Electronic Journal of Polish Agricultural Universities is the very first Polish scientific journal published exclusively on the Internet, founded on January 1, 1998 by the following agricultural universities and higher schools of agriculture: University of Technology and Agriculture of Bydgoszcz, Agricultural University of Cracow, Agricultural University of Lublin, Agricultural University of Poznan, Higher School of Agriculture and Teacher Training Siedlce, Agricultural University of Szczecin, and Agricultural University of Wroclaw.

ELECTRONIC JOURNAL OF POLISH AGRICULTURAL UNIVERSITIES

2001
Volume 4
Issue 2
Series ANIMAL HUSBANDRY

SAWA A. 2001. EFFECT OF FIRST LACTATION YIELD ON LIFE PERFORMANCE OF COWS **Electronic Journal of Polish Agricultural Universities**, Animal Husbandry, Volume 4, Issue 2.
Available Online http://www.ejpau.media.pl

EFFECT OF FIRST LACTATION YIELD ON LIFE PERFORMANCE OF COWS

Anna Sawa
Department of Cattle Breeding, University of Technology and Agriculture, Bydgoszcz, Poland

ABSTRACT

The studies were carried out on the population of 14215 cows. The first lactation yield, in kg of FCM, significantly differentiated both the yields of subsequent lactations and the indices of life performance of the cows. In high–production herds (with more than 5000 kg FCM), it is justifiable that the requirement should be met for heifer cows to reach the yield that would balance the costs of their rearing (5000–6000 kg of milk), as their high productivity during the first lactation positively influences their life performance, which is important especially from the perspective of the short period of productive life. In other herds, in the case of highly productive heifer cows, the lower the herd production level, the more intensive the following effects should be expected: decrease in the yield of subsequent lactations, lower overall life performance, fertility deterioration, lower number of born calves and shorter productive life.

Key words: productivity of heifer cows, performance traits

INTRODUCTION

The first lactation is considered as a "training" one, as the organism is still developing. The yield of the first lactation becomes important in the face of the falling trend in the productive life of cows, which has been observed for several years [1, 8, 10, 11, 12]. Juszczak *et al*. [5], who analysed the problem of the falling trend in the productive life in the scope of rearing cost compensation, stated that German producers aim at increasing even the first lactation yield in order to reach the level that would correspond to the costs, i.e. about 6000 kg of milk. In the herds with high production level, it is justifiable that the requirement should be met for heifer cows to reach the yield that would balance the costs, whereas in the case of the yields that do not exceed 8000 kg of milk, deterioration of reproductive indices and falling trend in life performance should be expected [5]. The results by Gnyp *et al*. [3] indicate that the yield of heifer cows that exceeded 6000 kg of FCM resulted in significant loss in their further fertility and lower number of calves, and in insignificant decrease of productive life and lower overall production of milk and its components. The studies by Kamieniecki and Stenzel [7], carried out on herds producing about 4000 kg of milk, demonstrated a yield decrease in subsequent lactations of the cows that had exceeded the level of 5000 kg for their first lactation. One should presume that the problem of high first lactation milk yield, in connection with performance traits level (among others lifespan and fertility), will attain more and more importance.

The aim of the present study was to determine the changes in milk yield in successive lactations in relation to the yield level of the first lactation. Bearing in mind that performance traits draw more and more attention, the evaluation of an effect of first lactation yield on life performance of cows was also carried out. The analysis allowed for the fact that the local herd had been improved with the HF breed, and the specificity of management conditions associated with the variability of production levels of the herds was taken into consideration.

MATERIALS AND METHODS

The materials for the study were taken from the SYMLEK system, as well as from the documentation collected by the Regional Animal Breeding Station (OSHZ) in Bydgoszcz. The analysis covered the origin, milk performance, fertility and culling of 14215 cows belonging to the population active in the area of the former provinces: Bydgoszcz, Torun and Włoclawek. The cows included in the study calved for the first time in 1988 (1^{st} lactation ≥ 200 days, heifer cows yield ≥ 2000 kg FCM) and were culled out until the end of 1999. For each cow, the values of the traits that influence life performance were estimated: life FCM yield, lifespan and productive life, number of calvings, number of live–born calves and duration of mean calving interval (CI).

Moreover, in order to evaluate the effect of heifer cows yield on the yield of subsequent lactations (II, III and IV), a group of 3705 cows were selected that completed the fourth lactation and whose lactations were not shorter than 200 days.

