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LONGEVITY OF HIGH-YIELDING COWS

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Abstract: Population of Black and White cattle has high genetic potential for production of milk. It exists in very complex production conditions where problems occur which are often manifested in different health disorders, high percentage of culling and short productive life. Longevity parameters are calculated within defined time limits. Bottom limit is determined by date of birth, and top limit by date of culling. The knowledge of the strength of the influence of environment on the longevity of high yielding cows is important from the aspect of its inclusion into the model. According to individual significance of systematic factors, their objective assessment was carried out in order to evaluate the obtained results as precise and correct as possible. Previous studies of the average age of cows at culling from the herd indicated relatively short productive life and life in general of high yielding cows, which due to high percentage of culling effects the herd remount. Consequently selection differential is reduced and in this way realized selection effect is diminished. Objective of this paper was to investigate using appropriate methodology the longevity of high yielding Black and White cows of different genotypes through major systematic influences. Investigated cows according to their origin belong to European type of Black and White cattle in final stage of intensive improvement using Holstein-Friesian breed. Investigated sample included 331 cows. Average age of cows at culling is 2265±463.26 days or 6.21±1.27 years. Observed by cow genotypes, mean values varied from 2140.99 days (> 73% HF), 2247.51 days (58-73% HF) to 2406.97 days (<58% HF). Average lifetime production was realized at the level of 25002.66±7755.39 kg of milk with 3.61±0.01% of milk fat.Bulls, sires of cows, class of HF genes and year of culling had highly significant effect ($p \leq 0.01$), whereas the effect of reason for culling was significant ($p \leq 0.05$) for life duration of cows.

Key words: high yielding cows, longevity, factors of influence

Introduction

Longevity is ability to survive in certain production conditions. Duration of lifetime depends on health first of all. This trait is of great economical importance. Longevity of high yielding cows is determined by voluntary or forced/compelled decision on culling of animals. At the same time, term culling determined duration of production and lifetime period of cow. Voluntary decision on culling of animal is based on low production of head of cattle and economical-social relations on the farm. Duration of production lifetime, age at culling and survival are indicators often used to describe longevity which is related to realized production of milk per day of lifetime period *(Ducrocq et al., 1988; De Vries, 2003)*.

There are two periods in duration of lifetime period of cows: period of growth from birth to first calving and production period, from first calving to culling. Indicators for assessment of longevity are duration of production period, age at culling, realized number of lactations, lifetime period, average milk yield per day of life and average milk yield per production day.

Actual longevity is determined by time during which cow remains in the herd of high yielding cows. Functional longevity of cows is connected to causes which determine culling of cows, and are not related to milk production. In this case, the decision by the breeder in regard to culling of cow is excluded.

Prolonging of production life of animal reduces the percentage of remount in the herd, which enables more strict selection in regard to other traits and additional income from sale of breeding material *(Boettcher et al., 1999; De Vries, 2003)*.

Longevity is for quantity of produced milk one of the key factors which influences the income realized from rearing of high yielding cows. Based on many data obtained in milk recordings, today, in numerous countries, because of the importance of longevity and its positive economical contribution, selection is done on longevity *(Jairath et al., 1998)*. For evaluation of total economical effects in rearing of high yielding cows, key information is the quantity of produced milk to the day of culling *(Ducrocq et al., 1988)*.

Causes for culling of cows are consequences of the size of hers, equipment present on the farm, nutrition technology and temperature stress. Basically, causes for culling are divided into two major groups: intentional culling – cows culled based on the decision of the breeder (low milk yield, reduction of the number of cows in herd, etc.) *(Caraviello et al., 2004)*; culling based on health reasons (diseases, udder damages, damages of legs, dew claws, milk fever, ketosis and other metabolic and digestive disorders), as well as fertility disorders, belong to group of unintentional culling under no immediate influence of the breeder *(De Vries, 2003)*.

The most often reasons for culling of cows are: fertility disorders, death (cause unknown), forced slaughtering (cause unknown), udder diseases (mastitis),

diseases of legs and dew claws, age, low production, udder injuries, digestive and metabolic disorders, injuries to legs and dew claws, sudden death, other illnesses, diseases of reproductive organs, etc. *(Lotthamer, 1999)*.

Black and white, low land cattle has important place in Serbia's cattle production. Especially because of high share in total milk production, in spite of relatively low share in total number of heads of cattle.

Introduction of Holstein-Friesian genes within the program of improvement of population of European Black and white cattle caused increase of milk yield. In herds of high yielding cattle with intensive production of milk problems are noticed which are manifested in form of health and reproductive disorders, high percentage of culled animals, short productive life and lifetime in general, which considerably decreases the economical results of this production.

