A relationship between production and reproduction traits in cows of Czech Pied cattle

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ABSTRACT: The purpose of the paper was to analyse the effect of the level of milk yield and breeding value on reproduction of Czech pied cows. In the study of cows that calved in the period 1999–2001 the results for 41 357 cows from the central database were used analytically. The study was focused on the following traits: breeding value of the father of the cow for kg of milk, breeding value of the mother of the cow for kg of milk, the cow's milk yield in the 1st to the 3rd lactation, and reproduction traits after the 1st and 2nd calving. To determine the effect of the breeding value of the father or mother of the cow on reproduction traits of daughters the test cows were divided into 3 groups depending on the BV of the parents. The results were processed by multifactor analysis of variance using the CORR and GLM procedures of the SAS statistical program, v. 8.1., and the model with fixed effects for the calculation itself. The results of the study show a negative correlation between the level of the milk yield of cows and their reproduction. It may be stated that the increased milk yield decreases reproduction traits characterised by the extension of days open and calving interval. The estimated correlation between the milk yield and the days open was $r = 0.38$ for milk yield, $r = 0.32$ for fat yield, and $r = 0.25$ for protein yield. A similar correlation between the level of milk yield and the days open was also found in other calving intervals.

Keywords: milk yield; pedigree value; Czech Pied cattle

Increasing demands for higher efficiency are the basic condition for the improvement of economic effectiveness of cattle breeding. An assumption to achieve this aim is a healthy animal, able to repeatedly achieve a high level and quality of production, while also achieving good reproduction results. This trend has led to searching for ways that would contribute to acceleration of selection progress and to overall improvement of economically important traits and attributes in cattle. Steinwidder and Greimel (1999) showed that the gain per cow and year and yield per time unit increased linearly with increasing milk yield. If the herd is the basic monitored unit, then its gain grows somewhat divergently and increases through improved efficiency and longevity of cows. The authors found that cattle gain grew up to increasing the cows' longevity to 6 lactations after which the level of gain decreased.

The basic assumption for the required longevity of cows, besides high production, is good reproduction traits of cows. This necessary aggregate of traits is, however, in a certain antagonistic relationship. Therefore optimising milk production of a dual-purpose breed in relation to other economically important traits is a very urgent problem to be researched. Roberts (2001) showed that the basic producer priorities for research in the area of livestock reproduction are the following problems: the relation between production and reproduction traits, the relationship between the animal's age and its reproductive performance and the effect of nutrition in relation to reproduction. Bertilsson *et al*. (1998) and Berglund *et al*. (1998) studied the relation between milk production and reproduction and the cows' health. They showed that increasing the milk efficiency considerably prolonged the length of the cow's rest period. Similar results were presented by Shapiro and Swanson (1991), who reported that milk production highly correlated with days open.

On the basis of an experiment with two sets of cows with different genetic values Swijders *et al*. (2001) confirmed the aforementioned conclusions of other authors. The set of cows with high average breeding value for milk efficiency presented high milk production and worse reproductive perform-

ance in comparison with a set of cows with medium breeding value. Similar results were presented by Loeffler *et al*. (1999), who stated that the effect of a cow's deviation from the herd in the production of milk, fat and protein in the initial stages of lactation predicted the reproduction risk very significantly.

MATERIAL AND METHODS

The aim of the paper was to analyse the effect of the level of milk efficiency and genealogical values on the reproduction of Czech Pied cattle.

