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LINEAR TYPE TRAITS FOR FEET AND LEGS, THEIR RELATION TO HEALTH TRAITS CONNECTED WITH THEM, AND WITH PRODUCTIVE AND REPRODUCTIVE TRAITS IN DAIRY COWS

TONCHO PENEV[1]*; IVILO MARINOV[2]; ZHIVKA GERGOVSKA[2]; JURII MITEV[1]; TCHONKA MITEVA[1]; DIMO DIMOV[1]; RUMEN BINEV[3]

[1] *Trakia University, Faculty of Agriculture, Department of Applied Ecology and Animal Hygiene, BG-6014 Stara Zagora, Bulgaria*
[2] *Trakia University, Faculty of Agriculture, Department of Animal Science, BG-6014 Stara Zagora, Bulgaria*
[3] *Trakia University, Faculty of Veterinary Medicine, Department of Internal Noninfectious Diseases, BG-6014 Stara Zagora, Bulgaria*

Abstract

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The objective of the study was to estimate the correlations between linear type traits for feet and legs, and their relation with locomotion disorders and productive and reproductive traits in Holstein cows reared in Bulgaria. The study included 136 cows from four dairy farms of different regions of Bulgaria. In all farms, cows were year-round reared group in free stalls with individual boxes for rest. In the study 7 linear type traits for feet and legs and the trait heel depth were included. On cows also a lameness scoring on a scale of 1 to 4 was carried out. Phenotypic correlations between linear traits were low. In cows with wider and parallel placed rear legs a tendency to straighter hock (-0.20) was reported, which was associated with a steeper foot (-0.16) and flatter hocks (-0.18). Cows with thicker bones and steeper foot (0.24) had and deeper heel (-0.24). When selection for thinner bones and optimal foot angle is conducted, it would be likely the heel depth to decline. Cows with straighter hock (-0.16), lower foot angle (0.18), shallower heel (-0.25) and better locomotion (0.25) had higher milk yield for 305 days. The selection for higher milk yield will be associated with a tendency for unfavorable phenotypic deviations in the various linear traits for feet and legs, with the exception of bone structure and locomotion. Cows with more pronounced X-shaped rear legs-rear view (-0.18), with flatter and dry hocks (0.16) and with thicker bones (-0.25) had longer interval from calving to first insemination. Cows with thicker bones had smaller number of inseminations for conception (0.20). The phenotypic correlations between clinical problems with feet and legs and linear traits were with low values (from -0.01 to 0.10). With the highest and negative value was the phenotypic correlation between linear trait locomotion and clinical problems with legs and feet (-0.37). Using only the linear traits for feet and legs to reduce the locomotive problems, without additional information about the various clinical problems with legs and feet will not have a considerable effect.

Key words: linear type traits; dairy cows; lameness; locomotion; productivity; reproduction

Abbreviations: LS – lameness score, CPLF – clinical problems with legs and feet, IFI – interval from calving to first insemination, DO – days open interval, NIC – Number of inseminations for conception, BS – Bone structure, FA – Foot angle, HD – Heel depth, HD – Hock development, L – Locomotion, RL-RV – Rear legs-rear view, RL-SV – Rear legs-side view

**Corresponding author*: tonchopenev@abv.bg

Introduction

Problems with feet and legs, as well as other problems of the locomotor system, are the third most common health problem and reason for culling of dairy cows after reproductive problems and mastitis (McDaniel, 1997; Sulayeman and Fromsa, 2012). Health problems with feet and legs cause not only problems to animal welfare as a result of causing pain and suffering of cows (McDaniels, 1997; Garbarino et al., 2004; Van Der Waiij et al., 2005) but they also lead to decrease of the profit for the farmer. Reasons for this are increased costs for veterinary treatment (Kossaibati and Esslemont, 1997), direct losses from lower productivity and milk culling (Warnick et al., 2001; Green et al., 2002) and indirect losses due to prolongation of calving interval (Sogstad et al., 2006), impaired reproduction (Hernandez et al., 2001; Melendez et al., 2003; Van Dorp et al., 2004; Koenig et al., 2005) and reduced duration of use of the animals (Sprecher et al., 1997; Booth et al., 2004). It is believed that actual culling rate related to problems with feet and legs is higher, because a part of culling for reproductive problems may actually be due to problems with feet and legs, as a result of which the estrus cannot be detected. Even a part of culling rate because of "low productivity" may actually be due to such problems (McDaniel, 1997). In numerical expression losses arising from lameness were associated with reduced milk yield of affected cows, which represented 40% of total losses, 34% of treatment costs and decreased conception rate – 26% (Olechnowicz and Jaskowski, 2011).

