 2016). The reproduction capacity plays a major role among the functional factors. The main factors controlled are the age of first calving, independence, service period and calving interval duration, the total fertility and impregnation after first insemination. In many regions of France, the first calving takes place after two years old. In 2017 the average first calving age of the Montbeliard cattle breed was 27-30 months (Janus et al., 2017). The Montbeliard cows which calved at such age indicated good milk production, longer productive lifespan and higher lifelong milk yield (Janus, 2016). Another study (Zółkiewski et al., 2018) indicates that the average first

calving age of the Montbeliard is 29.4 months, and that the breed had fewer ( $P \leq 0.05$ ) lactations when compared to the Simmental whose first calving age was between 24 and 27 months. Amine and Malika (2016) recommend that the Montbeliard first calving age be not earlier than 28.4 months. The first ever import of Montbeliard heifers in Bulgaria was executed in 2005, and by 2012 a total of 1,339 animals were imported (Karamfilov and Atanasov, 2013). The aim of the present study is to ascertain the reproductive capacity of the cows of the Montbeliard cattle breed during the adaptation period at the initial stage of the breed introduction in Bulgaria.

### MATERIALS AND METHODS

The study involves 1,222 cows of the Montbeliard cattle breed, controlled by the National Association for Breeding of Montbeliard and Simmental Cattle in Bulgaria in the period 2005-2013. Part of the cows are introduced from France, others were born in Bulgaria after the initial introduction. The cows are reared in 16 farms, situated all over the country. Cows having a calving interval of more than 900 days are not included in its examination. The data are processed via

analysis of variance with the linear models having the following statistical expression:

1. Age of first calving:  $Y_{ijk} = \mu + F_i + YB_j + SB_k + FY_{ij} + FS_{ik} + YS_{jk} + FY + S_{ijk} + e(M1)$ ;  $Y_{ijl} = \mu + F_i + YB_j + MBl + FY_{ij} + FMil + YM_{jl} + FYM_{ijl} + e(M2)$ ;  $Y_{ijm} = \mu + F_i + YB_j + Om + FY_{ij} + FOim + YO_{jm} + e(M3)$ ;  $Y_{ijkn} = \mu + F_i + YB_j + Sn + FY_{ij} + FS_{in} + YS_{jn} + e(M4)$ .

2. Calving interval:  $Y_{imnpqr} = \mu + F_i + Om + Sn + YC_p + MC_q + Lr + e$ , where:  $\mu$  - is the population average  $YB_j$ ,  $SB_k$ ,  $MBl$ ,  $Om$ ,  $Sn$ ,  $YC_p$ ,  $MC_q$ ,  $Lr$  are fixed effects of respectively the farm (16); year (9), season (4) and month of birth (4); origin (2- France and Bulgaria); father (237); year (9) and month of calving (12); order of lactation (7); e- residuals.  $FY_{ij}$ ,  $FS_{ik}$ ,  $YS_{jk}$ ,  $FYS_{ijk}$ ,  $FMi$ ,  $YM_{jl}$ ,  $FYM_{ijl}$ ,  $FOim$ ,  $YO_{jm}$ ,  $FS_{in}$ ,  $YS_{jn}$  are random effects of a certain factor within the scope of the preceding one (e.g.  $FY$  is a random effect of the year of birth in the farm). The statistical processing is performed via SPSS Statistics 21.

## RESULTS AND DISCUSSIONS

The heifers of the Montbeliard cattle breed reared in Bulgaria are relatively early maturing. They calve around the age of  $31.6 \pm 0.19$  months. Introduced Montbeliard age of first calving of above 30 months is reported by Vidu et al. (2010) - in Romania- 32 months, Madani (2008) - in Algeria - 33.1 months and others. According to the latter, the optimal first calving age of the breed is 30-36 months. The cows which have calved at an earlier age have exhibited lower milk yield in their lactation