Beside genetic improvement of milk traits, it is necessary to pay attention to secondary traits. The progress in secondary traits through breeding and simultaneous improvement of nutrition, conditions of care and health protection, should enable normal fertility, good health and satisfactory longevity. It is necessary to find compromise between demands for high milk production and good fertility.

Important characteristic of the longevity is high variability. Low heritability indicates important effect of rearing conditions and care on longevity of cows. Economical efficiency of production relates mainly to lifetime period nad number of lactations realized by the head of cattle during the exploitation period. Duration of exploitation of high yielding cows is often very short. Intensive utilization/exploitation of cows over longer period of time leads to significant problems related to the duration of their exploitation. Shortening of exploitation of cows because of high percentage of culling increased herd remount, decreases the selection progress as well as economical result *(Nenadović et al., 1978; Panić and Simović, 1980; Ducrocq et al., 1988; Vollema and Groen, 1996; Lotthamer, 1999; Hare et al., 2006)*.

Panić (1978) established average age at culling of 6.9 years in Black and White cows, lifetime milk production of je 19.344 kg with3.74% of milk fat. During production life in average 4.18 completed lactations were realized. Index of exploitation was 67.65%.

Milic (1985) stated average age at culling of 6.51 years in cows of Black and white breed, duration of production life of 4.16 years, average number of realized lactations was 3.77, average lifetime production 21.685 kg of milk with 3.52% of milk fat. *Antov (1986),* in his investigation of longevity and lifetime production of imported Red low land cattle (rotbunt) established average age at culling of 8.06 years. In their production life cows realized in average 4.67 lactations. Lifetime milk production was 18.941 kg with 3.67% of milk fat.

Vasović et al. (1988) established that in comparative investigation of Black and white and Simmental breed, average age at culling in Black and White cattle was 6.13 years, and Simmental 6.23 years. Average production life in black and white breed was 3.88 years, and in Simmental 3.99 years. Total number of realized lactations was 3.54 and 3.71, quantity of milk 20.365 and 15.759 kg, respectively. Difference in lifetime production of milk between these two breeds was statistically very significant.

Investigating the effect of Black and White sires on phenotype parameters of lifetime milk production of their daughters, *Petrović (1988)* established that cows were culled at the average age of 6.38 years, whereas average duration of production life was 4.35 years. Cows realized in average 3.30 lactations, lifetime milk production was 18.277 kg with 3.89% of milk fat.

Jovanovac et al. (1990) established that age of Holstein-Friesian cows at culling was 6.27 years. *Lazarević (1994)* stated that in Austria, average exploitation period of Black and White cows was 5.9 years, Simmental 6.5 years, Brown breed 7.2 years, Pinzgauer breed 6.4 years, Grey 8.5 years, whereas average for all breeds was 6.6 years. Prolonging of production life contributes to higher number of cows in later, more productive lactations. Increase of average number of realized lactations from three to four increases the average yield of milk in lactation and income by 11 to 13% *(Vukasinovic et al., 1997)*.

For breeding bulls (sires of future generations of cows) it is important to know their breeding value in regard to longevity as soon as possible *(Vollema and Groen, 1996)*. In investigation which included 13.8 million dairy cows, which calved for the first time in interval of 15 years, sample consisted of cows of different dairy breeds (Ayrshire 0.5 %, Brown Swiss 0.9 %, Guernsey 1.3 %, Holstein 92.6 % and Jersey 4.7 %). Average value of survival was 73 % to the second lactation, 50 % to the third lactation, 32 % to the fourth, 19 % to the fifth, 10 % to the sixth, 5 % to the seventh and 2 % of cows reached the eighth lactation *(Hare et al., 2006)*.

Beside the effort invested into increase of the level of production, it is necessary to consolidate certain physical qualities of cows using selection, in order to contribute to increase of production and prolonging of the lifetime period of cows in the herd. This is especially important if stress effects of intensive rearing system are taken into consideration, as well as housing conditions and exploitation conditions. Study of the body development and type should be more in focus of the attention through defining of certain breed type of animal which would be most suited for the breeding purpose. Body development/condition and type should be considered in relation to rearing conditions and realized production. Methods of visual scoring/evaluation should enable better valuing of body development of cows in regard to increase of production and reproduction abilities/capacities. Prolonging of productive life and general lifetime period of cows is based on this. Disadvantages of the animal type can cause increase of culling from the herd, and

process is amplified by increase of cows' age. If body development and type are neglected totally, general adaptive ability of population can be considerably weakened *(Latinović, 1985)*.