Van der Waaij et al. (2005) claimed that the impact of environmental factors on the hooves health was very high and because of the low heritability of hoof diseases, improving their health in the short term could be achieved most easily by improving the environmental factors. However, in the long term, direct or indirect selection, or both, could be the best means to improve the hooves health. Surveys of Haggman and Juga (2013) indicated that indirect selection to improving the hooves health by using linear type traits for feet and legs as indicator would not be effective in the selection of Finnish Holstein. The results emphasized the need of collecting information about health problems with feet and legs at national level too. Researches in this direction of different authors and in different populations of cattle were not uniform, both in terms of controlled traits and for the direction of selection.

The objective of the study was to estimate the correlations between linear type traits for feet and legs and their relation with locomotion disorders, and on productive and reproductive traits in Holstein cows reared in Bulgaria.

Materials and Methods

The study included 136 Holstein cows of 4 dairy cattle farms from different regions of Bulgaria, respectively, Gabrovo, Plovdiv, Stara Zagora and Sliven. In all farms, cows were year-round reared group in free stalls with individual boxes for rest and milked in milking parlor.

On all cows a linear type scoring of 6 linear traits related to legs and feed (rear legs-rear view, rear legs-side view, hock development, bone structure, foot angle and locomotion) on a scale from 1 to 9, in accordance with the instructions for conformation recording (ICAR, 2012) was performed. Additionally to these traits the trait heel depth was included (Atkins and Shannon, 2002).

The cows were scored in the period from 30^{th} to 210^{th} day of lactation. In the study all animals of technological groups in the first and second period of lactation were included, respectively on first, second and third lactation.

Apart from scoring of the linear trait locomotion, on all cows a scoring of lameness on a scale from 1 to 4 (Defra, 2008) was carried out.

From the primary documents of farms and the data on productivity control a basic data set for the animals and their productive and reproductive traits were taken. From the veterinary records the data for various clinical problems with feet and legs during the current lactation were taken. The various problems with feet and legs were not differentiated, because they were not accurately described and recorded in every farm, and sometimes they were pointed just as cases of clinical problems.

On the base of these data the interval from calving to first insemination (IFI) days open interval (DO), number of inseminations for conception (NIC) and the percentage of non-conceived cows were calculated.

Results and Discussion

The average milk yield for normal lactation of cows included in the study was 8430.9 kg, (Table 1). With the highest milk yield were cows in Farm 1, respectively 9420.9 kg, while the lowest was in cows of Farm 4 – 7433.6 kg. Significant difference in milk yield for 305 days between cows of the four farms was reported. Cows from all of the farms were with a relatively high milk yield for our country. It should be borne in mind that in all farms, more than half of cows included in the study were on the first lactation – 51.5%.

Reproductive traits, however, were comparatively poorer in comparison with the productive ones. The average duration of IFI was 83.12 days, DO was 155.96 days and there were an average of 3.03 inseminations for conception. This

Table 1
Means (± SE) for studied traits by farms

Traits	Means for all farms n = 136	Farm 1 Venec n = 39	Farm 2 Lenovo n = 30	Farm 3 Velkovci n = 35	Farm 4 ZI n = 32
	x ± SE	x ± SE	x ± SE	x ± SE	x ± SE
305milk yield, kg	8430.9±155.68	9420.9±286.63[a]	7730.3±292.31[ab]	8763.9±275.10[bd]	7433.6±252.16[ad]
IFI, days	83.12±2.76	73.58±1.95[ab]	66.80±2.74[adef]	96.24±5.54[bd]	98.19±8.90[fe]
DO, days	155.96±6.95	144.71±10.33	150.73±13.65	173.10±13.65	153.96±15.67
NIC	3.03±0.17	3.22±0.29[a]	3.77±0.37[b]	2.13±0.27[abc]	3.13±0.39[c]
Non-conceived %	18.4	25.8	13.3	11.4	28.1
LS	1.71±0.06	1.54±0.10[a]	1.93±0.15[a]	1.69±0.11	1.75±0.13
CPFL, %	22.8	23.1	30.0	14.3	25.0