In order to characterise the yields in the subsequent lactations and the indices of life performance of the cows, as the effects of first lactation yield x genetic and environmental factors interaction, the analysis of variance was carried out according to the following model:

$$Ykip = \mu + b + lk + gi + p_p + (lp)_{kp} + (lg)_{ki} + e\ kip$$

μ – overall mean,
b – coefficient of regression on the age on the day of first calving,
lk – effect of k–th FCM level during the first lactation (≤ 4000 kg FCM, 4001–5000, 5001–6000, > 6000), k = 1… 4
gi – effect of i–th genetic group (BW, <50% HF, 50% HF, > 50% HF), i = 1… 4,
p_p – effect pf p–th level of herd yield estimated basing on the average yield of cows in the herd in 1988 (≤ 4000 kg FCM, 4001–5000, > 5000), p = 1… 3,
$(lp)_{kp}$ – interaction first lactation FCM yield level x herd yield level,
$(lg)_{ki}$ – interaction first lactation FCM yield level x genetic group,
e kip – random error.

Test F was used to test the significance of the effect of the studied factors on the subsequent lactations yields and life performance traits, and the significance of differences between the means of particular traits within the classification factors was tested with Scheffe test.

RESULTS AND DISCUSSION

The results of the analysis of variance and F test (Table 1) demonstrate that most of the traits are highly significantly influenced by the considered factors and their interactions. It was observed that in the subsequent lactations, the effect of first lactation yield decreased, whereas the effects of herd production level and genotype on FCM yield increased.

Table 1. Results of analysis of variance (F values) for performance indices of cows

Index	Source of variability					
	FCM yield for 1st lactation (I)	herd production (P)	genotype (G)	regression on age on the day of 1st calving	interaction	
					(I × P)	(I × G)
FCM for 1st lactation	1957.3**	29.7**	5.5**	8.0**	5.9**	8.9**
FCM for 2nd lactation	96.7**	86.6**	18.5**	2.3*	1.8*	4.1**
FCM for 3rd lactation	44.6**	113.5**	19.4**	8.0**	2.1	4.3**
FCM for 4th lactation	15.3**	121.6**	24.7**	34.2**	3.7**	2.8**
FCM life yield	111.0**	92.5**	62.9**	41.3**	9.2**	4.3**
Lifespan	19.2**	0.2	29.6**	213.5**	3.4**	1.1
Productive life	19.2**	0.2	29.6**	28.2**	3.4**	1.1
Number of calvings	8.2**	12.1**	36.9**	30.9**	5.1**	0.8**
Number of born calves	10.2**	15.8**	31.5**	35.4**	5.3**	0.8
Mean CI	1095.5**	278.5**	6.4**	3.9*	18.4**	4.0**

*** – significant at p ≤ 0.05, ** – significant at p ≤ 0.01.**

Milk production increases with cow's age. The analyses carried out indicate (confirming the results obtained by Kamieniecki *et al*. [7]) that the rate of yield increase in consecutive lactations is different for the animals of low and high performance (Tables 2 and 3). The cows that attained the 1st and 2nd level of FCM yield in the first lactation reached its peak yield in the third or fourth lactation, whereas the high–production heifer cows (group 3 and 4) had their peak yield during the first lactation. The studies by Hibner *et al*. [4] demonstrated that modern–rearing cows reach their maximum lactation yield in the 3–5th lactation.

It was observed that the cows that attained higher yield during the first lactation were also characterised by better milk yield in the subsequent lactations. Their predominance, however, varied depending on the herd production (Table 2) and genotype (Table 3). The most intensive increase in milk yield (+49% over the first lactation) was observed for the cows that produced up to 4000 kg FCM as heifer cows, and were kept in the herds of the highest production. Within the first two FCM yield groups of the first lactation, it was observed that the superiority in subsequent lactations increased with the herd production level. The cows whose first lactation yield was 5001–6000 kg FCM, or more than 6000 kg FCM, decreased their yield after subsequent calvings (with one exception). The drop of the subsequent lactation yields of high–production cows was the higher, the lower was the herd production level, which demonstrated improper feeding and care during rearing and the first lactation, and is an evidence that environmental conditions were not adjusted for the needs of high–production animals. Lower increase of yield in subsequent lactations may also result from the fact that the cows achieved their genetic potential already during the first period of production. After subsequent calvings, they remained at the high level of yield, especially in the herds of the highest production (better selection, higher qualifications of maintenance personnel and veterinary service, more rational feeding). Unfortunately, even in those herds, the heifer cows that yielded over 6000 kg FCM did not increase their yield in the subsequent lactations. Other authors draw attention to the influence of management conditions on the yield shaping in subsequent lactations [6, 7]. The studies by Dorynk *et al.* [2] demonstrate that with the increase of herd breeding level, a decrease in the percentage lactation yield growth rate in relation to the previous lactation was observed.

