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Relation of the length of productive life and the body conformation traits in Slovak Simmental breed

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Abstract

Data obtained from the evaluation of longevity in 118 646 dairy cows of the Slovak Simmental breed were analyzed. The average length of productive life reached 1 451 days (3.88 years). Based on the analysis of the length of productive life for the whole cattle population, we calculated the ratio of cows that reached more than 12, 24, 36, 48, 60, 72 and 84 months respectively.

The most important effects were the sire (F=53.43, $P<0.001$) and the farm effect (F=26.32, $P<0.001$). The milk production at first lactation was an important factor, too. The effects of conformation traits on the length of productive life were analyzed in a group of 6 585 culled cows. From the main conformation traits the most important effects were recorded for body frame, udder, feet and legs. For a detailed evaluation, the level of the effects of a particular body conformation trait were tested. The most important effects were rump angle, croup height and body depth. The analysis of udder traits showed that the most important effects were udder depth, teats length, rear udder attachment and rear udder. From the feet and legs traits the most important effects were recorded for fetlock, foot and rear legs.

Keywords: cattle, length of productive life, functional traits, body conformation traits, Simmental

Zusammenfassung

Beziehungen zwischen Nutzungsdauer und Exterieurmerkmalen bei Simmentaler Kühen der Slowakei

An 118 646 Simmentaler Kühen der Slowakei wurde die durchschnittliche Nutzungsdauer, welche 1 451 Tage (3,88 Jahre) betrug, ermittelt. Berechnet wurde auch der Anteil Kühe, der jeweils die Nutzungsjahre eins bis sieben erreichte. Von den ausgewählten und nach einem linearen Modell berechneten Effekten wurde das Nutzungsalter am stärksten von dem Bullen, gefolgt vom Betrieb und dem Erstlaktationsalter, beeinflusst. Für die Untersuchung der Beziehungen zwischen der Nutzungsdauer und Exterieurmerkmalen standen vollständige Datensätze von 6 585 gemerzten Kühen zur Verfügung. Von den Merkmalen waren übten vor allem Rahmen, Euter und Fundament Einfluss auf die Nutzungsdauer aus. An Einzelmerkmalen mit besonderer Wirkung sind zu nennen Beckenneigung, Kreuzhöhe und Körpertiefe, Fessel, die Trachten und die Sprunggelenkwinkelung. Bei den Eutermerkmalen waren es die Eutertiefe, Zitzenlänge, Hintereuteraufhängung und das Schenkeleuter.

Neben diesen Merkmalen bestätigte sich der bedeutende Einfluss der Milchleistung auf die Nutzungsdauer.

Schlüsselwörter: Rind, Nutzungsdauer, Sekundärmerkmale, Exterieur, Simmentaler

Introduction

Longevity, reproduction and total milk production in cows become the important traits among selection criteria criterions, which have tight connections to economic effectiveness of milk and beef production (MESZAROS *et al.* 2008) for Pinzgau Cattle, (SZAJKO 1987, DISTL 2001, CUE and ONGE 2002, BERGFELD and KLUNKER 2002, SWALVE 2003).

The fundamental problem of the selection for longevity is its low heritability. DUCROCQ (1987) calculated the heritability coefficient of longevity h^2=0.09 in Holstein cattle. KARRAS *et al.* (1985) calculated h^2 from 0.05 to 0.09 for Simmental cattle in Germany and SÖLKNER *et al.* (2000) h^2=0.1 in Austria. One possibility is the selection based on the highly positive genetic and phenotype correlations between milk yield at first lactation and longevity traits. Several authors state the genetic correlation between 0.2 and 0.6 and the phenotype correlation between 0.2 and 0.4 (VAN RADEN and KLAASKATE 1993, SAWA and KREZEL-CZOPEK 2009, DAKAY *et al.* 2006, TEKERLI and KOCAK 2009).