The differences between the traits by farms marked with equal letters were statistically significant at $P < 0.05$

showed that the first insemination is postponed quite a long after the second estrus for different reasons – health problems and treatment of cows after calving or subjective decisions in farms. Furthermore and an average of more than 3 insemination for conception were reported. All this affected the duration of DO. With the shortest IFI were cows of Farm 2 – 66.80 days and with a DO of 150.73 days, but with the largest NIC – 3.77. Cows on farm 3 had long IFI – 96.24 days and the longest DO – 173.10 days, but with the lowest NIC – 2.13. This definitely showed certain subjective decisions on the farms, especially in terms of IFI. Varner et al. (2014) determined the duration of DO over 145 days and more than 2.3 inseminations for conception in dairy herds as a signal of serious reproductive problems, indicating that in the studied of us farms there was a lot to be desired in the reproductive management.

LeBlanc (2013) showed that in many herds the IFI can be severely impaired by the management, mostly by low-intensive detection of estrus, but also by subjective decisions when to be inseminated some of the cows or all cows in the herd. DO interval is determined only by the number of the conceived cows. It is difficult to evaluate the reproductive performance of all cows which for various reasons were not conceived, and were excluded from the evaluation.

Relatively high percentage of cows included in the study – 22.8% were not conceived during the current lactation. The lowest percentage of non-conceived was among the cows in Farm 3 – 11.4%, while the highest was in Farm 4 – 28.1%. We should note that the data was only for the cows included in the study, not for all cows on the farms. Part of non-conceived cows have not been inseminated during the current lactation at all for various reasons, including selection ones.

Grohn and Rajala-Schultz (2000) indicated that low-productive cows which were not conceived at the beginning of lactation were usually culled. High-productive cows were more likely to be inseminated more times and were less likely to be culled. All this affected the statistical data on reproductive traits.

Average values for reproductive traits of sampled in the study cows were not much different from those obtained by other authors for Holstein cows in other countries. Yamazaki et al. (2014) found in Holstein cows in Japan average duration of IFI 83.1, 84.6 and 85.8 days, NIC 2.5, 2.6 and 2.6, and OD 144, 151 and 153 days at a milk yield 8300, 9467 and 9815 kg, respectively for cows at I-st, II-nd and III-rd lactation. Rahbar et al. (2016) found in Holstein cows in Iran average duration of DO 140.36 days and 2.73 NIC.

Better reproductive performance for Czech Holstein was reported from Zink et al. (2012): average IFI 80.86 days and average DO 113.93 days at an average milk yield for 305 days 8353.76 kg. Rzewuska and Strabel (2015) pointed for Polish Holstein an average IFI – 79.9 days, average DO – 124.4 days and average NIC – 2.10.

Table 1 presents and the average LS of cows included in the survey by farms. With a highest average LS were cows from Farm 2 – 1.93, it means that the biggest number of cows with lameness (scores above 2) were reported in it. With the lowest average score were cows in Farm 1, respectively an average score 1.54. The same table presents the percentage of cows with CPFL during the current lactation by farms. The number and respectively the percentage of cows with clinical problems were reported for the period of the whole lactation, unlike the LS, which was a current status of cows at the scoring date. With the highest percentage of clinical problems requiring treatment were cows from farm 2 (30.0%), as among those cows and the highest percentage of CPFL was reported. With the lowest percentage of CPFL were cows from farm 3 (14.3%), which however, did not have the lowest average LS – 1.69. The lowest was LS in cows from farm 1 (1.54), where a higher percentage of cows with CPFL – 23.1% was reported. The disparity between the average LS and the percentage of cows with CPFL probably was due to the fact that in CPFL all animals suffered from such problems throughout the lactation were covered and LS reflected only problems with the movement of cows reported at the time of scoring. There were cows that have had problems with the movement (clinical lameness) more than once during lactation, and these problems have been occurred in different periods. This definitely indicated the need for collecting information about CPFL. The scoring of lameness must be periodically in order to timely taking action for treatment or other procedures in animals with problems with movement, but it is not proper for the needs of selection.