periods and lower lifelong milk yield, and the service period between the first and second lactation and the calving interval respectively have been 20 days longer. Similarly to other countries where livestock breeding is well developed, in France there has also been a tendency of decreasing the age of first calving. Thus the duration of the non-productive lifespan is diminished, the breeding efficiency is increased and the costs are reduced (Le Cozler et al., 2009; Cooke et al., 2013). According to LCP (2014) cows which have had initial calving at three years old have yielded 177 liters less milk than those who have calved for the first time at the age of 2 years. The study of the Bulgarian Montbeliard population carried out by us shows that the cows born in Bulgaria have calved earlier than those born in France- respectively  $30.9 \pm 0.32$  and  $32.7 \pm 0.38$  months; the difference, however, is improbable (Table 1). The earlier calving has two possible explanations. First, the heifers reared in Bulgaria are impregnated early without waiting for them to gain the necessary live weight. The age is a major factor in most of the farms and the fact that the Montbeliard cows are medium and not early maturing breeds is not taken into account. Karamfilov (2014) claims that the above mentioned is indirectly proved by the fact that at the end of their growth period, the cows born in Bulgaria were ( $P < 0.05$ ) lower and shorter than those born in France. The second reason for the difference in the age of first calving of the animals with different origin could be found in the adaptation period which is required by the imported animals.

Table 1. Influence of some major factors on the first calving age

Factor	M1		M2		M3		M4	
	MS	F	MS	F	MS	F	MS	F
F	121.6	9.239 <sup>a</sup>	118.2	11.933 <sup>a</sup>	107.9	7.312 <sup>a</sup>	63.6	5.446 <sup>a</sup>
YB	296.6	22.532 <sup>a</sup>	242.8	24.511 <sup>a</sup>	258.1	17.496 <sup>a</sup>	157.7	13.507 <sup>a</sup>
SB <sup>M1</sup> ; MB <sup>M2</sup> ; O <sup>M3</sup> ; S <sup>M4</sup>	85.5	6.494 <sup>a</sup>	122.5	12.368 <sup>a</sup>	14.6	0.987	14.5	1.240 <sup>c</sup>
F*YB	75.6	5.746 <sup>a</sup>	69.8	7.046 <sup>a</sup>	67.0	4.541 <sup>a</sup>	41.8	3.584 <sup>a</sup>
F*SB <sup>M1</sup> ; *MB <sup>M2</sup> ; *S <sup>M4</sup>	14.8	1.127	17.3	1.751 <sup>a</sup>			22.6	1.939 <sup>a</sup>
YB*SB <sup>M1</sup> ; *MB <sup>M2</sup> ; *O <sup>M3</sup> ; *S <sup>M4</sup>	27.8	2.109 <sup>b</sup>	29.5	2.981 <sup>a</sup>	35.3	2.391 <sup>b</sup>	13.6	1.168
F*YB*SB <sup>M1</sup> ; F*YB*MB <sup>M2</sup>	27.2	2.063 <sup>a</sup>	26.0	2.625 <sup>a</sup>				

F-Farm; YB-Year of birth; SB Season of birth; MB Month of birth; O - Origin; S- father; a<0.001; b<0.01; c<0.05

Part of the heifers were pregnant, others were not. It is possible that the stress during transportation, the new conditions, and the different feeding pattern with new feeds and so on have negatively affected the reproduction functions of the animals.

The adaptation process, however, has not depended so much on the new natural and climatic conditions as on the farming conditions (Table 2). The difference in the age of first calving in the farms ranges from 0.08 to

5.4 months ( $P < 0.001$ ) and the latter is between farms situated in one and the same region. Along with that, in 8 of 14 farms where introduced as well as born-in-Bulgaria heifers were reared, the introduced animals calved at an older age.

The age difference ranges from 0.42 to 7.0 months. The difference regarding the six farms with earlier calving of introduced heifers is within similar scope. In one of those farms, however, the difference is almost a year.

Table 2. Average first calving age of cows in farms from different regions of the country (in months)

Region	Farm	LSM± SE	Region	Farm	LSM± SE
North East	1	32.53±0.323	South	5	31.06±0.602
	6	33.45±0.708		7	32.60±1.451
South - West	10	29.82±0.991	North	8	33.81±1.100
	14	30.20±1.622		12	33.19±0.773
	15	33.56±0.898		13	28.87±0.465
	2	31.25±0.810		4	30.12±0.725
	3	31.10±0.847		16	34.40±0.988
	11	32.84±0.631		9	29.90±1.451

Along with the farm, the year of birth also has a significant effect on the age of first calving. Through an abundant complex of factors, both the year and month of birth influence the normal course of the ontogenesis during the embryonic and postembryonic stage, the growth speed, development, including of the reproductive organs, the capability of normal fertilisation and pregnancy maintenance. (Allouche et al., 2018). Figure 1 clearly shows that in the course of monitoring, there is a downward trend in the first calving age. During the initial years after the importation of the first animals in 2005, the increase of their number in the herds was due to the import of pregnant heifers but, as we have already pointed out, they calved at an older age.

