

The analysis of factors affecting the calving difficulty in Slovak Spotted cattle

Barbora Olšanská*, Juraj Candrák

Slovak University of Agriculture in Nitra, Faculty of Agrobiological and Food Resources, Department of Animal Genetics and Breeding Biology, Slovak Republic

Article Details: Received: 2018-09-10 | Accepted: 2018-10-25 | Available online: 2018-09-31

<https://doi.org/10.15414/afz.2018.21.03.119-124>



Licensed under a Creative Commons Attribution 4.0 International License

The aim of this study was to analyse several genetic and non-genetic factors that can affect the calving difficulty of Slovak Spotted cattle and to find out their statistical significance. A total of 417030 calving difficulty records from 174795 dams were collected during the calving parity from 2001 to 2017. The impact of factors affecting the calving difficulty was analysed by using procGLM implemented in SAS 9.3 on the basis of multifactor analysis of variance. The effects of the herd, a year of calving, the sex of a calf, a breed type, a month of calving, the parity and the sire were tested. The sex of born calf was the most significant factor ($R^2 = 25.5\%$). The calving difficulty was significantly affected also by the herd, a year of calving, a month of calving, the parity and sire. Each of these effects showed high level of significance ($P < 0.001$). The lowest level of statistical significance was found for effect of breed type. Based on obtained results we recommend continuing to use the recording of calving difficulty for the purposes of evaluation of effect of sire on inheritance.

Keywords: cattle, calving difficulty, non-genetic factors, reproduction

1 Introduction

Reproduction makes the greatest contribution to genetic gain in cattle measured in economic units. Reproduction can be as much as four times more economically important than end-product trait. In Slovak Spotted cattle, the calving ease can be regarded as one of the most important reproduction traits from the point of view of its breeding objective (Slovak Simmental Breeders Association, 2018).

The calving difficulty can be affected by various genetic and non-genetic factors. Non-genetic factors include the sex of calf, the age of dam, the parity, and the season of calving, nutrition condition of dam before calving, and environmental conditions. On the other hand, the length of gestation, breed type and maternal dimensions of the dam are considered as genetic factors (Záhradková, 2009).

An indicator that greatly affects animal welfare, the livestock economy and the amount of farm work is the calving difficulty. The calving difficulty is influenced by direct and maternal genetic components. Animal

selection and breeding strategies can optimize the accuracy of genetic evaluations and correctly highlight the calving difficulty in the multi-tagged indexes that provide estimates of genetic parameters (Strapák et al., 2011).

Slovak Spotted is autochthonous breed which belongs to the Simmental group of cattle. The Simmental is among the oldest and most widely distributed across of all breeds in the world. The Slovak spotted cattle as an important dual-purpose breed with a long tradition of breeding in Slovakia has excellent dairy as well as beef production. Slovak spotted was created by the crossbreeding of several breed (grey-brown Carpathian cattle, red Carpathian cattle and grey Steppe cattle) and it is recognized as one of autochthonous officially accepted as breed in 1958. This breed is typical of a good balance between milk and meat production and is characterized by a larger body frame, symmetrical body stature, good sex expression and good musculature. They are known for their gentle nature, impressive stature and excellent dairy qualities. (Kadlečík et al., 2013, Strapák et al., 2013, Shevhezhev and Belik, 2017, Bogdányi et al., 1996).

***Corresponding Author:** Barbora Olšanská, Slovak University of Agriculture in Nitra, Faculty of Agrobiological and Food Resources, Department of Animal Genetics and Breeding Biology, Tr. Andreja Hlinku 2, Nitra, Slovak Republic, e-mail: barbara.olsanska@uniag.sk

The aim of this study was to analyse several genetic and non-genetic factors that can affect the calving difficulty in Slovak Spotted cattle and to observe their statistical significance.