Table 2. Least square means (LSM) of FCM yields for consecutive lactations in relation to heifer cows' yields and herd production level

FCM yield for 1st lactation	Herd production (kg FCM)	n	Lactation						
			I	II		III		IV	
			FCM (kg)	FCM (kg)	growth in relation to 1st lactation (%)	FCM (kg)	growth in relation to 1st lactation (%)	FCM (kg)	growth in relation to 1st lactation (%)
≤ 4000	≤ 4000	558	3177 A,a	3761 A,a	+18	4106 A,B	+29	4009 A,B	+26
	4001–5000	580	3420 A	4219 A	+23	4597 A	+34	4512 A,a	+32
	> 5000	77	3511 a	4459 a	+27	5131 B	+46	5243 B,a	+49
4001–5000	≤ 4000	294	4401	4265	–3	4710 A	+7	4487 a,A	+2

	4001–5000	611	4493	4626 a	+3	5055 B	+13	4920 a,b	+10
	> 5000	1266	4596	5233 a	+14	5691 A,B	+24	5389 A,b	+17
5001––6000	≤ 4000	104	5342	4629 A	–13	4769 a,A	–11	4191 A,B	–22
	4001–5000	336	5459	5148 a	–6	5417 a,B	–1	5143 A,C	–6
	> 5000	312	5484	5580 A,a	+2	6013 A,B	+10	5759 B,C	+5
> 6000	≤ 4000	38	6814	5218 A	–23	5171 A	–24	4643 A	–32
	4001–5000	150	6860 A	5845 B	–16	5769 B	–16	5280 B	–23
	> 5000	379	7210 A	6540 A,B	–9	6748 A,B	–6	6263 A,B	–13

A,B,C – within classes of first lactation yields, the values marked with the same letters differ highly significantly at P ≤ 0.01,
a,b,c – within classes of first lactation yields, the values marked with the same letters differ significantly at P ≤ 0.05.

Table 3. Least square means (LSM) of FCM yields for consecutive lactations in relation to heifer cows' yields and genotype

FCM yield for 1st lactation	Genotype	n	Milk yield for lactation						
			I	II		III		IV	
			FCM (kg)	FCM (kg)	growth in relation to 1st lactation (%)	FCM (kg)	growth in relation to 1st lactation (%)	FCM (kg)	growth in relation to 1st lactation (%)
≤ 4000	BW	532	3384	4005	+18	4413	+30	4304	+27
	< 50% HF	388	3435	4050	+18	4479	+30	4324	+26
	50% HF	167	3422	4140	+21	4595	+34	4559	+33
	> 50% HF	27	3302	4545	+38	7899	+48	4876	+48
	UO	101	3306	3993	+21	4671	+41	4876	+47
4001––5000	Cb	472	4501	4603	+2	4928	+9	4540	+1
	< 50% HF	354	4508	4595	+2	4958	+10	4596	+2
	50% HF	224	4485	4814	+7	5316	+19	5074	+13
	> 50% HF	50	4520	4956	+10	5541	+23	5614	+24
	UO	71	4471	4573	+2	5018	+12	4835	+8

5001––6000	BW	257	5448	5033	–8	5283	–7	4777	–12
	< 50% HF	203	5384	5107	–5	5396	0	5032	–7
	50% HF	188	5420	5306	–2	5605	+3	5071	–6
	> 50% HF	70	5407	5550	+3	5752	+6	5467	+1
	UO	34	5483	4599	–16	4960	–10	4807	–12
> 6000	BW	134	6732 A	5639 A	–16	5448 A	–19	5043 A	–25
	< 50% HF	137	6872 B	5763 B	–16	5838 B	–15	5220 B	–24
	50% HF	170	6982 C	5696 C	–18	5782 C	–17	5526 c	–21
	> 50% HF	107	7564 A,B,C,D	7075 A,B,C,D	–6	7151 A,B,C,d	–5	6510 A,B,c,d	–14
	UO	19	6657 D	5167 D	–22	5260 d	–21	4678 d	–30

UO – unknown origin.

