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THE ANALYSIS OF REPRODUCTION IN POPULATION OF THE SLOVAK SPOTTED DAIRY COWS

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Abstract

The aim of study was to analyse the reproduction and factors affecting on reproduction traits of dairy cows in population of Slovak Spotted cattle from 2007 to 2016 the results for 37,274 dairy cows: days to first service (DFS), days open (DO), number of inseminations per conception (NIC), age of first calving (AFC) and calving interval (CI). The basic statistical analysis were analysed using the SAS version 9.3. For the actual computation a linear models with fixed effects was used: For the actual computation a linear models with fixed effects was used: $y_{ijklm} = \mu + HYS_i + BT_j + F_k + B_l + e_{ijklm}$. The linear model represents coefficients determination R^2 = 0.452117% (P < 0.001) for DFS, R^2 = 0.377715% (P < 0.001) for DO, R^2 = 0.348442% (P < 0.001) for NIC and R^2 = 0.317128% (P < 0.001) for CI with all fixed effects. Correlation coefficients among DFS with DO, NIC, AFC and CI were r = 0.37275, r = -0.06881, r = 0.06493 and r = 0.08348. These coefficients were highly statistically significant (P < 0.001).

Keywords: Slovak Spotted cattle, dairy cows, reproduction traits, correlation, coefficient of determination, genetic and non-genetic factors

INTRODUCTION

Slovak Spotted cattle is autochthonous breed with belongs to the Simmental group of cattle. The Slovak Spotted cattle is an important dual-purpose breed with a long tradition of breeding in Slovakia with a good milk and meat production (Strapák *et al.*, 2013). An important condition for successful breeding program of the Slovak Spotted cattle is also good reproduction and good state of health heifer and dairy cows (Kasarda *et al.*, 2015; Slovak Simmental Breeders Association, 2019).

The reproduction of dairy cows is the most important factor that is an assumption for sustainable dairy production system and influencing the productivity (Rodriguez-Martinez *et al.*, 2008; Cassandro, 2014; Ibrahim, Seid, 2017; Crowe *et al.*, 2018). Reproduction is affected by a variety of factors and increasingly trend of intensification the role of the different aspects of management including nutrition and breeding become significant (Gálik *et al.*, 2011; Berry *et al.*, 2014; Bragança, Zangirolamo, 2018).

Reproductive performance traits include number of inseminations per conception (NIC), days open (DO) and calving interval (CI) are important criteria for profitable dairy farming (Kasarda *et al.*, 2015; Bujko *et al.*, 2018a).

Fertility is a very broad term which is influenced by various factors including genetic, nutritional, hormonal, physiopathology, management and environment or climate. The fertility traits in dairy animals show a very low heritability value, and this indicates that most of the variations in the fertility are determined by non-genetic factors or environmental effect (Dochi *et al.*, 2010; Dayyani *et al.*, 2013; Karcol *et al.*, 2017; Bolacali, Öztürk, 2017; Bujko *et al.*, 2018a and other).

The reproduction traits in population dairy cows of the Simmental cattle were evaluated by Ulutaş and Sezer (2009), Pantelić *et al.* (2011), Bujko *et al.* (2013), Cziszter *et al.* (2017), Toledo-Alvarado *et al.*, (2017), Bujko *et al.* (2018a) and others.

For reproductive traits the heritability estimates were 0.09 ± 0.03 for days open (DO), 0.11 ± 0.04 for calving interval (CI), and 0.47 ± 0.06 for age at first calving (AFC). The genetic correlation among production traits were generally high (> 0.7) and between reproductive traits the estimates ranged from 0.06 ± 0.13 for AFC and DO to 0.99 ± 0.01 between CI and DO (Ayalew *et al.*, 2017). A negative correlation exists among reproduction traits of dairy cattle as shows results Wall *et al.* (2003), M'hamdI *et al.* (2010), Pantelić *et al.* (2011), Ayalew *et al.*, (2017), Bujko *et al.* (2018a), Brzáková *et al.* (2019).

The aim of study was to analyse the reproduction and factors that affect the reproduction traits of dairy cows in population of Slovak Spotted cattle.