Positive relations or genetic correlations between production traits, morphological traits, QTL, body conformation traits and longevity are stated by several authors (VUKAŠINOVIČ *et al.* 1995), HANSEN *et al.* 1999, FREYER and ERHARDT 2000, JUSZCZAK *et al.* 2001, BUENGER *et al.* 2001, VALENCIA *et al.* 2004).

BOUŠKA *et al.* (2007) present that heifers with the lowest intensity of growth have a significantly longer productive life than other animals (P<0.01).

The positive genetic correlation between longevity and the evaluation of the udder and teats is presented by VUKAŠINOVIČ *et al.* (1995) in Brown Swiss cattle and by LARROQUE and DUCROCQ (2001) in Holstein breed.

The relations between functional traits, body conformation traits and direct herd life were analyzed by MIGLIOR *et al.* (2001). They determined an order of traits by impact on direct herd life: mammary system, feet and legs, somatic cell count, rump angle, milkability and calving ease. Animals with low somatic cell count, excellent legs and udder, high milking speed, easy calving and correct rump angle have a higher tendency to survive longer than the mean of the herd. Some traits like body size, chest width and body depth (r=−0.21, −0.22 and −0.25) had negative relations to direct herd life.

POWELL and VAN RADEN (2003) evaluated longevity and the relation of longevity to other traits in 11 countries. The correlations between length of productive life and somatic cell count and body conformation traits are on similar levels in all investigated countries. The correlations of milk production traits to the length of productive life were different, according to the system of evaluation of longevity by direct herd life or functional herd life in cows. The authors state that the longevity is an indicator of fitness and keeper satisfaction, but evaluated traits are defined and analysed in various ways in each country (SÖLKNER *et al.* 2000). Correlations in longevity between selected production and functional traits ranged from −0.27 to 0.51, but the coefficients are a little bit higher in countries which use direct herd life instead of functional herd life. VACEK *et al.* (2006) found negative correlations between herd life or production life and teat length and udder depth as well as rump angle and rear leg set. Despite that most of the body traits had slightly positive correlations to the herd life, i.e. larger cows live longer.

SÖLKNER *et al.* (2000) and BAUMUNG *et al.* (2001) underline that longevity in cow is an integral part of selection in cattle breeds with dual purpose. Auxiliary traits which indirectly influence the length of productive life in dairy cows are body conformation traits, classified during body conformation classification, mainly feet, legs and mammary system.

The aim of this paper was the evaluation of the length of productive life in the Slovak Simmental cattle population. In addition, the paper focusses on the testing of effects that affect the length of productive life and the analysis of relations between conformation traits and the length of productive life.

Material and methods

The starting point for the analysis of the productive life duration were records of 118 646 culled cows from the database of the State Breeding Institute of the Slovak Republic and the Slovak Simmental Cattle Herd Books from the years 1997 to 2006.

The duration of the productive life was calculated in days for each dairy cow in the database of culled cows, the average of the length of productive life taken from the whole group and then we analyzed the number and ratio of the dairy cows which survived the defined levels 12, 24, 36, 48, 60, 72 and 84 months after first calving, respectively.

Using information from literature sources and stated hypotheses, we picked up effects, which can affect the length of productive life considerably: farm, milk production at 1st lactation, breeding group (S_0, S_1, S_2), sire, year of culling and age at first calving. Breeding group is defined in accordance with the Slovak Simmental Herdbook: S_0 – pure breed cows, S_1 – crossbreeds with 12.5 up to 22 % of other breeds, S_2 – crossbreeds with 25.1 up to 50 % of other breeds.

The impact of the evaluated effects on the length of productive life in cows was calculated by a simple linear model

$$Y_{ijklmno} = \mu + M_i + F_j + B_k + S_l + C_m + R_n + A_o + e_{ijklmno} \quad (1)$$

where $Y_{ijklmno}$ is the length of productive life, μ is the mean, M_i is the effect of *i*-milk production at first lactation, F_j is effect of *j*-farm, B_k is the effect of *k*-breeding group, S_l is the effect of *l*-Sire, C_m is the effect of *m*-year of culling, R_n is the effect of *n*-reason of culling, A_o is the effect of o-age at first calving and $e_{ijklmno}$ is the residual error.