Cows that calved in the period 1999–2001 were monitored. Data from the central database on the lifetime production of cows was used and in total the results of 41 357 cows were analysed. The following traits were monitored:

– breeding value of the cow's father for kg of milk
– breeding value of the cow's mother for kg of milk
– actual milk production in the 1st to the 3rd lactation: milk kg, fat kg, protein kg
– cow reproduction traits after the 1st to 3rd calving: rest period, days open and calving interval after the 1st and 2nd calving

To determine the effect of father's or mother's breeding value on the reproduction traits of daughters the set of cows was divided, according to the breeding value (BV) of the parents, into 3 groups:

Group	BV of father	BV of mother
1	lower than $\bar{x}$– 0.5 s	lower than $\bar{x}$ – 0.5 s
2	from $\bar{x}$ – 0.5 s to $\bar{x}$ + s	from $\bar{x}$ – 0.5 s to $\bar{x}$ + 0.5 s
3	higher than $\bar{x}$ + s	higher than $\bar{x}$ + 0.5 s

For data processing the results a multifactor analysis of variance were used and the CORR procedure and the GLM statistical program SAS version 8.1. were applied. For the actual computation a linear model with fixed effects was used:

$$Y_{ijk} = \mu + HYS_i + B_j + \beta\ (x - \bar{x}) + e_{ijk}$$

where: μ = mean value
HYS_i = effect of herd, year and season of 1st calving
B_j = alternative effect
$\beta\ (x - \bar{x})$ = regression on the age of 1st calving
e_{ijk} = residual error

Alternatively the fixed effect of the father's or mother's breeding value for kg of milk was introduced into the basic model.

RESULTS AND DISCUSSION

The basic traits of milk production in the monitored set of cows are presented in Table 1. In the first lactation the cows produced 4 630.52 kg of milk, 199.41 kg of milk fat and 159.8 kg of milk protein. An increase in production in the 2nd lactation was 9.9% for milk, 8.2% for milk fat and 9.6% for milk protein. In the third lactation a slight increase in production was achieved in comparison with the previous one, with a range of 1.4% to 2.4%.

The results of the set are presented in Table 2. The average length of the rest period was in the range of 72.34 to 77.18 days, the length of days open from 94.76 days to 101.86 days and the length of calv-

Table 1. Average milk production of a set of cows of Czech Pied breed

Traits		Statistical values		
		n	μ	SD
1st lactation	milk (kg)	41 357	4 630.52	1 093.60
	fat (kg)	41 357	1 99.41	46.16
	protein (kg)	41 357	159.81	38.16
2nd lactation	milk (kg)	21 190	5 089.97	1 304.74
	fat (kg)	21 190	215.85	56.83
	protein (kg)	21 190	175.20	46.83
3rd lactation	milk (kg)	8 182	5 214.51	1 435.51
	fat (kg)	8 182	219.69	59.43
	protein (kg)	8 182	177.86	50.19

Table 2. Reproduction traits for a set of cows of Czech Pied breed

Traits		Statistical values		
		n	μ	*s*
Interval	after 1st calving	37 557	77.18	20.68
	after 2nd calving	18 534	73.87	18.25
	after 3rd calving	7 094	72.34	19.93
Days open SP	after 1st calving	38 863	101.86	35.05
	after 2nd calving	19 017	97.29	33.22
	after 3rd calving	7 140	94.76	31.09
Calving interval	1	21 190	388.34	39.05
	2	8 182	382.05	34.93

ing interval was found to be 388.34 or 382.05 days. Comparing these basic traits Esl and Voith (2002) presented the following results for Austrian Simmental cows: milk production in the 1st to 3rd lactation at a level of 3 860 kg to 4 336 kg and the days open in the range of 101.3 to 103.0 days. The set we monitored, in comparison with these authors' results, showed considerably better efficiency and reproduction traits.

A part of the study was also to determine the relation between the cows' breeding value and the reproduction results. The relation between the father's breeding value and the daughters' reproduction is presented in Table 3; it is clear that an increasing breeding value of the father increases the length of daughters' days open (SP). In SP 1 the largest difference was 9.23 days, in SP 2 the difference was 5.71 days and in SP 3 it was 5.86 days. It is possible to state that with increasing cow age the realised selection decreases the difference between the groups and the absolute length of days open. Stádník and Louda (1999) obtained similar results. They demonstrated that increasing the fathers' breeding value prolonged the length of days open and the maximum difference was 20.85 days. The differences between the groups are statistically highly significant.