MATERIALS AND METHODS

Data

The material for evaluation of reproduction traits in population of Slovak spotted dairy cows was provided from the database of Breeding Services of the Slovak republic (BSSR, 2017).

A total of 37,274 dairy cows between 2007 and 2016 were observed during evaluation: days to first service (DFS), days open (DO), number of inseminations per conception (NIC), age of first calving (AFC) and calving interval (CI).

We divided dairy cows only breed-type S_0 – cows with genetic proportion of pure Slovak spotted blood into 87.5%. S_1 – cows with genetic proportion of pure Slovak spotted blood from 75% to 87.4%, S_2 – cows with genetic proportion of pure Slovak spotted blood from 50% to 74.9% (Bujko *et al.*, 2018b; Slovak Simmental Breeders Association, 2019).

Statistical Analyses

The basic statistical and variability characteristics (least square means, standard deviations) were evaluated using the Statistical System (SAS) version 9.3. The mixed procedure was used for the final analysis. The value of statistical significance (P), the value of the F-test and the coefficient of determination (R^2) of the above mentioned of reproduction traits were evaluated with its relation to: herds- year and season, breeding type, father and effect of bull.

For the actual computation a linear model with fixed effects was used:

$$y_{ijklm} = \mu + HYS_i + BT_j + F_k + B_l + e_{ijklm},$$

where: μ = mean value of depended variable, HYS_i = fixed effect of herds-years-season (HYS) (1 - 6 160), BT_l = fixed effect of breeding type (1 - 3), F_m = fixed effect of father (1 - 816), B_n = fixed effect of bull (1 - 800), e_{ijkl} = residual error.

Statistical evaluations of the differences between traits were tested at the levels of statistical significance: $^{-}P > 0.05$ $^{+}P < 0.05$, $^{++}P < 0.01$ or $^{+++}P < 0.001$.

Statistical analyses were also performed using GraphPad Prism 6.01 (GraphPad Software Incorporated, San Diego, California, USA). One-way analysis of variance (ANOVA) and the Tukey´s multiple comparison test was used for statistical evaluations.

RESULTS

Analysis of Reproduction Traits for the Whole Period

In this study overall 37,274 reproduction traits of Slovak Spotted dairy cows, collected during the season from 2007 to 2016, were collected. The basic traits of reproduction traits (DFS, DO, NIC, AFC and CI) in dairy cows Slovak Spotted cattle were 82.97 ± 61.46 days, 136.85 ± 101.97 days, 2.29 ± 2.49 times, 1,101.28 ± 106.17 days and 418.1 ± 99.37 days (Tab. I). Compared to our results, Toledo-Alvarado *et al.* (2017) reported at dual-purpose breeds as Simmental and Alpine Grey have a greater reproductive potential than the dairy cows (for example Holstein), a difference that is only partly attributable to different production levels. The average values have 92.4 or 92.8 days for DFS, 145.2 or 141.7 days for DO and 1.89 or 1.83 times for NIC. These results are comparable to the average of value reproduction traits we have calculated in our assessed population.

Overall our finding are in accordance with finding reported by Cziszter *et al.* (2017), their reported lower values of analysis of reproduction traits in Simmental cattle reared in Romania (32.8 ± 0.29 months for AFC, 122.0 ± 4.11 days for DO, 1.78 ± 0.03 times for NIC and 385.8 ± 1.65 days for CI). These results are similar with our findings.

Reached conclusion by Pantelić *et al.* (2011) was the average duration of service period was

I: *Statistical characteristic of reproduction traits in Slovak Spotted dairy cows*

Traits	Statistical parameter					
	n[1]	$\bar{x}$[2]	SD[3]	CV[4]	MODE[5]	MEDIAN[6]
Days to first service (DFS)	37 274	82.97	61.46	74.08	65.0	68.0
Days open (DO)	37 274	136.85	101.97	74.51	65.0	106.0
Number of inseminations per conception (NIC)	37 274	2.29	2.49	108.0	1.0	2.0
Age of first calving (AFC)	2 522	1 101.28	106.17	9.64	1 161.0	1 139.0
Calving interval (CI)	37 274	418.1	99.37	23.77	354.0	388.0