2 Material and methods

A total of 417030 calving difficulty records from 174795 dams were used in this study. The calving difficulty records were collected from the first to the sixth lactation during the parturition course from 2001 to 2017. All of records were provided by the Breeding Services of the Slovak Republic, s. e. Any additional information including pedigree data were obtained in cooperation with the Slovak Simmental Breeders Association. The impact of factors affecting the calving difficulty was analysed by using General Linear Models (GLM) procedure implemented in SAS 9.3 (SAS Institute Inc., 2011). The effects of the herd, year of calving, the sex of a calf, breed type, month of calving, parity and sire were tested. To prevent inaccuracy, the effect of year, month and herd were analysed separately and not as combined "contemporary groups". The impact of the individual factor was analysed based on multifactor analysis of variance using following linear model:

$$Y_{ijklmno} = HERD_i + YEAR_j + MONTH_k + SL_l + SEX_m + BREED_n + SIRE_o + e_{ijklmno}$$

where:

- $Y_{ijklmno}$ – a calving difficulty
- $HERD_i$ – fixed effect of the herd ($i = 802$)
- $YEAR_j$ – fixed effect of a year of calving ($j = 17$)
- $MONTH_k$ – fixed effect of a month of calving ($k = 12$)
- SL_l – fixed effect of the parity ($l = 6$)
- SEX_m – fixed effect the sex of calf ($m = 4$)
- $BREED_n$ – fixed effect of the breed type ($n = 3$)
- $SIRE_o$ – fixed effect of the sire ($o = 1852$)
- $e_{ijklmno}$ – represents random effect of the residual

Evaluation of calving difficulty (4 – point scale)

For evaluation of the calving difficulty was used 4 – point scale: 1 – spontaneous calving (no assistance required); 2 – easy calving (assistance of 1 – 2 person); 3 – difficult calving (assistance of 3 or more persons or a veterinarian); 4 – caesarean section.

State code of the sex of calf

For identification of sex in the data were used specific codes from animal recording used in Slovak republic: code 1 (bulls); code 2 (heifers); code 16 (live – born but calf died); code 61 (stillbirth).

3 Results and discussion

Analysis of a calving difficulty by years of calving

In this study overall 417030 calving difficulty records of Slovak Spotted cattle, collected during the season from 2001 to 2017, were evaluated. All of collected records for 174795 dams were complete. A total of 87% parturitions occurred easy, while only 0.03% required medical intervention. The value of determinant coefficient for the evaluated effect is $R^2 = 3.5\%$. Table 1 shows the number of observations within each evaluated class of calving score.

Table 1 Calving difficulty in the analysed population

Calving difficulty	Count	%
1 spontaneous	360,997	86.56
2 easy	51,380	12.32
3 difficult	4,511	1.08
4 caesarean section	142	0.03

Compared to our results, Eaglen and Bijma (2009) reported for Holstein cows only 42.07% calving occurred spontaneous, easy calving 50.17%, difficult calving 7.46% and caesarean section 0.29%. Overall our findings are in accordance with findings reported by Strapák et al. (2011), he reported lower frequencies of easy calving of Slovak spotted cattle in 66.48% for heifers and cows had 75.46% of spontaneous calving, the frequencies of easy calving for heifers 20.1% and for cows 12.83% of Slovak spotted cattle. Ryba (2010) demonstrated similar values for all breeds of cattle within the range from 13.94% to 20.05%. Reached conclusion by Kotásek (2012) was the frequencies of easy calving for Holstein breed within the range from 15.62 to 17.34%, the frequencies of difficult calving for all breeds of cattle is little bit higher within the range from 2.05 to 3.36%, the frequencies of calving difficulty for Holstein breed within the range from 1.57 to 2.51%, and Hinrichs and Taller (2011) observed the frequencies of calving difficulty 8.96% for the Holstein breed. Kotásek (2012) demonstrated result for the frequencies calving where which it was necessary caesarean section 0.03 to 0.04% for Holstein breed and Hinrichs and Taller (2011) observed frequencies calving with caesarean section for the Holstein breed was 0.02%. Silvestre et al. (2018) reported for Portuguese dairy cattle per three generations from 320 953 records only 35.55% calving occurred spontaneous, easy calving 63.16%, difficult calving 1.21%, caesarean section 0.08%, in compared with our results we have more proportion of spontaneous calving. Inoue et al. (2017) describes the calving difficulty for Japanese black cattle in five-point scale from 1,850 records: 1. No problem or unobserved

76.1%; 2. Slight problem 13.8%; 3. Cow needed assistance 9%; 4. Considerable force used to deliver 1%; 5. Extremely difficult calving 0.2%. Reached conclusion by Cortes-Lacruz et al. (2017) for Parda de Montana beef breed from 5739 records was for spontaneous calving by 70.3%, easy calving 24.9%, difficult calving 3.1% and caesarean section 0.9%. In compared with our dual-purpose breed has a beef cattle higher proportion of difficult calving and caesarean section.