Calculated significantly positive effects will be regarded in the genetic evaluation of the length of productive life.

Since the 1.10.1997, the »System 97« – an integrated European system for type classification in Simmental cattle – is used for type classification in Slovakia.

We have evaluated the relations between conformation traits and the length of productive life in a group of 6 298 cows, for which we obtained official records of type classification. The precise estimation of the interactions between the effects was done by a general linear model in the statistical software SAS 9.1. In the present study the impact of main and partial traits and groups of conformation traits on the length of productive life was tested.

For the main traits:

$$Y_{ijklm} = \mu + B_i + M_j + L_k + U_l + C_m + e_{ijklm} \qquad (2)$$

where Y_{ijklm} is the length of productive life, μ is the mean, B_i is the *i*-body frame, M_j is the *j*-muscularity, L_k is the *k*-legs, U_l is the *l*-udder, C_m is the *m*-udder cleanness and e_{ijklmn} is the residual error.

Similar linear models were used for the estimation of the impact of udder, legs and body measurement traits. The rate of the effects was calculated as the sum of squares of a particular trait divided by the total sum of squares.

Results and discussion

The evaluation of length of productive life in dairy cattle

In this paper was evaluated the level of the reached real length of the productive life in a population of the Slovak Simmental breed. The average length of the productive life in the analyzed group of 118 646 cows was 1 451 days (3.88 years), which represents an average level of 3.4-3.6 lactations in dairy cows, under suitable reproduction conditions. EGGER-DANNER (2005) found out that the length of the productive life decreases in cows of a particular breeds in Austria. Simmental-Fleckvieh cattle reached 3.56 years of age in 2004, Holstein cattle reached 3.21 years of age and Pinzgau reached 3.53 years of age. The author suggests the stricter selection at farms as the reason for this tendency, because the genetic trends for the productive production lifetime are relatively fixed.

An analysis of the length of productive life in a whole population of culled cows of the Slovak Simmental breed shows that 87.16 % of the cows reach 12 months of age, 24 months of age are reached by 72.39 % of the cows, 36 months of age by 58.16 % and 48 months by 44.11 %. Results for the length of productive life are presented in Figure 1.

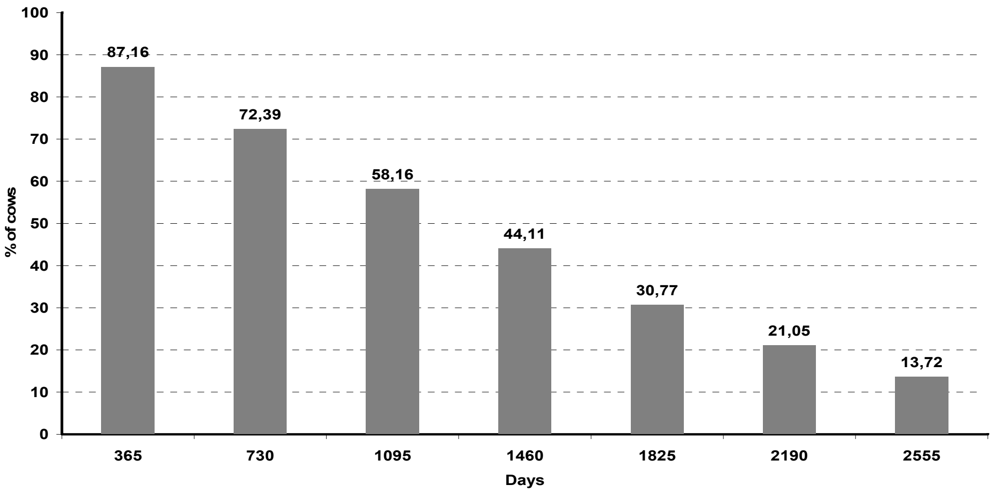

Figure 1
Percentage of cows that reached particular levels of length of productive life in days (n=118 646).
Anteil der Kühe, welche die einzelnen Nutzungsjahre erreichten (Zahlenangaben in Tagen)