[1]Number of observations, [2]Average, [3]Standard deviation, [4]Coefficient of variation, [5]Mode (value that appears most often in a set of data)

II: *Statistical characteristic of reproduction traits in Slovak Spotted dairy cows by breed-type*

	Traits	Statistical parameter					
		n[1]	$\bar{x}$[2]	SD[3]	CV[4]	MODE[5]	MEDIAN[6]
S_0	Days to first service (DFS)	20,190	82.28	61.41	74.63	49.0	67.0
	Day open (DO)		133.82	100.04	74.76	65.0	104.0
	Number of inseminations per conception (NIC)		2.25	2.01	89.19	1.0	2.0
	Age of first calving (AFC)	1,430	1,092.26	113.42	10.38	1,181.0	1,137.0
	Calving interval (CI)	20,190	414.75	95.78	23.09	354.0	386.0
S_1	Days to first service (DFS)	7,035	84.01	61.88	73.65	45.0	69.0
	Day open (DO)		140.12	106.51	76.01	68.0	108.0
	Number of inseminations per conception (NIC)		2.41	3.84	159.13	1.0	2.0
	Age of first calving (AFC)	352	1,111.85	99.67	8.96	1,180.0	1,145.5
	Calving interval (CI)	7,035	422.16	101.98	24.16	354.0	391.0
S_2	Days to first service (DFS)	10,049	83.63	61.27	73.26	65.0	69.0
	Day open (DO)		140.64	102.37	72.79	67.0	110.0
	Number of inseminations per conception (NIC)		2.32	2.14	92.44	1.0	2.0
	Age of first calving (AFC)	740	1,113.69	92.17	8.28	1,156.0	1,141.0
	Calving interval (CI)	10,049	422.0	104.23	24.70	353.0	391.0

[1]Number of observations, [2]Average, [3]Standard deviation, [4]Coefficient of variation, [5]Mode (value that appears most often in a set of data, [6]Median (value separating the higher half from the lower half of a data sample)

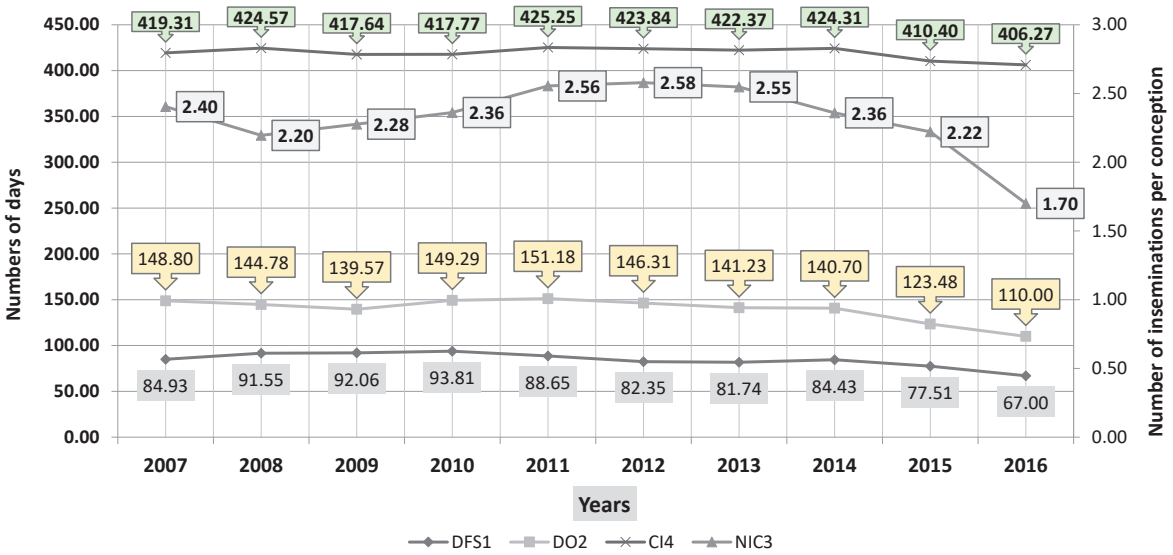
110.79 days, with standard deviation of 53.81 days. Variability of the service period was rather high and ranged from minimum of 40 to maximum of 361 days. Average age of cows at first calving was 778.73 days with coefficient of variation of 11.13.