Analysing the proportional distribution of cows by the first lactation yield groups (Tables 4 and 5), it may be observed that only 32% of the studied population reached the level of 5000–6000 kg FCM as heifer cows; the level deemed as balancing the cost of rearing [9]. The fact should be considered as unsatisfactory. According to Juszczak *et al.* [5], the cows whose first lactation yield exceeded 5000 kg constituted 60% of the population, however, those studies covered the top herds of the country.

Table 4. Least square means (LSM) of life performance indices in relation to heifer cows' yields and herd production level

FCM yield for 1st lactation	Herd production (kg FCM)	N	Life performance indices					
			life FCM performance (kg)	lifespan (days)	productive life (days)	no. of calvings	no. of born calves	mean CI (days)
≤ 4000	≤ 4000	2791	9742 A,a	1879	1002	3.05	2.91 A	373 A,a
	4001–5000	2355	11629 A	1928	1050	3.28 a	3.17 A	377 A,B
	> 5000	347	12115 a	1864	986	3.16 a	3.03	357 a,B
4001––5000	≤ 4000	1164	13217 A	2045	1168	3.29	3.11	407 A,B
	4001–5000	2137	14271	2022	1145	3.39	3.32	383 A,C
	> 5000	906	15498 A	1988	1110	3.37	3.30	369 B,C
5001––6000	≤ 4000	398	13891 A	2045	1168	3.17	3.05	430 A,B
	4001–5000	1167	15664 B	2058	1181	3.34	3.26	405 A,C

	> 5000	940	18379 A,B	2095	1218	3.57	3.49	386 B,C
> 6000	≤ 4000	191	15536 A	2069	1191	2.87	2.71	494 A,B
	4001–5000	671	16491 B	2025	1148	2.91 A	2.81 A	468 A,c
	> 5000	1148	21032 A,B	2126	1249	3.39 A	3.31 A	431 B,c

Table 5. Least square means (LSM) of life performance indices in relation to heifer cows' yields and genotype

FCM yield for 1st lactation	Genotype	N	Life performance indices					
			life FCM performance (kg)	lifespan (days)	productive life (days)	no. of calvings	no. of born calves	mean CI (days)
≤ 4000	BW	2527	10247 A	1832	955 A	3.01 A	2.90 a	366
	< 50% HF	1610	10902	1878	1001	3.14	3.02	365
	50% HF	518	12874 A,B	2034 A	1157A,B	3.55 A	3.42 a	366
	> 50% HF	88	12324	1963	1086	3.38	3.17	366
	UO	750	9629 B	1744 A	866 B	2.72	2.65	361
4001––5000	BW	1826	13027 A	1951	1073	3.17	3.09	387
	< 50% HF	1243	13904	2000	1123	3.32	3.23	382
	50% HF	636	15701 A,B	2114	1237	3.59	3.49	387
	> 50% HF	133	16982 a	2154	1277	3.78 a	3.68	385
	UO	369	12030 B,a	1873	995	2.90 a	2.86	391
5001––6000	BW	967	14740 a	2007	1129	3.16	3.07	412
	< 50% HF	709	15710	2062	1185	3.34	3.25	406
	50% HF	514	17233	2139	1262	3.58	3.46	402
	> 50% HF	152	19068 a,b	2227	1349	3.86	3.78	400
	UO	163	13140 b	1897	1019	2.86	2.78	414
> 6000	BW	597	15208 A	1978 a	1100 a	2.80 a	2.72	472
	< 50% HF	505	16735 B	2045	1167	3.02	2.89	455
	50% HF	547	17859 C	2083	1206	3.14	3.04	454
	> 50% HF	268	24116A,B,C,D	2270 a	1393 a	3.60 a	3.43	456
	UO	93	14514 D	1991	1114	2.71	2.63	484

UO – unknown origin.