The incidence of problems with feet and legs in dairy farming has greatly increased in recent decades. In dairy herds in the UK, it has increased from <10% before 1980 (Russel et al., 1982) to> 20% after 1990 (Clarkson et al., 1996). In the US lameness in dairy cows was between 21.1% and 23.9% (Cook, 2003). According to Broom, (2001) lameness in cattle in the United States ranged from 35 to 56%, and in England it was 22% (Whay et al., 2002). A study of Green et al. (2002) showed that over 70% of the cows had problems with feet and legs at least once during their seven-month study. Studies in cattle farms in Netherlands showed that over 70% of the cows had at least once problems with hooves (Somers et al., 2003; van der Waaij et al., 2005). Mitev et al. (2012) in study in three dairy farms in Bulgaria found lameness from 18 to 28% for the various farms.

On Table 2 the means for linear type traits for feet and legs for all animals as averages and by herds are presented. For all the cows covered by the study can be summarized, that they had a moderate widely placed, slight toe-out rear legs (5.19), normal curve of the hock (5.57), intermediate hock development, without swellings (5.11), intermediate thickness of bones (5.58) and a trend towards lower foot angle – 4.57, heel depth above the mean values (6.02) and relatively good locomotion, with a bit shorter stride and slight abduction (5.13), which is in connection with the average value of the score for rear legs – rear view.

Ptak et al. (2009) reported in Polish Holstein cows means for the traits rear leg-side view –5.36, rear legs-rear view – 4.69 and for foot angle-5.24. Němcova et al. (2011) showed similar to our means for linear traits for feet and legs in Czech Holstein primiparous – rear legs-rear view -5.3, rear legs-side view 5.2, foot angle -4.9 and bone structure -5.8. Zink et al. (2014) presented averages for Czech Holstein primiparous, and most of the linear traits were with averages around score 5. Rear legs – rear view (5.05) and locomotion (5.15) were with almost the same values as for our cows. Tapki and Ziya Guzey (2013) showed lower averages for the foot angle (4.06), rear legs-side view (4.50) and locomotion (4.52) in Holstein in Turkey. Duru et al. (2012) also for Holstein in Turkey reported lower averages for the traits for feet and legs – rear legs-side view (4.73), rear legs- rear view (4.90), foot angle (4.74) and hock development (5.15).

In most of the traits associated with feet and legs a significant difference between herds was reported, except for the traits hock development, foot angle and locomotion. With more undesired deviations were average values for the traits in cows from farm 2 – a tendency for a more sickled rear legs set (6.00), coarser hocks (4.70) and problems with locomotion (4.73). This is also the farm with the highest average score of lameness (1.93) and the highest percentage of cows with CPFL (30%). The reported deviations in herds in linear traits for feet and legs were probably due to different heredity.

On Table 3 the phenotypic correlations between studied linear traits are presented. The vast majority of the correlations were low, close to 0, with positive and negative values.

Between the traits for feet and legs some correlations with higher and significant values were reported. Between the rear legs-rear view and rear legs-side view a negative

Table 2
Means for linear type traits by farms

Traits	Means n = 136	Farm 1 n = 39	Farm 2 n = 30	Farm 3 n = 35	Farm 4 n = 32
	x ± SE	x ± SE	x ± SE	x ± SE	x ± SE
Rear legs – rear view	5.19±0.10	5.21±0.16	5.47±0.16^{a}	4.83±0.18^{a}	5.34±0.29
Rear legs – side view	5.57±0.12	4.95±0.17^{abc}	6.00±0.24^{a}	5.69±0.26^{b}	5.81±0.24^{c}
Hock development	5.11±0.12	5.17±0.23	4.70±0.23	5.40±0.31	5.09±0.15
Bone structure	5.58±0.11	5.56±0.19^{ab}	6.57±0.20^{adc}	4.94±0.20^{bd}	5.38±0.24^{c}
Foot angle	4.57±0.05	4.51±0.10	4.70±0.10	4.54±0.09	4.53±0.11
Heel depth	6.02±0.09	5.59±0.16^{ab}	5.70±0.18^{cd}	6.23±0.17^{ac}	6.63±0.17^{bd}
Locomotion	5.13±0.13	5.38±0.19	4.73±0.36	5.29±0.23	5.03±0.24

The values marked with equal letters for the traits by farms have statistically significant differences at P <0.05

Table 3
Phenotypic correlations between linear type traits

	Rear legs – side view	Hock development	Bone structure	Foot angle	Heel depth	Locomotion
Rear legs – rear view	**-0.20**	-0.07	0.12	0.12	-0.11	0.08
Rear legs – side view	1.00	**-0.18**	-0.01	**-0.16**	0.05	0.05
Hock development		1.00	0.06	**-0.16**	0.06	-0.09
Bone structure			1.00	0.07	**-0.24**	-0.06
Foot angle				1.00	**0.24**	0.08
Heel depth					1.00	-0.05