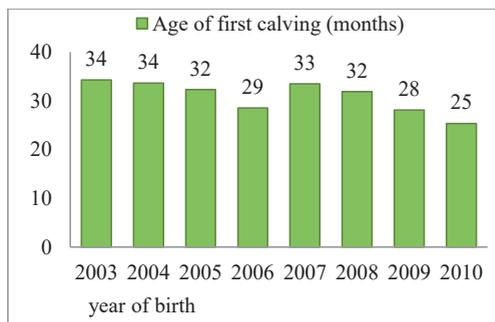


Figure 1. Influence of the year of birth on the first calving age

After the establishment of own reproduction, it is observed that with reference to the animals born between 2007-2010 there was a steady downward trend in the age of first calving.

The optimal first calving age is attained at the initial periods but subsequently, the age continues to diminish and by the end of the 8-year examination period, it is decreased by 9 months (Figure 2).

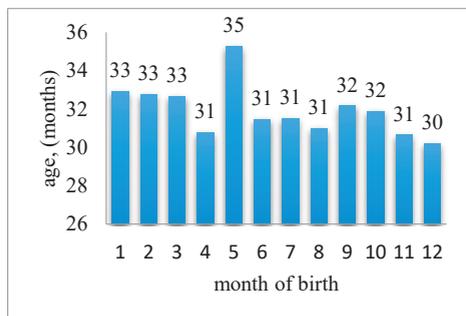


Figure 2. Influence of the month of birth on the first calving age

This cannot be regarded as a favourable tendency when taking into account the time necessary for the heifers of the Montbeliard cattle breed to reach the optimal farming maturity. In most of the farms both in France and in Bulgaria, the Montbeliard cattle breed is extensively and semi-intensively bred.

Therefore, the month of birth, by means of the complex of climatic and feeding conditions, has a significant influence on the course of the embryonic and post-embryonic ontogenesis which in itself is related to the heifers' impregnation ability and their first calving age. Teke and Akdag (2012) have ascertained that the calves born in the summer attain breeding age later than those born in the other seasons. The later calving generates losses from 123 to 164 USD per head.

Our survey shows that the influence of month of calving needs to be analysed as a priority. Grouping of months into seasons is too provisional and, as it can clearly be seen from table 3, the season is not a reliable source of variation for the first calving age within the farms. Along with that, figure 2 indicates that the heifers born in the period January-March, which are in different seasons, calved at one and the same age. The biggest differences, on the other hand, are observed in those animals born in April and May which are in one and the same season.

Upon analysing longer periods, we ascertained that as a whole, the heifers born in June, July and August calved the earliest, and those born in January, February and March- the latest with a 2-month difference in the first calving age.

The second major controlled factor of the reproductive capacity is the length of the calving interval. This is a complex factor indicating the cows' reproductive capacity because it is connected with the postpartum period, uterus involution, independence and service period length, etc.

The average length of the calving interval of the cows studied by us -  $453 \pm 20$  days is far from the optimal one. With reference to the cows born in Bulgaria it is negligibly longer ( $456.8 \pm 24.6$ ) when compared to that of the cows born in France ( $449.8 \pm 21.1$ ); the origin of the cattle is not a reliable source of variance of the trait (Table 3). When it comes to the Montbeliard cows introduced in Morocco, the average calving interval length was 385.6 days (Boujenane and Aïssa, 2008), in Great Britain- 402 days (NMR, 2009), in Tanzania - 369 (Bouraoui et al., 2009) etc.