The relation between the level of the mother's breeding value for kg of milk and the reproduction of her daughters is presented in Table 4. The length of the cows' days open after the 1st calving ranged from 96.29 days to 107.95 days while the increasing breeding value of the mother prolonged the daughters' days open. The difference between the 2nd and 1st group was 6.04 days and between the 3rd and 2nd group 5.72 days. Essentially similar differences were ascertained for the length of days open after the 2nd and 3rd calving and the days

Table 3. Relation between the father's breeding value for kg milk and daughters' reproduction

Traits of daughters' reproduction		Groups according to father's breeding value for kg milk								
		1			2			3		
		n	$\mu + B_i$	$s_\mu + B_i$	*n*	$\mu + B_i$	$s_\mu + B_i$	*n*	$\mu + B_i$	$s_\mu + B_i$
Days open SP (days)	SP 1	10 092	97.30	1.26	12 892	102.64	1.21	9 256	106.53	1.28
	SP 2	5 954	93.92	1.33	7 564	97.89	1.27	5 427	99.63	1.37
	SP 3	2 109	90.76	3.22	3 075	96.27	2.89	1 936	96.62	3.48
Calving interval (days)	M 1	6 690	382.31	1.12	8 436	386.22	1.07	5 958	389.64	1.16
	M 2	2 451	366.08	3.92	3 497	369.59	3.90	2 210	369.57	3.95

SP 1 ÷ 1 : 2.3; 2 : 3; SP 2 – 1 : 2.3; SP 3 – 1 : 2.3; M 1 – 1 : 2.3; 2 : 3
Stat. signif. differences: $P < 0.01$

Table 4. Relation between the mother's breeding value for kg milk and daughters' reproduction

Traits of daughters' reproduction		Groups according to mother's breeding value for kg milk								
		1			2			3		
		n	$\mu + B_i$	$s_\mu + B_i$	n	$\mu + B_i$	$s_\mu + B_i$	n	$\mu + B_i$	$s_\mu + B_i$
Days open SP (days)	SP 1	SP 2	SP 3	1.31	15 794	102.23	1.16	8 749	107.95	1.30
	SP 2	4 463	91.17	1.42	9 346	97.91	1.20	5 136	102.37	1.39
	SP 3	1 693	88.67	4.02	3 538	96.60	3.98	1 889	96.69	4.12
Calving interval (days)	M 1	4 539	382.30	1.18	10 416	385.95	1.02	5 641	389.92	1.18
	M 2	1 976	364.38	3.95	4 041	369.44	3.86	2 141	371.41	3.98

SP 1 ÷ 1 : 2.3; 2 : 3; SP 2 – 1 : 2.3; 2 : 3; SP 3 – 1 : 2.3; M 1 – 1 : 2.3; 2 : 3; M 2 – 1 : 2.3

open were prolonged by a maximum of 11.2 and 8.02 days. The same trend was recorded in both assessed calving intervals and with the increasing breeding values of the mothers their overall length was prolonged. At the same time differences in the length of days open and the intervals between the assessed groups of cows according to the mother's breeding value were statistically significant.

The closeness of the relation between the actual efficiency and the length of days open expressed by Pearson's correlation coefficient r is presented in Table 5. The highest correlation value between the length of days open and the cows' milk production traits was ascertained for milk production; in contrast to this the lowest value was recorded for protein production. For efficiency in the first lactation and the length of days open after the 1st calving (SP 1) the estimated value was $r = 0.38$ for milk production, $r = 0.32$ for fat production and $r = 0.25$ for protein production. Efficiency in the 1st lactation correlates with the length of SP 2 at a level in the range of $r = 0.21$–0.24, for SP 3 the range is $r = 0.18$–0.20. Milk efficiency after the cows' 2nd lactation and the length of days open after the second calving demonstrate a medium strong dependence, characterised by the r value of 0.35 for milk production in kg, $r = 0.31$ for fat production and $r = 0.28$ for protein production. For the relationship to the length of days open after the 3rd calving the correlation values were $r = 0.27$ for milk production, $r = 0.24$ for fat production, and $r = 0.22$ for protein production. If we assess the relation between milk production in the third lactation and the length of days open after the 3rd calving (SP 3), we can state that the estimated correlation coefficients are in the range of $r = 0.31$–0.38. It can also be mentioned