Correlations marked with bolt were statistically significant at P <0.05

correlation with moderate value (-0.20) was observed, which means that in terms of phenotype in cows with wider and parallel placed rear legs tended to be with straighter hock and vice versa – x-shaped rear legs were associated with more sickle hock. Between rear legs-side view, foot angle and hock development, albeit with low value a negative correlation (-0.16) was reported. In cows with straighter hock a steeper foot angle and flatter hocks were reported. Also a slight tendency (0.12) for cows with wider and parallel placed rear legs to have thinner bones and steeper foot was observed. In the trait locomotion a significant correlation with any of the other linear type traits was not accounted.

The heel depth had a negative correlation with bone structure (-0.24) and a positive with foot angle (0.24). Cows with thicker bones had steeper foot angle and deeper heel. This means that when selection for thinner bones and optimum foot angle is conducted, it would be likely the heel depth to decline. This result indicated that the inclusion of the trait heel depth in the classification system should be considered.

Atkins and Shannon (2002) showed that bulls breeding evaluations have shown a very low dependence between foot angle and heel depth, which was the reason why the Canadian Holstein Association continues to describe and assess the heel depth. Onyiro (2009) showed, that the bone structure, which is a new trait in the classification scheme has moderate and positive genetic correlations with locomotion and the traits for feet and legs. Phenotypic correlations between the bone structure, locomotion, foot angle and overall assessment of feet and legs, give base for suggestion that regarding the phenotype, cows with less locomotive problems, steeper foot and higher assessment of feet and legs will have as a result a flatter and finer bones.

Similar to the dependencies obtained by us, but with higher values reported and Nemcova et al. (2011). Phenotypic correlation between foot angle and rear legs-side view was (-0.40). This means that in cows with a straighter hock, defiantly a trend to steeper foot and vice versa was observed. Phenotypic correlation between foot angle and rear legs-rear view was 0.24, cows with wider and parallel placed rear legs had steeper foot angle, but also straighter hock (-0.31). Cows with a steeper foot angle and straighter legs had much better locomotion according to a study of Van Dorp et al. (2004). Van der Waaij et al. (2005) showed phenotypic correlation between rear legs-side view and locomotion (-0.20), rear legs -rear view (-0.51), and foot angle (0.32).

On Table 4 the phenotypic correlations between included in the study linear traits and productive, reproductive and health traits (lameness score and clinical problems with feet and legs) are presented. All linear traits for feet and legs in our study had low values of phenotypic correlation with 305 days milk yield. Unfavorable correlations, albeit with low to moderate values between milk yield and some of the linear traits for feet and legs were reported. Cows with straighter hock (-0.16), lower foot angle (0.18) and shallower heel (-0.25) had higher milk yield for 305 days. The higher milk yield was associated with better locomotion (0.25) and a trend towards thinner bones (0.12). All this shows that the selection for higher milk yield will be associated with a tendency for unfavorable phenotypic deviations in the various linear traits for feet and legs, with the exception of bone structure and locomotion.

De Groot et al. (2002) found that genetic correlations between traits for feet and legs with milk yield ranged from 0.107 (for rear legs-rear view) to 0.83 (for rear legs-side view) and had significantly higher values compared to those pointed by Misztal et al. (1992) and Short and Lawlor (1992).

Gordon and Shannon (2002) showed that the bone structure was an indication of good body condition and good development of the legs and had a high positive genetic correlation with the traits dairy character and milk yield. Cows with flat and fine bones had good locomotion as a result of a decrease in bone mass and reduced contact area, especially at the hock joints, which can reduce problems with the legs.