Analysis Reproduction Traits by Breeding Type

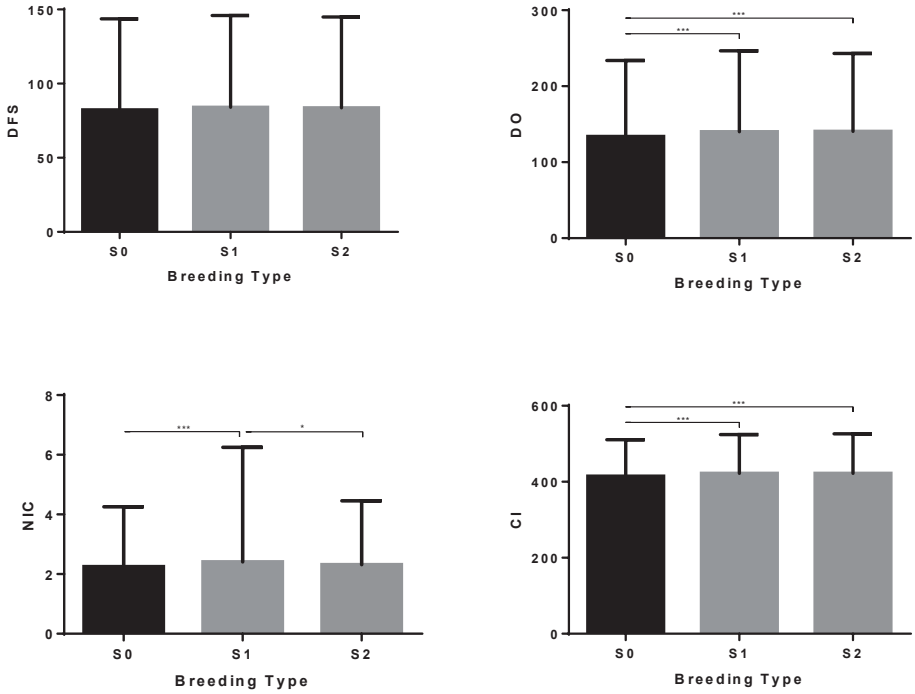
The results demonstrated in this section match state of reproduction traits for three breeding type. From in total of 37,274 records, 20,190 came from group of S_0, 7,035 came from group of S_1 and 10,049 came from group of S_2. Compared to others factors tested in this study, the analysis proved that breeding type is significant effect on DO, NIC and CI. Average values of individual reproductive traits has with increasing share of other breed at S_1 + 1.73 days and at S_2 + 1.35 days for DFS, at S_1 + 7.41 days and at S_2 + 7.25 days for CI. These results are similar with conclusions authors as Riecka *et al.* (2010) and Bujko (2011) where average values reproduction traits has fluctuating tendency.

Analysis of Reproduction Traits by Years of Calving

In Fig. 1 shows average values of reproduction traits (DFS, DO, NIC and CI) according to years of evaluation 2007 to 2016 in population Slovak Spotted dairy cows, where average of values have a fluctuating tendency. The results show that since 2012 it has gradually reduced the average values of reproductive traits related to the improvement of reproduction traits, where the optimal value of calving interval should be around 400 days by breeding programme of Slovak Spotted breed. Similar tendency was also observed DFS and DO, which is related to improving the breeding conditions.



1: *Reproduction traits of dairy cows in population Slovak Spotted cattle by years of calving*
[1]Days to first service (DFS), [2]Days open (DO), [5]Number of inseminations per conception (NIC), [4]Calving interval (CI)