A relatively high rate of cows reached 72 and 84 months of age (30.77 %). From this fact it can be stated that up to a third of the dairy cows of the Slovak Simmental breed survive up to 6-7 lactations in herds, which generates conditions for the achievement of the maximal milk production at the 4th and 5th lactations. Changes in survival of cattle are interesting from an historical point of view, too. AVERDUNK and GEOURGOUDIS (1985) present the persistence data of cows of particular breeds by year of birth from 1970 to 1978 in Bavaria in Germany. The mean of 48 months survival in cows ranged from 60.6 % to 76.8 %, 60 months survival ranged from 43.0 %-61.5 %, 72 months survival ranged from 30.3 % to 50.5 % and 84 months survival ranged from 20.7 % to 40.9 %. PSOTA (1993) presents the persistence of cows in Slovakia at the age of 48 months from 53.4 % to 86.2 %, at the age of 60 months from 26.2 % to 55.9 % and at the age of 72 months from 13.9 % to 31.9 %. In Saxonia, functional longevity was reduced from 39 to 30 months from 1994 to 2001 (BERGFELD and KLUNKER 2002).

A relatively low rate of culled cows was recorded in cows at the first lactation, which indicates moderately applied selection of cows by milk production at first lactation, at first milk recording or at 100 and 200 days of first lactation.

In the present study a more intensive culling (14.77 %) was recorded during the second lactation, which is evidence for a noticeable selection by information about milk recordings at first lactation and first recordings at second lactations. This recording has a most important role in the next position of the cow in the herd. This is evidence for the breeders' experience in milk production in this dual purpose breed, in which a considerable increase of milk production is recorded just at the beginning of the second lactation, in contrast to pure milk breeds. CASANOVA and SCHMITZ (1987) evaluated the longevity of Simmental cattle in Switzerland in a total number of 34 583 daughters of 2 887 Sires, which first calved in 1979. The persistence of the whole evaluated group was 92.5 % at 36 months, 68.6 % at 48 months, 52.7 % at 60 months, 39.8 % at 72 months and 28.2 % at 84 months of age. The decrease of persistence between the 36 months and the 48 months level suggests a considerable level of culling due to low milk production. The length of the productive life increased with a higher milk yield at the first lactation. An increasing milk production at the first lactation had a positive effect on the longevity, but conversely, the high yielding dairy cows (with a production over 4 000 kg of milk per lactation) had an average longevity lower than dairy cows with a production under 4 000 kg milk per lactation. The positive relation between the breeding value of milk production traits and the length of productive life is also suggested by ABDALLAH *et al.* (2002).

The effects influencing the length of the productive life

The factors farm, milk at 1st lactation, breeding group, sire, year of culling and age at first calving were used for the analysis of the evaluated group of 118646 culled cows of Slovak Simmental breed. The analysis shows that all factors have considerable effects on the length of productive life. The degree of the effects varied (Table 1).

Table 1
Analysis of the effects of the factors on the length of productive life (n=118 646)
Faktorenanalyse für die Dauer produktiven Lebens der Kühe

Effect	d. f.	Mean Square	Rate of effect, %	F-value	
Milk at 1st lactation	1	1429393 661	2.37	7736.88	***
Year of culling	1	903530 047	1.50	4890.54	***
Age at 1st calving	1	509876 840	0.84	2759.81	***
Farm	1734	4862	14.02	26.32	***
Reason of culling	12	50331 807	1.00	272.43	***
Breeding group	4	3342 002	0.22	18.09	***
Sire	2838	9871 201	46.59	53.43	***
Residual error	0.336254				

The most important effects were the sire (46.59%, F=53.43, *P*<0.001) and the farm (14.02%, F=26.32, *P*<0.001) which confirms equity of the selection for longevity while otherwise exploiting the breeding values for the length of productive life in the selection indexes in the cattle (SÖLKNER *et al.* 2000, BAUMUNG *et al.* 2001). Similar results are presented by OJANGO *et al.* (2002).