Significant with moderate and negative value (-0.28) was the phenotypic correlation between milk yield and CPFL. Cows with clinical problems during the current lactation had

Table 4
Correlations between linear traits and milk yield, reproductive and health traits

	305 days milk yield	IFI	DO	NIC	CPFL	LS
Rear legs – rear view	0.05	**-0.18**	-0.15	-0.02	0.07	**-0.19**
Rear legs – side view	**-0.16**	-0.04	0.12	0.05	0.03	0.06
Hock development	0.00	**0.16**	-0.02	-0.02	0.05	0.06
Bone structure	0.12	**-0.25**	-0.08	**0.20**	-0.01	0.08
Foot angle	**-0.18**	-0.15	-0.02	0.01	-0.05	-0.13
Heel depth	**-0.25**	0.13	0.02	-0.11	-0.10	0.08
Locomotion	**0.25**	-0.04	0.09	-0.09	**-0.37**	**-0.87**
CPFL	**-0.28**	-0,05	0.07	**0.19**	**-**	**0.42**
Lameness score	**-0.28**	0.00	-0.05	0.12		-

Correlations indicated with bolt were statistically significant at $P < 0.05$

with 12.1% lower milk yield (1046.7 kg) than the cows without any problems Figure 1. Also a trend for lower milk yield in cows with higher lameness score (-0.28) was reported. Ingvartsen et al. (2003) found unfavorable genetic correlation between milk yield and lameness (0.24 – 0.48).

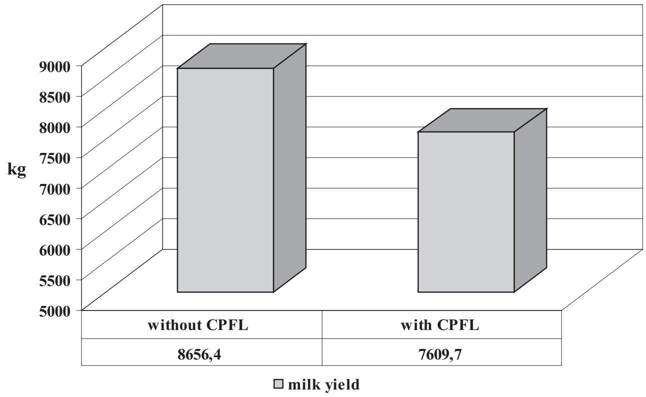

Fig. 1. Average 305 days milk yield depending on CPFL

The significant and with higher values phenotypic correlations between reproductive traits and linear traits for feet and legs were less in number. A greater number were correlations with the IFI. Cows with more pronounced X-shaped rear legs-rear view (-0.18), with flatter and dry hocks (0.16), with thicker bones (-0.25) and tending for a lower foot angle (-0.15) had longer IFI. At the same time cows with thicker bones had smaller NIC (0.20). With the DO significant and with higher values phenotypic correlations were not reported. These differences probably were due to the fact that some of the cows with first insemination were not conceived and DO was not accounted for them.

Onyiro (2009) found that cows with straighter hocks, steeper foot and flatter, finer bones had and better conception rate.

Phenotypic correlations between CPFL and linear traits were with low values both positive and negative. With the highest negative value was the phenotypic correlation between linear trait locomotion and CPFL (-0.37). Cows with problems in locomotion had more clinical cases of lameness. The lack of significant phenotypic correlations between CPFL and some of the linear traits for feet and legs could be due to the specifics of their scoring – desired values were around the middle of the scale – score (5), but also and to the different etiology of CPFL. This means that the use of only linear traits for feet and legs in selection, without additional information about the various CPFL, will not have a considerable effect.

Konig et al., (2005) supposed that established by them genetic correlation between clinical lameness and the score for rear leg-side view around zero indicated that neither parallel nor sickle set were closely related with the clinical lameness.

Van der Waiij et al. (2005) pointed that genetic correlations between hoof problems and linear traits for feet and legs were low to moderately high and phenotypic correlations were very low as general and ranged from -0.08 to 0.05. Koenig et al., (2005) estimated genetic correlations between various hoof diseases and rear legs-side view were from 0.13 to 0.27, with rear legs – rear view from -0.07 to -0.21 and with foot angle from -0.05 to -0.31, which showed a tendency in cows with straighter hock, wider and parallel placed rear legs and steeper foot to have less problems with feet and legs and longer life. Onyiro (2009) found decreased incidence of the hoof disease digital dermatitis in cows with, flatter, finer bones, higher value of scores for locomotion and traits for feet and legs.

According to McDaniel, (1997) the characteristics of individual body parts of cows which can be reported at the beginning of lactation and which can be used to predict potential problems, would be one of the most used for selection purposes in this direction. The author concluded, that as long as we still have not learned much more about the genetic factors, which are the base of lameness, the biggest improvement in resistance to lameness would be result of improving the structure of the various body parts, that provide animals less problems with feet and legs, because they are the most common cause of poor motion.