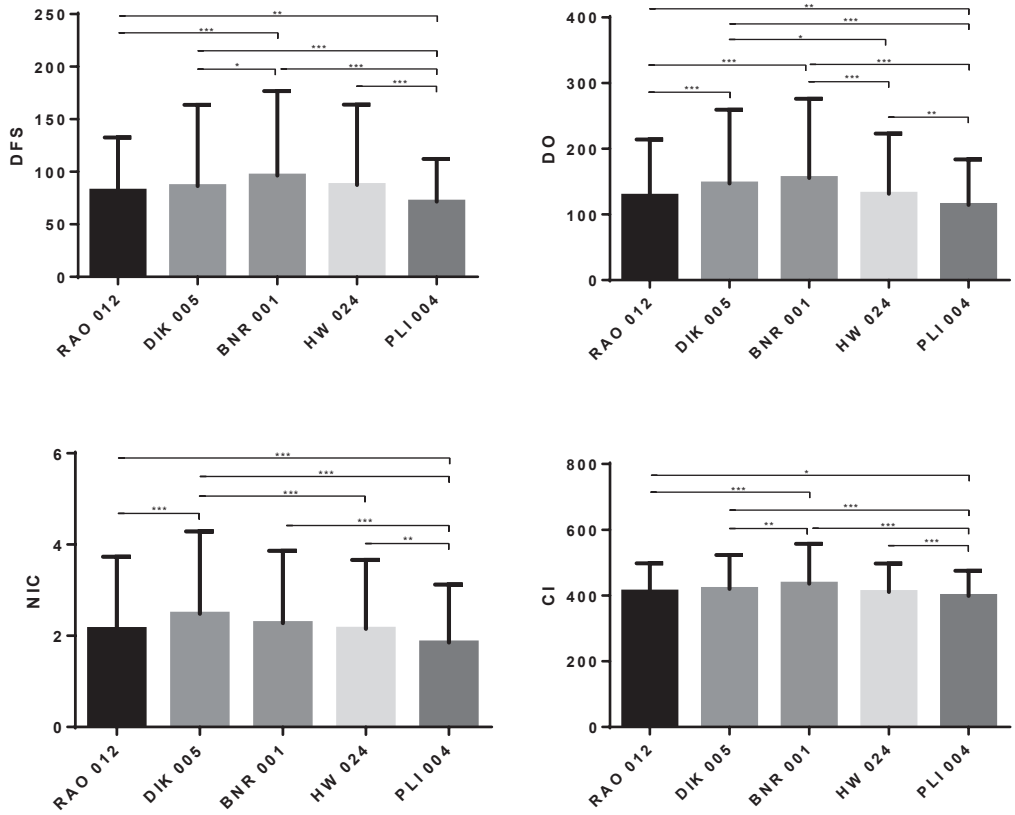
2: *Statistical significance (ANOVA) between breeding type's evaluations by reproduction traits: Days to first service (DFS), Days open (DO), Number of inseminations per conception (NIC) and Calving interval (CI). *p < 0.05; **p < 0.01; ***p < 0.001. Statistical analysis was performed using one-way analysis of variance (ANOVA) and the Tukey´s multiple comparison test.*

Analysis of Reproduction Traits by Breeding Type

The breeding type affects the reproduction traits (DFS, DO, NIC and CI). Effect of breeding type is one of the possible sources of reproduction traits. In the dataset of Slovak Spotted dairy cows were three breeding type (S_0, S_1 and S_2). The values of reproduction traits in day between breeding types have rising tendency, which is related to the breeding goal. These difference were significant (P < .0001) for DO, NIC and CI (Fig. 2).

Analysis of Reproduction Traits by the Sire

The sire affects the reproduction traits (DFS, DO, NIC and CI). Effect of sire is another of the possible sources of reproduction traits. In the dataset of Slovak Spotted dairy cows were 815 sires in breeding. For the evaluation were used selected



3: *Statistical significance (ANOVA) between select sire's evaluations by reproduction traits: Days to first service (DFS), Days open (DO), Number of inseminations per conception (NIC) and Calving interval (CI). *p < 0.05; **p < 0.01; ***p < 0.001. Statistical analysis was performed using one-way analysis of variance (ANOVA) and the Tukey´s multiple comparison test.*

III: *Relation between evaluations of reproduction traits in population Slovak Sotted dairy cows by Pearson Correlation Coefficients*

Traits	DFS[1]	DO[2]	NIC[3]
DO[2]	0.37275^{+++}	-	-
NIC[3]	-0.06881^{+++}	0.23454^{+++}	-
AFC[4]	0.06493^{++}	0.01714^{-}	0.22031^{+++}
CI[5]	0.08348^{+++}	0.29529^{+++}	0.02255^{+++}

[1]Days to first service (DFS), [2]Days open (DO), [3]Numbers of inseminations per conception (NIC), [4]Age of first calving (AFC), [5]Calving interval (CI), $^{+++}P < 0.001$

five bulls according to the highest number of rated daughters, where there were statistically significant differences in individual evaluated reproductive traits (P < .0001) as shows Fig. 3.