The evaluation of changes in FCM yield for subsequent lactations in relation to the first lactation yield and the genotype led to conclusion that the heifer cows reaching up to 4000 kg FCM had the higher subsequent lactations yields, the higher HF gene share was in their genotype. Maximum yield (by 30–48% higher than in the first lactation) the cows attained at the third lactation, except for the cows of unknown origin. The cows that produced 4001–500 kg FCM as heifer increased their subsequent lactations yield to much lesser extent than their age mates of lower milk yield. The growth of yield in the third lactation, which was the peak for most of the cows, ranged between 9% for BW group and 19% for the F_1 generation. The cows with more than 50% of HF genes increased their yield until the fourth lactation, reaching 24% excess over the first lactation. Among the cows between 5001–6000 kg of FCM first lactation yield, only the group with more than 50% of HF genes increased the yield until the third lactation (growth by 6%). The cows that produced more than 6000 kg FCM as heifers the more reduced their subsequent lactations yields, the less HF genes were in their genotype. Dorynek and Kaczmarek [2] observed that BW x HF crossbreds were characterised by higher growth of milk yield in subsequent lactations.

The FCM yields in the first lactations significantly differentiated life performance indices of the cows, and at the same time, the performance shaped differently in the herds of different overall production levels (Table 4). A significant increase in life FCM yield was observed along with the increase of heifer cows' yield and the overall production of the herd (ranging between 9742 and 21032 kg FCM). Moreover, the cows that were qualified to the group 1 or 2 of first lactation yield demonstrated a trend to have shorter productive life as the overall herd production increased, whereas the tendency was reverse for the other cows. Basing on the present studies, the fertility performance should be considered good for those cows whose yield after the first calving did not exceed 4000 kg FCM (CI about 370 days). The fertility of the cows producing 5001–6000 kg FCM, especially of those with more than 6000 kg of yield, was low (CI 386–494 days). The negative impact of high milk productivity on the fertility performance was confirmed by moderate correlation (r = 0.34**, Table 6). For the remaining, lower yield levels, the coefficient of correlation was about 0.12**. The estimated LSM values demonstrate an improvement of fertility performance (represented as CI length) along with the herd production increase (Table 4). The evaluation of reproductive performance, as a number of born calves, demonstrated (like in the studies by Juszczak *et al*. [5]) its reduction with the increase in first lactation yield, especially if the level of 5000 kg FCM was exceeded, which resulted from the elongation of calving intervals. The cows of the 1st and 2nd classes of FCM first lactation yields produced the highest number of calves if they were kept in the herds of middle production level. In the case of the cows of the 3rd and 4th classes, the number of calvings grew with the increase in the herd production, which would demonstrate very good conditions of maintenance and care in the herds. The analysis allows concluding that the first lactation yield level, optimal from the point of view of the management efficiency, changes depending on the herd production level, which is used as a measure of maintenance conditions quality.

In addition, the first lactation yield x genotype interaction significantly differentiated the life performances of the cows. Among the cows that had not exceeded 4000 kg FCM for the first lactation, the F_1 generation achieved the best life performance (12874 kg FCM, 2034 days of life, 3.42 calves, 366 CI days). Among the remaining cows, regardless their first lactation yield, a trend of increased life FCM yield was observed, longer lifespan and productive life and increased number of calves, along with the advanced improvement with the HF breed. The cows with more than 50% of HF genes, which produced more than 6000 kg FCM for the first lactation, lived the longest (2277 days), produced the most milk (24116 kg FCM) and gave birth to the highest number of calves (3.04).

The relationship between the first lactation FCM yield and life FCM performance was described with the coefficient of correlation, which for the general population of the cows was 0.35** (Table 6). The dependence, considered for the cows divided into first lactation yield groups, indicates that predictions of the cow's life performance basing on its first lactation are not always precise. Kamieniecki *et al*. [6] also observed a trend of decrease in the mentioned relationships with the increase in the first lactation yield. Juszczak *et al*. [5], studying the high–production cow performance indices, concluded that the first lactation yield did not differentiate the life performance of cows, which was 22500–24900 kg FCM.

Another step, important for life performance evaluation, is an analysis of culling factors (Table 7). The cows that achieved the highest first lactation yields were less often sold or culled because of low milk performance, whereas they were more often eliminated due to infertility of casual aCIdents. Gnyp *et al*. [3] demonstrated that the culling rate caused by infertility or udder disorders increased with the level of the first lactation yields.