Correlations between CPFL and reproductive traits were low, -0.05, 0.07 and 0.19 with IFI, DO and NIC respectively. More pronounced was the dependence for a larger NIC in cows with CPFL. Cows with CPFL during the current lactation had 7 days shorter IFI, but with 13.6 days longer DO, than those without CPFL, Figure 2. Cows with CPFL had an average of 3.63 NIC versus 2.89 among the healthy cows. The influence of CPFL on studied reproductive traits depended largely on that in which period after calving cows had such problems. Cases of CPFL after the first insemination or after the conception can not affect these traits.

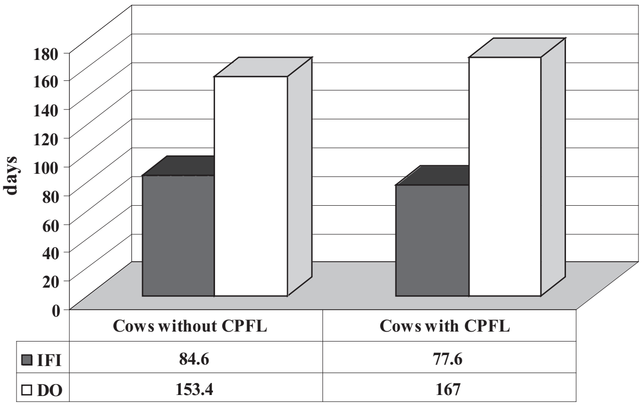

Fig. 2. Duration of IFI and DO in cows without and with CPFL

According to Penev (2013) cows with lameness had poorer reproductive traits – increased DO, larger NIC and a longer IFI which increases with the degree of lameness reflected in the value of LS.

Figure 3 presents the percentage of non-conceived cows of the total number of cows covered by the survey and respectively the percentage of cows with and without CPFL during the current lactation.

There were different reasons for cows to remain non-conceived; some of them were not inseminated after calving at all. There were also cows which had first and more inseminations, but were not conceived. This means that not in all non-conceived cows we can look for connection with CPFL. However, in cows with CPFL the percentage of non-conceived was twice as high (40%) than in those without CPFL (18.9%).

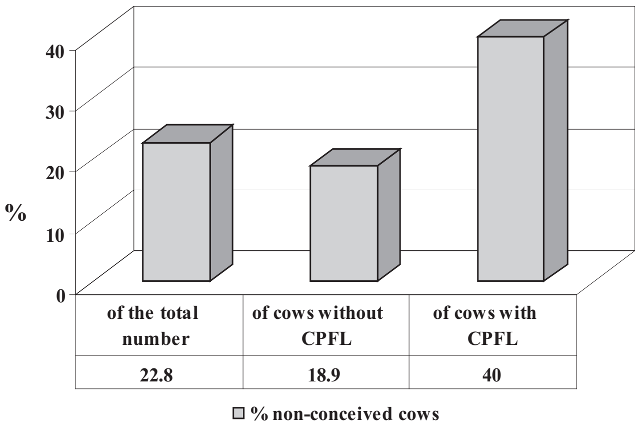

Fig. 3. Percentage of non-conceived cows depending on CPFL

Conclusion

In all of the studied farms a high percentage of CPFL -from 11.4 to 28.1% was reported. In cows with wider and parallel placed rear legs a tendency to straighter hocks was observed, which was associated with steeper foot and flatter hocks. Cows with thicker bones and steeper foot had and deeper heel. This means that the selection for thinner bones and optimal foot angle could reduce the heel depth. This result showed that the inclusion of the trait heel depth in the classification system should be considered.

Between milk yield and some of the linear traits for feet and legs unfavorable correlations, albeit with low to moderate values were reported. Cows with straighter hock, with lower foot angle and shallower heel had higher 305 days milk yield. A selection for higher milk yield will be associated with a tendency for unfavorable phenotypic deviations in the various linear traits for feet and legs, with the exception of bone structure and locomotion.

Cows with clinical problems during the current lactation and high LS had a 12.1% lower milk yield than cows without such problems. Correlations between CPFL and reproductive traits were with low values. Phenotypic correlations between CPFL and linear traits were with low values, both positive and negative. With the highest, negative value was the phenotypic correlation between linear trait locomotion and CPFL (-0.37). This means that in selection, the use of only linear traits for feet and legs to reduce the locomotive problems, without additional information about the various CPFL will not have a considerable effect.

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