Effects on longevity are quantity of produced milk, somatic cell count, linear type score (primarily height to withers, body length, body depth, udder traits), herd, percentage and amount of milk protein and fat, season of first calving, etc. Heritability for longevity is low and varies between 0.03 and 0.2 depending on the selected method used for assessment of longevity *(Boettcher et al., 1999)*.

The knowledge of the strength of the influence of environment on the longevity of high yielding cows is important from the aspect of its inclusion into the model. According to individual significance of systematic factors, their objective assessment was carried out in order to evaluate the obtained results as precise and correct as possible. Considering that they greatly contribute to economical and breeding results, it is necessary to determine major systematic effects which lead to significant phenotypic variations of investigated trait. Objective of this paper was to investigate using adequate methodology longevity of high yielding Black and White cows of different genotypes through major systematic influences.

Materials and Methods

Investigation of longevity was carried out on heads of high yielding Black and White cattle. Investigated heads were European type of Black and White cattle which are presently in the final stage of intensive improvement/breeding using Holstein-Friesian genes. Investigated sample of culled cows (N=331) were under same conditions of housing (tie system), nutrition (complete diet), care and exploitation. Within longevity traits the age at culling (AC) was investigated and presented in days.

Analysis of the effect of certain systematic influences was done by method of least squares *(Harvey, 1987)* whose advantage was displayed in the possibility of simultaneous determining of multiple effects on investigated traits. For application of the method it is not necessary to have the same number of classes (treatments) of investigated influences, number of repetitions can be different in every class. Mathematical-statistical analysis of data in samples for studied trait of longevity was done by application of following linear models:

Distribution according to classes:

Class of HF genes	< 58%	58-73%	>73%
n	83	125	123
Year of culling	94	95	96
n	88	140	103
Reason for culling	1	3	4
n	278	47	6

Applied models:

a. Mixed

$Yijklm = \mu + O_i + HF_j + G_k + R_l + e_{ijklm}$

b. Fixed (in order to obtain better solutions for sire-bulls)

$Yijklm = \mu + O_i + HF_j + G_k + R_l + e_{ijklm}$

where:

Y_{ijklm} = result of **m** cow, daughter of **i** sire, belonging to **j** group according to share of HF genes, culled in **k** year, because of **l** reason
μ = general average
O_i = in mixed model – random, in fixed model – fixed effect of **i** sire
HF_j = fixed effect of **j** group of HF genes
G_k = fixed effect of **k** year of culling
R_l = fixed effect of **l** reason for culling
e_{ijklm} = random error

Within applied model following codes were used: 1 – economical culling, 3-forced culling and 4 – death.

Results and Discussion

Age at first calving and duration of productive life are time periods which directly determine the age of cows at culling. Average age of cows at culling was 2265±463.26 days or 6.21±1.27 years (Table 1). According to genotypes of cows, mean values varied from 2140.99 days (> 73% HF), 2247.51 days (58-73% HF) to 2406.97 days (< 58% HF). Average lifetime production was realized at the level of 25.002.66±7755.39 kg of milk with 3.61±0.01% of milk fat.

Similar values were established by *Vasović et al. (1988), Jovanovac, (1990)* and *Hare et al., (2006),* whereas higher values were obtained by *Panić (1978), Milić (1985)* and *Petrović (1988)*. For Black and White breed, slightly lower values are stated by *Lazarević (1994)* and *Lotthamer (1999)*.

Table 1. Deviations and deviation errors from general average (μ), mean values (lsm) and mean value errors (Slsm) of least squares for investigated effects for duration of lifetime (days)