Analysis of calving difficulty by the month of calving

Within the evaluation of calving difficulty, we found the highest occurrence for the spontaneous calving during months March and April (97.60%). The lowest occurrence was found for calving requiring the caesarean section during month May and June (0.06%). The value of determinant coefficient for the evaluated effect is $R^2 = 0.03\%$. Table 2 shows the number of observations within each evaluated class of calving score by the month of calving.

By comparing the results from Soltner (1978) for Charolais cows occurred the calving ease during months March and April with value 76.06%. Vavrišínová (2007) observed for Charolais cows highest occurrence of difficult calving

during months January, February, and from September to December. Results from Johanson and Berger (2003) suggest that calf born during winter has higher weight and then has higher possibility of occurrence difficult calving of up to 15%.

Analysis of calving difficulty by the breed type

The results demonstrated in this section match state of calving difficulty for three breed types. Minimal value of Slovak spotted cattle within group S0 is 87.5% in genotype, breed type S1 has proportion of Slovak spotted cattle 75–87.5% and breed type S2 has proportion of Slovak spotted cattle 50–75%.

From in total of 417030 records, 225832 came from group of S0 cows, 73709 from the group of S1 cows and 117483 records was from the group of S2 cows. Compared to other factors tested in this study, the analysis proved that the breed type is significant effect on calving difficulty. Each of analysed groups showed approximately the same level of calving difficulty. Differences between breed types were negligible, therefore the effect of breed type was not considered in the model equation. The value of determinant coefficient for the evaluated effect was $R^2 = 0.002\%$. Table 3 shows the number of observations

Table 2 Frequencies of calving difficulty by the month of calving

Month of calving	1 spontaneous		2 easy		3 difficult		4 caesarean section	
	count	%	count	%	count	%	count	%
January	31,807	86.32	4,632	12.57	396	1.07	12	0.03
February	30,273	86.58	4,298	12.29	384	1.10	9	0.03
March	38,048	87.60	4,918	11.32	451	1.04	16	0.04
April	32,027	87.60	4,177	11.42	350	0.96	7	0.02
May	29,756	86.62	4,150	12.08	424	1.23	21	0.06
June	28,751	86.66	4,047	12.20	370	1.12	10	0.03
July	30,965	86.68	4,355	12.19	383	1.07	20	0.06
August	28,431	86.38	4,140	12.58	337	1.02	6	0.02
September	25,983	85.98	3,881	12.84	341	1.13	14	0.05
October	25,359	86.53	3,609	12.31	327	1.12	11	0.04
November	29,540	85.89	4,496	13.07	349	1.01	6	0.02
December	30,057	85.53	4,677	13.31	399	1.14	10	0.03

Table 3 Frequencies of calving difficulty by the breed type

Breed type	1 spontaneous		2 easy		3 difficult		4 caesarean section	
	count	%	count	%	count	%	count	%
S0	195319	86.49	27782	12.30	2641	1.17	90	0.04
S1	63918	86.72	8962	12.16	806	1.09	23	0.03
S2	101760	86.61	14636	12.46	1064	0.91	29	0.02

within each evaluated class of calving score by the breed type. Due to assignation to the breed type is specific within each Herd book there is no direct comparison of the results. Breed type has usually low proportion on total variance, but significant as proved by our results.

Analysis of calving difficulty by the sex of calf

During the calving of cows and heifers was recorded almost the same frequency between the calving difficulty of live-born bulls 46.4% and live-born heifers 46.2%. The proportion of live- born calf but calf died was 2.2% and the proportion of stillbirth was 5.2%. The value of determinant coefficient for the evaluated effect is $R^2 = 6.11\%$. Detailed results are presented in Table 4.