Table 5. Relation between actual milk production and the length of the cows' days open

Traits		r		
		SP 1	SP 2	SP 3
1st lactation	milk (kg)	0.38	0.24	0.20
	fat (kg)	0.32	0.21	0.18
	protein (kg)	0.25	0.23	0.19
2nd lactation	milk (kg)	0.31	0.35	0.27
	fat (kg)	0.28	0.31	0.24
	protein (kg)	0.22	0.28	0.22
3rd lactation	milk (kg)	0.29	0.33	0.38
	fat (kg)	0.28	0.31	0.34
	protein (kg)	0.23	0.28	0.31

Table 6. Correlations between the length of the cows' 1st–3rd days open (SP 1–SP 3)

	SP 1	SP 2	SP 3
SP 1	–	0.43	0.32
SP 2	–	–	0.39

that the relation between protein production and the length of days open increases with the cows' ageing. In the 1st lactation the value r = 0.25 to SP 1 was found, in the 2nd lactation a maximum of r = 0.28 and in the 3rd lactation the correlation between protein production and the length of days open SP 3 was r = 0.31. These results confirm the conclusions of Bech Andersen *et al*. (1993). The authors presented an estimated value for the genetic correlation between milk protein production and the length of days open at a level of r_g = 0.30.

The relation between the length of days open after the 1st and 3rd calving is presented in Table 6, from which it is clear that between SP 1 and SP 2 or SP 3 a medium strong dependence was found, characterised by the correlation value at the level of r = 0.43 and r = 0.32, respectively. Between the length of SP 2 and SP 3 a correlation value at the level of r = 0.39 was recorded.

The results confirm the negative relation between the level of the cows' milk production and their reproduction. It is possible to state that increasing production worsens the cow reproduction traits, characterised by a prolonged days open and length of the interval.

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ABSTRAKT

Vztah mezi ukazateli produkce a reprodukce u krav českého strakatého skotu

Cílem práce bylo analyzovat vliv úrovně mléčné užitkovosti a rodokmenové hodnoty na reprodukci krav českého strakatého skotu. Při sledování krav otelených v období let 1999–2001, bylo z centrální databáze analyticky využito výsledků u 41 357 krav. Vlastní sledování bylo zaměřeno na tyto ukazatele: plemenná hodnota otce krávy pro kg

mléka, plemenná hodnota matky krávy pro kg mléka, vlastní mléčná užitkovost v 1. až 3. laktaci, reprodukce krav po 1. a 2. otelení. Pro stanovení efektu plemenné hodnoty otce, resp. matky na reprodukční ukazatele dcer, byl soubor krav rozdělen dle PH rodičů do tří skupin. Pro zpracování výsledků byla použita vícefaktorová analýza variance s použitím procedur CORR a GLM statistického programu SAS verze 8.1., pro vlastní výpočet byl využit model s pevnými efekty. Výsledky práce potvrzují negativní vztah mezi úrovní mléčné užitkovosti krav a jejich reprodukcí. Lze konstatovat, že se zvyšující se produkcí se zhoršují ukazatele reprodukce krav, charakterizované prodloužením délky servis periody a délky mezidobí. Mezi mléčnou užitkovostí a délkou servis periody byla odhadnuta hodnota korelace na úrovni $r = 0,38$ u produkce mléka, $r = 0,32$ pro produkci tuku a $r = 0,25$ pro produkci bílkovin. Obdobný vztah mezi úrovní mléčné užitkovosti a délkou servis periody byl zjištěn i v dalších mezidobích.

Klíčová slova: mléčná užitkovost; rodokmenová hodnota; český strakatý skot

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