Table 3. Influence of major factors on the calving interval length of cows from the Montbeliard cattle breed

Factor	Df	MS	F
Father	250	12,687.722	1.123
Farm	15	53,938.376	4.774a
Origin	1	1,912.541	0.169
Year of calving	7	86,374.902	7.645a
Month of calving	11	24,966.034	2.210i

a -  $P < 0.001$ ; c -  $P < 0.05$ ;

Data of COOPEX (2020) reveal that the Montbeliard has the best reproductive capacity

of all dairy breeds in France. The cows impregnation from first insemination is

achieved with approximately 1.7 doses of seminal fluid against 2.4 for the Holstein. The success rate of using sexed semen is approximately 28.2 % with reference to the Montbeliard and 14.7 % regarding the Holstein. The calving interval is approximately 392 days against 420 for the Holstein. Nevertheless, a study of Mefiti (2016) finds out that the calving interval of cows of the Montbeliard cattle breed was approximately 493 days and the average total fertility of the herd- 69.04% which is definitely indicative of the specificity of the effect of the environmental conditions on the cows reproductive capacity. Of all the factors examined by us, the farm and the year of calving have had the most significant influence on the calving interval. The difference in the length of the calving interval in the farms reaches up to 219.9% (Table 4). Similarly to the first calving age, the rate of the factor is determined not by the natural and climatic

conditions but by the farming ones. Thus, the difference in the calving interval in the individual farms is 41.4% in North-East region, 55.0% in South-West and 186.2% in the North region. The only farm with a shortened calving interval (4) was with a relatively early first calving age of the cows (5th rank). The other farms display more significant rank changes but as a whole the rank correlation of the farms with reference to length of the calving interval and first calving age (Table 5) is positive and high enough (+0.618). Such is the correlation between the calving interval and lactation length - +0.697. The first calving age correlates positively with the lactation length. The older first calving age and the longer calving interval are connected to lower milk yield. The decrease in the farms average milk yield per normal lactation is also related to the lactation prolongation.

Table 4. Average calving interval of cows reared in different farms (in days)

Region	Farm	LSM± SE	Region	Farm	LSM± SE
North-East	1	388±24	South	5	473±23
	6	549±26		7	525±26
South - West	10	465±28	North	8	441±29
	14	400±28		12	453±21
	15	434±42		13	484±35
	2	500±50		4	282±87
	3	620±29		16	384±36
	11	483±27		9	371±67

Table 5. Rank correlations between the farms with reference to the calving interval, first calving age, lactation length and milk yield per normal lactation

Traits	First Calving Age	Length of Lactation	Milk Yield per Normal Lactation
Calving interval	0.618	0.697	-0.447
First calving age		0.476	-0.306
Length of lactation			-0.512

During the first years after the introduction of the Montbeliard cattle breed in Bulgaria, the calving interval varied greatly (Figure 3) which once again can be connected to the adaptation processes running. After 2009 a steady tendency for decreasing the length of the calving interval is observed. The cows which calved in 2012 had approximately 18% shorter calving interval when compared to those which calved in 2009. The lactation length of cows

which calved in different years follows a similar pattern. The order of calving is not indicated as a factor which affects the length of the calving interval probably because of the high intra-group variance, however, the trends are clearly expressed (Figure 4). The first calving interval of the population controlled in Bulgaria is the longest and there is a clear downward trend up to the fourth one. The second calving interval is 8.4% shorter than the

first one, the third is 3.7% shorter than the second, and the fourth is 4.6% shorter than the third one.

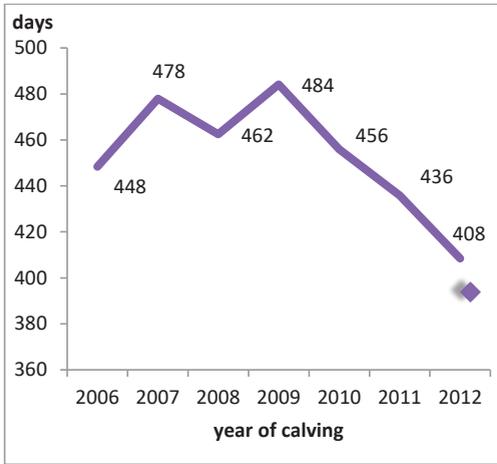


Figure 3. Length of the calving interval of the cows which calved in different years

The total decrease between the first and the fourth calving interval is 15.9%.