The milk production at first lactation also plays an important role (2.37 %, F=7736.88, *P*<0.001). This fact shows the trend to a more intensive increase of he milk efficiency in the Slovak Simmental breed. VALENCIA *et al.* (2004) found out, that the genetic correlation between traits of longevity and milk production at first lactation raged from 0.33 to 0.64, between milk production at first lactation and body conformation traits from −0.27 to 0.48 and between persistence at 48 months of age and body conformation traits from −0.30 to 0.69. Also SAWA and KREZEL-CZOPEK (2009) found positive genetic and phenotype correlations between total milk production traits, criteria of longevity and milk production at first lactation (r=0.64-0.92). MÉSZÁROS *et al.* (2008) suggest an importance of milk production at first lactation, too. Cows with milk yields of 1.5 standard deviations below the herd mean were 5.3 times more likely to be culled than cows with an average production.

Less or not important effects on the length of productive life were calculated for year of culling (1.5 %, F=26.32, *P*<0.001), age at first calving (0.84 %, F=2759.81, *P*<0.001) and breeding group (0.22 %, F=18.09, *P*<0.001). Contrarily, POWELL and RADEN (2003) mention the high importance of the year of birth and the year of culling on the longevity and length of productive life in cows. High negative correlations for the age at first calving (from r=−0.28 to r=−0.45) are presented by RIZZI *et al.* (2002), too. The importance of the year of culling and the year of birth may be caused by a generally increasing intensification of milk production and milk efficiency, an increasing intensity of the turnover in the herds, the decreasing care for dairy cows, and the increasing strain to the organism of the cows that's also connected to the increasing milk yield too.

The considerable effects of the tested factors confirm the accuracy of they selection (Table 1).

Relations between the length of productive life and body conformation traits

One implication of the indirect selection for longevity in dairy cows is the application of the correlated traits, which show the potentioal of the individual from a young age and are related to its survival in the herd. From the main and partial traits mainly the body conformation traits, the legs and the udder conformation were regarded.

The analysis done by a linear model in the investigated group (6 298 cows) shows a considerable effect of the main trait body frame (F=17.39, *P*<0.001) on the length of productive life (Table 2).

Table 2
The effects of main and partial traits of type classification on the length of productive life in cows (n=6298)
Einfluss der untersuchten Merkmale auf die Dauer des produktiven Lebens der Kühe

Evaluated traits	d. f.	Mean square	Rate of effect, %	F-value	
Main traits					
Body frame	9	8688 033.90	20.00	17.39	***
Muscularity	9	8029 225.80	1.85	16.07	***
Legs	8	3201 928.90	0.65	6.41	***
Udder	9	4710 680.30	1.08	9.43	***
Udder cleanness	9	1211 201.00	0.28	2.42	*
Partial traits					
Body length	8	683 317.72	1.68	3.96	***
Body depth	7	1144 225.20	2.47	6.63	***
Chest circumference	8	966 474.13	2.38	5.60	***
Pelvis length	8	1159 630.94	0.29	6.72	***
Rump width	8	142 826.31	0.35	0.83	ns
Croup height	8	977 525.00	2.41	5.66	***
Rump angle	6	2292 766.27	4.24	13.29	***
Rear legs	6	325 269.32	0.60	1.88	ns
Fetlock	6	1607 218.32	2.97	9.1	***
Heel joint expression	6	289 147.02	0.53	1.68	ns
Foot	6	94 425.31	1.74	5.47	***
Fore udder	6	162 212.19	0.30	0.94	ns
Rear udder	7	360 234.58	0.78	2.09	*
Rear udder attachment	6	373 336.65	0.69	2.16	*
Teats thickness	5	557 101.24	0.86	3.23	**
Teats length	5	3191 003.50	4.91	18.49	***
Teats position	5	571 428.88	0.88	3.31	**
Teats placement	6	472 486.36	0.87	2.74	*
Udder depth	7	4493 443.11	9.69	26.04	***
Suspensory ligament	7	170 979.39	0.37	0.99	ns
Residual error	0.581676				