Analysis of the Correlation Between Reproduction Traits

The correlation coefficients among days open (DO), number of inseminations per conception (NIC), ag of first calving (AFC) and calving interval (CI) with days to first service (DFS) were r = 0.37275, r = -0.06881, r = 0.06493 and r = 0.08348. These coefficients were highly statistically significant P < .0001 (Tab. III). These results are correspondence with Ríos-Utrera *et al*., 2010; Pantelić *et al*., 2011; Bujko *et al*., 2018. Rahbar *et al.* (2016) shows phenotypic correlation coefficients among DO, NIC, AFC, CI with DFS (r = 0.38 ± 0.3, r = 0.16 ± 0.12, r = -0.29 ± 0.28 and r = 0.32 ± 0.3). The results from Brzáková *et al.* (2019) reported the genetic correlations among AFC, DO, CI and FSC-C with AFC (r = 0.990 ± 0.003, r = –0.060 ± 0.0019, r = -0.129 ± 0.0017 and r = -0.182 ± 0.0017).

Analysis of the All Factors Involved Reproduction in Traits

Using the linear model we have found out the coefficient determination R^2 = 0.452117 for DFS,

IV: *Factors affecting on the reproduction traits in population Slovak Spotted dairy cows*

Sources of variability	DF[1]	R-Square[2]			
		DFS[3]	DO[4]	NIC[5]	CI[6]
Herd-Years-Season	6159	0.393998^{+++}	0.302132^{+++}	0.291775^{+++}	0.272371^{+++}
Breeding type	2	0.000153^{-}	0.001043^{+++}	0.000612^{+++}	0.001348^{+++}
Sire	815	0.059305^{+++}	0.052958^{+++}	0.027216^{+++}	0.051105^{+++}
Effect of bull	799	0.065983^{+++}	0.059135^{+++}	0.045174^{+++}	0.043129^{+++}
Together all factors	7679	0.452117^{+++}	0.377715^{+++}	0.348442^{+++}	0.317128^{+++}

[1]Grades of freedom, [2]Coefficient of determination (R^2), [3]Days to first service (DFS), [4]Days open (DO), [5]Numbers of inseminations per conception (NIC), [6]Calving interval (CI), $^{-}$P > 0.05, $^{+}$P < 0.05, $^{++}$P < 0.01, $^{+++}$P < 0.001

R^2 = 0.377715 for DO, R^2 = 0.348442 for NIC and R^2 = 0.317128 for CI. The analyses by the effect on reproduction traits showed the highest effect of Herd-Years-Season (HYS) R^2 = 0.393998 for DFS, R^2 = 0.302132 for DO, R^2 = 0.291775 for NIC and R^2 = 0.272371for CI, followed by the effect of bull R^2 = 0.065983 for DFS, R^2 = 0.059135 for DO and R^2 = 0.045174 for NIC. These effects were highly statistically significant P < .0001 (Tab. IV). These results are similar with results of Bujko *et al*., 2006; Dohi *et al.*, 2010; Dayyani *et al.*, 2013; Toledo-Alvarado *et al*., 2017; Bujko *et al*., 2018a, b. Rzewuska, Srabel (2015) and Bolacali, Öztürk (2017) report statistically significant influence of non-genetic factors as breeder, year and season of calving, order of lactation on reproductive traits, which correspond to our results.

CONCLUSION

The results confirm the effect of herd-years-seasons (HYS) on reproduction traits (DFS, DO, NIC and CI) were higher compared with effect of bull. These results were statistical high significant (P < 0.001). The correlation among reproduction traits days open (DO), number of inseminations per conception (NIC), age of first calving (AFC) and calving interval (CI) with days to first service (DFS) were lower and negative. These results were statistical high significant (P < .0001).

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