Effects	N	C	Sc	lsm	Slsm
			Total		
μ	331	2265.16	463.26	2265.16	63.26
		Class of HF genes, *(df1 =2, df2=307, f-exp=9.100**)*			
< 58%	83	141.81	35.99	2406.97	464.69
58-73%	125	-17.64	28.57	2247.51	464.11
> 73%	123	-124.17	32.50	2140.99	464.39
		Sires-bulls, *(df1 =17, df2=307, f-exp=54.541**)*			
23	42	568.47	56.91	2846.51	67.87
28	20	30.97	76.25	2309.01	91.72
33	3	1010.15	187.88	3288.19	205. 21
35	29	-588.45	66.04	1689.59	82.57
36	45	-353.95	55.31	1924.09	70.92
38	11	-999.98	101.98	1278.06	117.33
270	22	836.44	72.71	3114.48	87.89
283	5	1264.26	146.42	3542.29	161.69
293	8	-1378.67	118.04	899.37	132.47
337	7	-1186.92	124.63	1091.12	138.29
762	21	710.39	85.56	2988.43	89.95
795	6	1358.42	133.72	3636.46	149.53
816	33	378.76	65.64	2656.80	78.30
879	7	-860.65	123.11	1417.39	137.34
927	31	-278.06	62.32	1999.98	74.82
1040	19	-891.17	79.10	1386.87	92.07
1304	15	20.93	86.37	2298.97	101.83
5368	7	359.96	124.54	2637.10	137.89
		Year of culling *(df1 =2, df2=307, f-exp=53.762**)*			
94	88	-288.14	31.01	1977.02	463.85
95	140	15.63	26.84	2280.79	464.24
96	103	272.51	29.33	2537.67	464.43
		Reason for culling *(df1 =2, df2=307, f-exp=3.108*)*			
1	278	90.46	52.68	2355.62	461.23
3	47	143.39	58.89	2408.55	463.40
4	6	-233.85	97.22	2031.31	481.71

N.S.- $p>0.05$ *-$p\leq0.05$ **-$p\leq0.01$

Sires-bulls, class of HF genes and year of culling had highly significant effect ($p\leq0.01$), whereas the reason for culling was significant effect ($p\leq0.05$) on duration of lifetime of cows.

Conclusion

Average age of cows at culling was 2265±463.26 days or 6.21±1.27 years. Sires-bulls, class of HF genes and year of culling had highly significant effect ($p \leq 0.01$), whereas the reason for culling was significant effect ($p \leq 0.05$) on duration of lifetime of cows).

Expression of longevity was not satisfactory which contributed to certain extent to reduction of phenotypic values of traits of lifetime milk production.

Research clearly indicates relatively short lifetime period of high yielding Black and White cows of different genotypes. Short exploitation period leads to high herd remount which is cause of reduction of selection intensity and low selection differential which reduces realized selection effects.

Monitoring and study of longevity in production conditions should be more important. Increase of genetic potential of cows for production of milk reduces their longevity. Importance of selection on those traits which influence health condition in relation to improvement of longevity is emphasized. Increase of longevity is one of the ways to reduce the costs and increase the amount of produced milk.

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Rezime

Efikasno korišćenje krava u intenzivnoj proizvodnji potrebno je da traje što duže. Vreme trajanja perioda od njihovog prvog teljenja do izlučenja iz stada treba da omogući poboljšanje ukupne životne produktivnosti. Ovo bi, pored smanjenja troškova sa manjim udelom amortizacije u ceni koštanja, omogućilo bolje ukupne selekcijske rezultate preko nižeg remonta stada uz veći selekcijski diferencijal. Mnogo veća pažnja mora se posvetiti vremenu korišćenja krava u proizvodnji i uzrocima njihovog izlučenja. Najčešći uzroci izlučenja su: slaba mlečnost, smetnje

u plodnosti, poremećaji posle teljenja, oboljenja nogu, bolesti organa za varenje, mastitis i dr.

Značajan broj istraživanja prosečne starosti krava pri izlučenju iz stada ukazuje na relativno kratak proizvodni i životni vek visokomlečnih krava. On se ispoljava preko visokog procenta izlučenja koji posledično utiče na veći remont stada. Cilj ovog rada je da se primenom odgovarajuće metodologije ispita dugovečnost visokomlečnih crno-belih krava različitih genotipova preko najvažnijih sistematskih uticaja.

Ispitivane krave svojim poreklom pripadaju evropskom tipu crno-belih goveda koje se nalaze u završnoj fazi intenzivnog oplemenjivanja holštajn-frizijskom rasom. Ispitivani uzorak uključio je 331 kravu.

Prosečna starost krava kod izlučenja iznosi 2265±463.26 dana ili 6.21±1.27 godina. Posmatrano po genotipovima krava srednje vrednosti su bile 2140.99 dana (> 73% HF), 2247.51 dana (58-73% HF) i 2406.97 dana (< 58% HF). Prosečna životna proizvodnja ostvarena je na nivou od 25002.66±7755.39 kg mleka sa 3.61±0.01% mlečne masti.

Bikovi-očevi krava, klasa HF gena i godina izlučenja imali su visoko značajan uticaj ($p \leq 0.01$), dok je uticaj razloga izlučenja bio značajan ($p \leq 0.05$) na trajanje života krava.

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