ns not significant, * *P*<0.05, ** *P*<0.01, *** *P*<0.001

HANSEN *et al.* (1999) found out that dairy cows of the Holstein breed with smaller body size reached a higher length of productive life at the levels of 72 months of age and 84 months of age in comparison with dairy cows with bigger body size. The difference between groups was 88 days (2.9 months) i.e. 15.4 %. At the level of 72 months the difference was statistically significant. Similar results are confirmed for Simmental cattle mainly in Germany and Austria, which have populations of the Slovak Simmental cattle with different body size (SÖLKNER and PETSCHINA 1999). Apart from the above mentioned, the present study evaluated cows culled from 1997 to 2003 and during this period the body size in the Slovak Simmental cattle population increased 4.3 cm, which can considerable affect results of the presented paper. VUKAŠINOVIČ *et al.* (1995) present a genetic correlation between longevity and body length (r=0.39) and body depth (r=0.42). A positive relation between body size or body height and longevity is presented by CASSANDRO *et al.* (1999) and STRAPAK *et al.* (2005).

The length of the productive life was considerable affected by udder (F=9.43, *P*<0.001) and legs (F=6.41, *P*<0.001), the same results are presented by BURKE and FUNK (1993), DEKKER *et al.* (1994) and in populations of Simmental cattle by SÖLKNER and PETCHINA (1999) and HAMANN and DISTL (2002).

The detailed analysis of the partial traits from the body frame group shows the considerable effects of rump angle (F=13.29, *P*<0.001), body depth (F=6.63, *P*<0.001) and croup height (F=5.66, *P*<0.001).

The correlation analysis of partial traits of the legs to the length of productive life (Table 2) shows the most important effects fetlock conformation (F=9.1, *P*<0.001), feet (F=5.47, *P*<0.001) and rear legs set (F=1.88, *P*<0.001). The cows with sound conformation of the rear legs, the fetlock and the feet reach a longer productive life. The results of the present paper confirm conclusions of authors which found unalterable positive relations between leg conformation and longevity regardless of the breed (SÖLKNER and PETSCHINA 1999, HAMANN and DISTL 2002, STRAPAK *et al.* 2005). BURKE and FUNK (1993) found a longer productive life in cows with a correct rear leg set in all husbandry systems. VUKAŠINOVIČ *et al.* (1995) found low or moderate genetic correlations of rear leg posture (r=0.35), foot angle (r=0.25) and fetlock (r=0.21) in Brown Swiss cattle.

The analysis of partial traits of the udder shows that the most important effects on the length of productive life result from udder depth (F=26.04, *P*<0.001), rear udder (F=2.09, *P*<0.01) and rear udder attachment (F=2.16, *P*<0.001). The udder suspensory ligament shows a relatively considerable effect on the production lifetime, too. VUKAŠINOVIČ *et al.* (1995) found significant genetic correlations between longevity and the evaluation of the udder and the teats (r ranged from 0.38 to 0.66). Similar findings are presented by BURKE and FUNK (1993), especially for simmentalized breeds in Europe. STRAPÁK *et al.* (2005) and VACEK *et al.* (2006) suggest well attached fore udder, high attached rear udder, strong central ligament, close front teat placement and moderately long teats as important traits for a long productive life with *P*-values of <0.05-0.001.