The results from Vavrišínová et al. (2007) reported the frequency of stillbirth for Charolais breed as follows: spontaneous calving 0.9%, easy calving 1.5%, and difficult calving 26.8% and for caesarean section 37.7%. Olson (2009) observed in his study the frequency of difficult calving for Holstein breed 19.98% and for Jersey breed 5.73%. Authors dealing with evaluation of calving difficulty (Vavrišínová et al., 2007; Olson, 2009) confirmed the highest frequency of difficult calving for sex with code 61 (stillbirth) and confirmed the easiest calving for sex with code 2 (heifers).

Analysis of calving difficulty by the parity

The multiparous cows were observed the highest occurrence of spontaneous calving. More frequent occurrence of dystocia has heifers. This is mainly because

of their incomplete physical development and the reduced space of the pelvis.

The analysis proved that the most calving difficulty was occurred in the heifers. In the second lactation calving difficulty was noticeably reduced compared to the first lactation. The value of determinant coefficient for the evaluated effect is $R^2 = 1.04\%$. Maternal effect was not part of the analysis. Detailed results presented in Table 5 shows the number of observations within each evaluated class of calving score by the sequence of lactation.

Results of Gaafar et al. (2010) showed the frequency of the difficult calving 7.7% stating that the age has an impact to the calving difficulty. Juozaitiene et al. (2017) observed for Lithuanian black and white dairy cows from 559,304 records that 48.75% of calving were evaluated as easy, 13.43% had slight problems, 34.71% of cows needed assistance, 2.87% needed considerable and 0.24% of cows had a difficult parturition, the majority difficult calvings were recorded in heifers or in cows between 6 and 8 lactations. Græsboell et al. (2015) in his study monitored the influence of selected factors on milk production. One of the factors was the calving difficulty, where they observed that spontaneous calving has the consequence on the higher milk production and observed a significant impact of the difficulty of the first calving. Schaeffer (2003) studied the application of random regression models and one of the examined factors was the application to fertility in dairy cattle and proposed a model with parity, and he reported that the

Table 4 Frequencies of calving difficulty by the sex of calf

Sex of calf	1 spontaneous		2 easy		3 difficult		4 caesarean section	
	count	%	count	%	count	%	count	%
Bulls	169,886	87.81	22,157	11.45	1,380	0.71	54	0.03
Live- born but calf died	6,771	72.12	2,263	24.11	340	3.62	14	0.15
Heifers	172,109	89.40	19,575	10.17	803	0.42	30	0.02
Stillbirth	12,231	56.50	7,385	34.11	1,988	9.18	44	0.20

Table 5 Frequencies of calving difficulty by the parity

Parity	1 spontaneous		2 easy		3 difficult		4 caesarean section	
	count	%	count	%	count	%	count	%
1.	101,794	81.15	21,599	17.22	1,984	1.58	63	0.05
2.	90,844	88.30	11,093	10.78	916	0.89	25	0.02
3.	68,398	88.87	7,888	10.25	655	0.85	27	0.04
4.	48,327	89.14	5,404	9.97	468	0.86	16	0.03
5.	32,131	89.48	3,446	9.60	325	0.91	8	0.02
6.	19,503	90.21	1,950	9.02	163	0.75	3	0.01

result of such an analysis would be a different genetic value for each animal for each parity.

Analysis of calving difficulty by the sire

The sire affects the length of gestation, calving weight and proportions of calf. Effect of sire is one of the possible sources of calving difficulty. Each sire is unique and can affect calving difficulty in different way.

In the dataset of Slovak spotted cattle were in total 1803 sires used in breeding. For the evaluation were used only 14 most important sires, which influenced the results. In the population of Slovak spotted cattle were the most used sire with the state register code HAT001 (Name: Xirno, line: Haxist) and the highest occurrence of difficult calving was observed by sire DIK005 (Name: GS Dionis, line: Dirteck). The value of determinant coefficient for the evaluated effect is $R^2 = 5\%$. Table 6 shows the number of observations within each evaluated class of calving score by the sire.

Analysis of the all factors involved in calving difficulty

The influence of the selected factors was verified based on General Linear Models (GLM) under ANOVA. From the short review above, key finding emerges: the overall explanatory effect of all factors on the variability of the calving difficulty was highly statistically significant and reached the value of the determinant coefficient ($R^2 = 25.5\%$). The determinant coefficient (*R*-square) of 0.254796 means that 25.5% variability of calving difficulty is explained by the effects examined, and the remaining

74.5% variability of calving difficulty can be explained by other reasons than the linearity between the variables. Cumulative value of determinant coefficient of all factors observed by one-way analysis was 30.282%. This leads us to conclusion that other interactions between factors should be considered in future analysis.