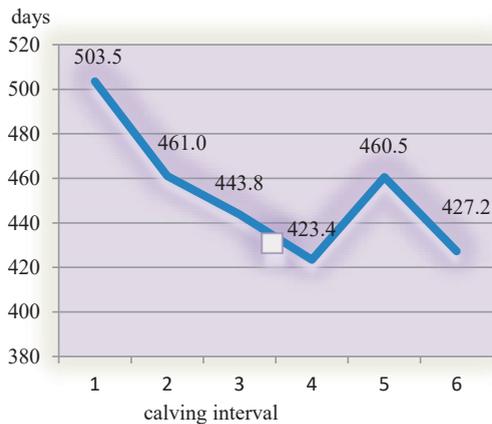


Figure 4. Length of the calving interval depending on the order of calving

The dynamics we observed in the length of the calving interval is different from what other authors have reported. Gadzhev (2005) for example, ascertained gradual increase in the length of the calving interval from 1st to 11th with 5.6% which is explained with the growing insemination problems. Ferris et al (2014) claim that the Holstein cows population in

Ireland observed by them had first calving interval of 389 days, the second one was 1 day longer, the third one - 8 days longer, the fifth one - 10 days longer, and the sixth - 2 days longer. A parallel examination of the Norwegian Red Cattle breed, however, shows that the longest calving interval was the first one - 399 days; the second and the third decrease to 379 and 376 respectively, and after that the calving interval increases to 384, 386 and 383 days. Similarly to the population studied by us, the Norwegian cows were imported in Ireland as heifers. Obviously, the explanation for the significantly prolonged first calving interval and its gradual decrease may be found in the adaptation processes. The month of calving also influences the length of the calving interval and the reason for this can clearly be seen in Figure 5. As a whole, the calving from September to January is less dynamic - within 2% but from February to August it is considerable and nonlinear. The cows born in August had the longest calving interval. This is the month when the cows in our country experience the most unfavourable conditions- the high temperatures are combined with the drying of the pastures. When it comes to the preceding months, they are related to the transition from winter to summer feeding and more noticeable fluctuations in the climatic factors. Mouffok et al (2019) have found that the season influences the cows total fertility. In the winter the pregnancy rate was 73.3%, 69.4% in spring, 69.2 in the summer and 63.2% during the autumn.

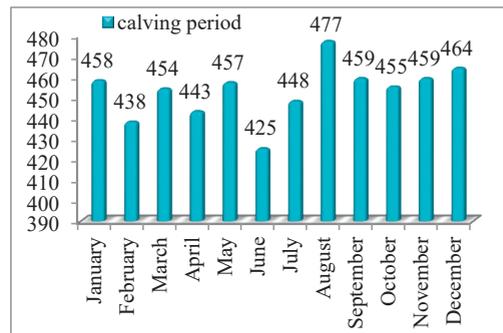


Figure 5. Length of the calving interval of the cows which calved in different months

The father does not affect the length of the calving interval. This probably stems from the inability to group the bulls due to their large number, the smaller number of daughters lactating in different farms, different years, seasons and so on. However, the difference in the length of the calving interval of the daughters of the individual bulls is considerable- from 248±104 to 805±144 days. The shortest calving interval in Bulgaria was displayed by the daughters of IMPOSTEUR - FR 3993030061. In France IMPOSTEUR is ranked ISU - 102 with 95% milk yield reliability and 95% regarding linear traits. The daughters of UCIFE - FR 7401927569 had the longest calving interval of approximately 805±144 days. In France the UCIFE has ISU-84 but has a relatively low reliability with reference to the reproduction index- 66%.

## CONCLUSIONS

During the first 8 years after the introduction of the Montbeliard cattle breed in Bulgaria the heifers calved at an approximate age of 31.6±0.19 months, and the length of the calving interval is 453±20 days on average.

The farm, father, year and month of birth influence the age of first calving, and the farm, year and month of calving affect the calving interval length.

The cows born in Bulgaria have calved 2 months earlier and their calving interval is negligibly longer than that of the cows born in France, however, the difference observed in these two factors are unreliable.

The adaptation of the introduced animals is mainly affected by the breeding conditions in the farm. The Montbeliard adapts successfully and has good reproductive capacity in the farms which offer a good level of rearing and feeding technology.

After the initial adaptation period there is a steady downward trend in the first calving age and the length of calving interval of the Montbeliard cattle breed population in Bulgaria.

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