From the evaluated traits of the teats in the present study the most important and significant effect on longevity was calculated for teat length (F=18.49, *P*<0.001). The positive effect of the teat conformation on the production lifetime is confirmed by VUKAŠINOVIČ *et al.* (1995) and ROGERS *et al.* (1998). The present results shows that dairy cows with less shallow udder but well attached, wide and long rear udder and moderate teat length reach a higher longevity in herds.

The results of the linear model for the estimation of the effects of all partial traits together confirm the effects of the same traits as in the partial models of the body measurements, the udder and the legs. The most important were the effects of the udder depth, teat length and rump slope.

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References

Averdunk G, Georgoudis G (1985) Stayability – a new concept in cattle breeding. Schule und Beratung, 3, IV4-IV5 [in German]

Baumung R, Sölkner J, Gierzinger E, Willam A (2001) Ecological total merit index for an Austrian dual purpose cattle breed. Arch Tierz 44, 5-13

Bergfeld FJ, Klunker M (2002) Importance of functional traits in cattle breeding and possibilities to improve by breeding. Arch Tierz 45 Special Issue, 60-7 [in German]

Bouška J, Štípková M, Krejčová M, Bartoň L (2007) The effect of growth and development intensity in replacement heifers on economically important traits of Holstein cattle in the Czech Republic. Czech J Anim Sci 52, 277-83

Buenger A, Ducrocq V, Swalve HH (2001) Analysis of survival in dairy cows with supplementary data on type scores and housing systems from a region of northwest Germany. J Dairy Sci 84, 1531-41

Burke BP, Funk DA (1993) Relationship of linear type traits and herd life under different management systems. J Dairy Sci 76, 2773-82

Casanova L, Schmitz F (1987) Studies on the life span of dairy cattle. Simmentaler Fleckvieh 4, 2 [in German]

Cassandro M, Gallo L, Carnier P, Penzo N, Bittante G (1999) Collecting functional traits in dairy herds: overview of a program currently running in Italy. In: Breeding value for functional longevity in the Netherlands. Proc Intern Workshop on EU Concerted Action on Genetic Improvement of Functional Traits in Cattle (GIFT), Breeding Goals and Selection Schemes Wageningen, The Netherlands. 7-9th November 1999, Bulletin 23, 123-30

Cue R, Onge A (2002) Economic values of traits for dairy cattle improvement estimated using field-recorded data. Can J Anim Sci 82, 29-39

Dakay I, Marton D, Bene S, Kiss B, Zsuppan Z, Szabo F (2006) The age at first calving and the longevity of beef cows in Hungary. Arch Tierz 49, 417-25

Dekker JCM, Jairath LK, Lawrarence BH (1994): Relationships between sire genetic evolutions for conformation and functional herd life of daughters. J Dairy Sci 77, 844-54

Distl O (2001) Implications of health traits in breeding of dairy cattle. Arch Tierz 44, 365-80 [in German]

Ducrocq VP (1987) An analysis of length of productive life in dairy cattle. PhD Thesis Cornell University, NY, USA

Egger-Danner Ch (2005) Austrian Simmental - wide upward trend. Fleckviehzucht in Österreich 1, 4-5 [in German]

Freyer G, Erhardt G (2000) First results of a MAS study in dairy cattle with respect to longevity. Arch Tierz 43, 241-7

Hamann H, Distl O (2002) Prediction of functional longevity for dairy cows by using foot quality traits in German holstein bulls. In: 7th World Congress on Genetics Applied to Livestock Production. 19-23 August 2002, Montpellier, France

Hansen LB, Cole JB, Marx GD, Seykora AJ (1999) Productive life and reasons for disposal of Holstein cows selected for large versus small body size. J Dairy Sci 82, 795-801

Juszczak J, Erhardt G, Kuczaj M, Zieminski R, Panicke L (2001) Relations between genetic variants of K-casein and ß-lactoglobulin and performance as well as longevity of Black and White and Polish Red cattle. Arch Tierz 44, 239-49 [in German]