Table 7 Statistical significance of the factors involved in calving difficulty

Factors	R-square (%)	Pr > F	S
Total	30.282	<0.0001	++
Herd	14.6	<0.0001	++
Year of calving	3.5	<0.0001	++
Month of calving	0.03	0.0009	++
Parity	1.04	<0.0001	++
Sex of calf	6.11	<0.0001	++
Breed type	0.002	0.0227	+
Sire	5	<0.0001	++

++ highly statistically significant ($P < 0.0001$), + statistically significant ($P < 0.05$)

4 Conclusions

Based on the results of the analysis we recommend continuing to use the recording of calving difficulty for the purposes of evaluation of effect of sire on inheritance. The results confirm the statistical proficiency between calving difficulty and selected factors. For the Slovak spotted cattle were the most significant and highly statistically significant factors: the sex of calf ($R^2 =$

Table 6 Frequencies of calving difficulty by the sires

Sire	1 spontaneous		2 easy		3 difficult		4 caesarean section	
	count	%	count	%	count	%	count	%
RAO012	14,131	84.34	2,420	14.44	190	1.13	13	0.08
EGE003	12,251	82.53	2,314	15.59	272	1.83	7	0.05
STG001	11,481	82.37	2,272	16.30	176	1.26	10	0.07
DSO001	10,082	91.74	883	8.03	24	0.22	1	0.01
PKN004	6,762	88.07	873	11.37	43	0.56	0	0.00
RSS001	5,412	78.19	1,349	19.49	155	2.24	6	0.09
MOL003	5,925	88.64	738	11.04	21	0.31	0	0.00
RNN001	5,309	93.12	380	6.67	12	0.21	0	0.00
PLI004	4,888	90.50	477	8.83	31	0.57	5	0.09
BNR001	4,129	79.25	1,000	19.19	78	1.50	3	0.06
HAT001	4,671	97.90	96	2.01	4	0.08	0	0.00
RDD001	3,766	79.59	894	18.89	69	1.46	3	0.06
HLG007	3,788	82.56	735	16.02	64	1.42	0	0.00
DIK005	3,218	74.10	1,012	23.30	110	2.53	3	0.07

6.11%), the parity ($R^2 = 1.04\%$) and the year of the calving ($R^2 = 3.5\%$). By the monitoring selected factors for the influence of calving we can influence selection of animals that have the premise of easy calving. Easy calving is a manifestation of the good reproduction and good reproduction means profitable economy of breeding.

Acknowledgments

Data for this research has been provided by the Breeding Services of the Slovak republic and by the Association of Slovak Spotted Cattle Breeders – Cooperative.

Slovak research and development agency is acknowledged for financial support under project No. APVV-17-0060. Scientific and education agency of Slovak Republic is acknowledged under project No.VEGA 1/0742/17.

References

SLOVAK SIMMENTAL BREEDERS ASSOCIATION (2018) *The history of the breed*. [Online]. Retrieved 2017-06-10 from <http://www.simmental.sk/o-plemene/historia-vzniku-plemena.html>

BOGDÁNYI I. et al. (1996) *Breeding target and breed standard of Slovak spotted cattle*. Trebišov: Slovak Simmental Breeders Association.

CORTES-LACRUZ, X. et al. (2017) Genetic evaluation of calving ease in Parda de Montana beef breed based on linear and threshold models. *Web of Science*, vol. 113, no. 2, pp. 158–175. doi: <https://doi.org/10.12706/itea.2017.010>

EAGLEN, S. A. E. and BIJMA, P. (2009) Genetic parameters of direct and maternal effects for calving ease in Dutch Holstein-Friesian cattle. *Journal of Dairy Science*, vol. 92, no. 5, pp. 2229–2237. doi: <https://doi.org/10.3168/jds.2008-1654>

GAAFAR, H. M. A. et al. (2011) Dystocia in Friesian cows and its effects on postpartum reproductive performance and milk production. *Tropical animal health and production*, vol. 43, no. 1, pp. 229–234. doi: <https://dx.doi.org/10.1007/s11250-010-9682-3>