Table 6. Coefficients of correlation between first lactation FCM yield and selected life performance indices of cows

FCM yield for 1st lactation	Life performance indices of cows				
	life FCM performance (kg)	lifespan (days)	productive life (days)	no. of calvings	mean CI
Total	0.35**	0.13**	0.13**	0.05**	0.45**
4000	0.25**	0.15**	0.15**	0.13**	0.13**
4001–5000	0.10**	0.04**	0.04**	0.03	0.11**
5001–6000	0.05**	0.01	0.01	–0.00	0.12**
> 6000	0.16**	0.01	0.02	–0.06	0.34**

Table 7. Proportion of sold or culled cows in relation to FCM yield for the first lactation

Reason of culling	FCM yield for the first lactation							
	≤ 4000		4001–5000		5001–6000		> 6000	
	n	%	n	%	n	%	n	%
Sale	1050	19.1	693	16.5	383	15.3	213	10.6
Low performance	1000	18.2	661	15.7	374	14.9	241	12.0
Udder disorders	246	4.5	187	4.4	99	4.0	93	4.6
Infertility	1631	29.7	1379	32.8	812	32.4	725	36.1
Infectious diseases	29	0.5	19	0.5	10	0.4	13	0.6
Age	27	0.5	35	0.8	24	0.9	15	0.7
Leukaemia	300	5.5	270	6.4	140	5.6	101	5.0
Casual accidents	1210	22.0	963	22.9	663	26.5	609	30.4

CONCLUSIONS

In the evaluation of the first lactation yield, it is advisable to allow for production level of the cow's herd. In the herds of high production (more than 5000 kg FCM), it is justifiable that the requirement should be met for heifer cows to reach the yield jthat would balance the costs of their rearing (5000–6000 kg of milk), as their high yield for the first lactation positively influences their life performance, which is important especially from the perspective of cow's short life span. In other herds, in the case of highly productive heifer cows, the lower the productivity level of the herds, the more intensive following effects should be expected: decrease in the yield of subsequent lactations, lower overall life performance, fertility deterioration, lower number of born calves and shorter life production period.

REFERENCES

1. Detkens S., 1972, Lifespan and reasons of BW cows and heifers culling from the POZH herds, Pr. Mater. Zootech. 1, 53, 53–68 [in Polish].
2. Dorynek Z., Kaczmarek A., 1988, Performance of cows of various genotypes in relation to maintenance conditions, Rocz. Akad. Rol. Pozn. Zootech. 35, 13–22 [in Polish].
3. Gnyp J., Malyska T., Kamieniecki K., Kowalski P., 1999, Influence of heifer BW cows milk yield on their milk performance, fertility and productive life in subsequent lactations, Zesz. Nauk. PTZ 44, 117–124 [in Polish].
4. Hibner A., Zachwieja A., Zieminski R., 1995, Milk performance and the level of some traits in the BW cattle population transformed into dairy type, Prz. Hod. 10, 5–8 [in Polish].
5. Juszczak J., Hibner A., Zachwieja A., Tomaszewski A., Krzyskow S., 1994, The problem of high milk yields, Prz. Hod. 4, 3–5 [in Polish].
6. Kamieniecki K., Zalewski W., Stenzel R., Gnyp. J., 1988, Milk yield of cows in different lactations in relation to the yield level for the first lactation, Acta Acad. Agric. Tech. Olst. Zootech. I, 185–189 [in Polish].
7. Kamieniecki K., Stenzel R., 1992, Influence of production level of cows in the first lactation on their subsequent performance, Ann. Univ. Curie–Skłodowska Sect. EE, 10 (8), 41–44 [in Polish].
8. Litwinczuk Z., Borkowska D., Oberda A., 1984, Observations on the duration of milk productive life and culling reasons in breeding herds, Med. Wet. 2, 122–125 [in Polish].
9. Okularczyk S., 2001, Milk quality and market factors in milk production profitability, Zesz. Nauk. PTZ 55, 113–121.
10. Pawlina E., Nowicki B., Hibner A., Kruszynski W., 1997, Productive life and performance trait merits of BW cows, Zesz. Nauk. Akad. Rol. Wroc. 307, 105–113 [in Polish].
11. Postler G., 1999, Basics in ecological cattle breeding exemplified with ecological overall breeding value, Prz. Hod. 1, 5–8 [in Polish].
12. Sawa A., 1998, Genetic and environmental factors of cows performance in the particular periods of life, Zesz. Nauk. Akad. Tech. Rol. Bydg. Rozpr. 88, 1–69 [in Polish].

Submited:

Anna Sawa
Department of Cattle Breeding
University of Technology and Agriculture
Mazowiecka 28, 85–084 Bydgoszcz, Poland
Tel. (+4871) 348-41-42
e–mail: sawa@atr.bydgoszcz.pl