Karras K, Hoeschele I, Averdunk G (1985) Breeding on longevity. Der Tierzüchter 37, 116-8 [in German]

Larroque H, Ducrocq V (2001) Relationship between type and longevity in the Holstein breed. Genet Sel Evol 33, 39-59

Mészáros G, Fuerst Ch, Fuerst-Waltl B, Kadlečík O, Kasarda R, Sölkner J (2008) Genetic evaluation for length of productive life in Slovak Pinzgau cattle. Arch Tierz 5, 438-48

Miglior F, Van Doormaal B, Kistemaker G (2001) Prediction of direct herd life proofs. Technical report to the Canadian Genetic Evaluation Board, April 2001, St. Hyacinthe, Quebec, Canada

Ojango J, Ducrocq V, Pollott G (2002) Survival analysis of factors affecting culling early in the productive life of Holstein-Friesian cattle in Kenya. Livest Prod Sci 92, 317-22

Powell LR, Van Raden MP (2003) Correlation of longevity evaluation with other trait evaluations from 14 countries. In: Proc of the Interbull Technical Workshop Beltsville, MD, USA 2-3 March 2003, Bulletin 30, 15-9

Psota T (1993) Milk production in culled dairy cows. Acta Zootechnica XLVIII, 31-9 [in Slovak]

Rizzi R, Bagnato A, Cerutti F, Alvarez JC (2002) Lifetime performances in Carora and Holstein cows in Venezuela. J Anim Breed Genet 119, 83-92

Rogers GW, Banos G, Nielsen SU, Philipsson J (1998) Genetic correlations among somatic cell scores, productive life, and type traits from the United States and udder health measures from Denmark and Sweden. J Dairy Sci 81, 1445-53

SAS (2005) User´s Guide 2005. Release 9.1.2005. SAS Institute Inc, Cary, NC, USA

Sawa A, Krezel-Czopek S (2009) Effect of first lactation milk yield on efficiency of cows in herds with different production levels. Arch Tierz 52, 7-14

Sölkner J, Petschina R (1999) Relationship between type traits and longevity in Austrian Simmental Cattle. In: Proc of Int Workshop on EU concerned action Genetic improvement of functional traits in Cattle (GIFT) Longevity, May 1999, Jouy-en-Josas, France, Bulltetin 21, 91-5

Sölkner J, Miesenberger J, Willam A, Fuerst C, Baumung R (2000) Total merit indices in dual purpose cattle. Arch Tierz 43, 597-608

Strapák P, Candrák J, Aumann J (2005) Relationship between longevity and selected production, reproduction and type traits. Czech J Anim Sci 50, 1-6

Swalve HH (2003) New breeding approaches for functional traits. Arch Tierz 46 Special Issue, 63-71 [in German]

Szajko L (1987) Comparison of dairy cattle breeds on the basis of the lifetime performance – breeding and economic aspects. Arch Tierz 30, 373-82 [in German]

Tekerli M, Kocak S (2009) Relationship between production and fertility traits in first lactation and life time Performances of Holstein cows under subtropical condition. Arch Tierz 52, 364-70

Vacek M, Štípková M, Němcová E, Bouška J (2006) Relationships between conformation traits and longevity of Holstein cows in the Czech Republic. Czech J Anim Sci 51, 327-33

Valencia M, Ruiz F, Montaldo H (2004) Estimation of genetic parameters for longevity and milk production in Holstein cattle in Mexico. Interciencia 29, 52-6

Van Raden PM, Klaaskate EJH (1993) Genetic Evaluations of Length of Productive life Including Predicted Longevity of Live Cows. J Dairy Sci 76, 2758-64

Vukašinovič N, Moll J, Kunzi N (1995) Genetic relationships among longevity, milk production and type traits in Swiss Brown cattle. Livest Prod Sci 41, 11-8

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