GRÆSBCELL, K. et al. (2015) Danish Holsteins favor bull offspring: biased milk production as a function of fetal sex, and calving difficulty. *Plos One*. doi: <https://doi.org/10.1371/journal.pone.0124051>

HINRICHS, D. and THALLER, G. (2011) Pedigree analysis and inbreeding effects on calving traits in large dairy herds in Germany. *Journal of Animal Science*, vol. 94, no. 9, pp. 4726–4733. doi: <https://doi.org/10.3168/jds.2010-4100>

INOUE, K. et al. (2017) Inferring causal structures and comparing the causal effects among calving difficulty, gestation length and calf size in Japanese Black cattle. *Animal*, vol. 11, no. 12, pp. 2120–2128. doi: <https://doi.org/10.1017/S1751731117000957>

JOHANSON, J. M. and BERGER, P. J. (2003) Birth weight as a predictor of calving ease and perinatal mortality in Holstein cattle. *Journal of Dairy Science*, vol. 86, no. 11, pp. 3745–3755. doi: [https://doi.org/10.3168/jds.S0022-0302\(03\)73981-2](https://doi.org/10.3168/jds.S0022-0302(03)73981-2)

JUOZAITIENE, V. et al. (2017) Relationship between dystocia and the lactation number, stillbirth and mastitis prevalence in dairy cows. *Acta Veterinaria Brno*, vol. 86, no. 4, pp. 345–352. doi: <https://doi.org/10.2754/avb20178604034>

KADLEČÍK, O. et al. (2013) Diversity of cattle breeds in Slovakia. *Slovak Journal of Animal Science*, vol. 46, no. 4, pp. 145–150.

KOTÁSEK, M. S. (2012) *Evaluation calving difficulty of heifers and cows in the Slovak Republic*: Ph.D. Thesis. Nitra: SUA (in Slovak).

OLSON, K.M. et al. (2009) Dystocia, stillbirth, gestation length, and birth weight in Holstein, Jersey, and reciprocal crosses from a planned experiment. *Journal of Dairy Science*, vol. 92, no. 12, pp. 6167–6175. doi: <https://doi.org/10.3168/jds.2009-2260>

RYBA, Š. (2010) *Evaluation calving difficulty cows of individual breeds in the Slovak Republic*: Ph.D. Thesis. Nitra: Slovak university of agriculture (in Slovak).

SAS Institute Inc. (2011) *SAS 9.3 Statements: Reference*. Cary, NC: SAS Institute Inc.

SCHAEFFER, L. R. (2003) Application of random regression models in animal breeding. *Livestock production Science*, vol. 86, no. 1–3, pp. 35–45. doi: [https://doi.org/10.1016/S0301-6226\(03\)00151-9](https://doi.org/10.1016/S0301-6226(03)00151-9)

SHAVHUZHEV, A. and BELIK N. (2017) Milk productivity of Simmental cows Austrian selection. In: *16th International Scientific Conference Engineering for Rural Development: Proceedings, 24–26. 5. 2017 Jelgava, Latvia*, pp. 1354–1358. doi: <http://dx.doi.org/10.22616/ERDev2017.16.N304>

SILVESTRE, A. Et al. (2018) Genetic parameters of calving ease in dairy cattle using threshold and linear models. *Italian Journal of Animal Science*. doi: <https://doi.org/10.1080/1828051X.2018.1482801>

SOLTNER, D. (1978) *La production de viande bovine*. 2nd ed. H. Siraudeau et cie Angers.

STRAPÁK, P. et al. (2011) *Evaluation calving difficulty in the Slovak Republic*. Nitra: SUA (in Slovak).

STRAPÁK P. et al. (2013) *Breeding cattle*. Nitra: SUA (in Slovak).

VAVRIŠÍNOVÁ, K. et al. (2007) Calving analysis in cows of Charolais breed at selected farm. *Journal of Central European Agriculture*, vol. 8, no. 2, pp. 183–190.

ZAHRÁDKOVÁ, R. (2009) *Beef cattle: from A to Z*. Praha: The Czech Beef Breeders Association (in Czech).