POLISH JOURNAL OF NATURAL SCIENCES
Abbrev.: Pol. J. Natur. Sc., Vol 25(2): 132–142, Y. 2010

DOI 10.2478/v10020-010-0011-0

THE EFFECT OF HERD SIZE ON THE YIELD AND PROXIMATE COMPOSITION OF MILK IN ACTIVE CATTLE POPULATIONS IN THE REGION OF WARMIA AND MAZURY (NE POLAND)*

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Key words: cows, herds size, milk yield, milk composition, fat, protein, inter-calving interval.

Abstract

The milk yield of 24 934 cows from herds monitored by the National Animal Breeding Center, Branch in Olsztyn, was analyzed. The data were collected in the years 1997–2006. The cows were divided into three groups, based on herd size: group I of up to 20 cows, group II of 21–50 cows and group III of more than 50 cows. Additional criteria for the above division were the number of successive 305-day lactations and full lactations as well as the length of inter-calving intervals. The objective of this study was to determine the effect of herd size on the yield and proximate composition of milk in active cattle populations in farms in north-eastern Poland over a ten-year period, taking into account lactations of normal length and full lactations, inter-calving interval (ICI) duration and lifetime cow productivity. The average yield over 305-day lactations was 6579 kg milk (6723 kg FCM), 273 kg fat (4.15%), 213 kg protein (3.24%), 309 kg lactose (4.70%) and 841 kg dry matter (12.78%). Cows in the largest herds (>50 head) were characterized by the highest productivity, and cows in the smallest herds (≤20 head) – by the lowest. The latter produced milk with the highest fat content (4.16%) and the lowest protein content (3.21%). In herds comprising more than 50 animals, cows with the longest ICI (>525 days) were marked by the highest milk production in full lactations (11 010 kg). As regards lifetime productivity, the highest values were noted in cows used for 3.44 years in the smallest herds (19 809 kg milk). In the largest herds cows were used for the shortest period of time (3.31 years), and their lifetime productivity reached 17 185 kg milk.

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* This work was supported by the Ministry of Scientific Research and Information Technology within the framework of grant no. N31105631/0237, funds allocated to research projects in the years 2006–2009.

WYDAJNOŚĆ I PODSTAWOWY SKŁAD MLEKA KRÓW POPULACJI AKTYWNEJ Z REGIONU WARMIŃSKO-MAZURSKIEGO W ZALEŻNOŚCI OD WIELKOŚCI STADA

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S ł o w a k l u c z o w e: krowy, wielkość stada, wydajność i skład mleka, tłuszcz, białko, okresy międzywycieleniowe.

A b s t r a k t

Do analizy posłużyły wyniki oceny użytkowości mlecznej 24 934 krów pochodzących ze stad kontrolowanych przez KCHZ oddział w Olsztynie w latach 1997–2006. Materiał badawczy podzielono na 3 grupy, uwzględniając wielkość stad: w I grupie (gr. I) było do 20 krów, w II (gr. II): 21–50, w III (gr. III) – ponad 50 krów. Dodatkowymi kryteriami podziału były: kolejne 305-dniowe i pełne laktacje oraz długość okresów międzywycieleniowych. Celem pracy była analiza wpływu wielkości stada na wydajność i podstawowy skład mleka populacji aktywnej krów utrzymywanych w gospodarstwach północno-wschodniej Polski w okresie dziesięciolecia, z uwzględnieniem laktacji standardowych i pełnych, długości okresów międzywycieleniowych (OMW) i wydajności życiowej krów. W badaniach wykazano, że przeciętna wydajność krów w laktacjach 305-dniowych wynosiła: 6579 kg mleka (6723 kg mleka FCM), 273 kg tłuszczu (4,15%), 213 kg białka (3,24%), 309 kg laktozy (4,70%) i 841 kg suchej masy (12,78%). Największa produkcyjność charakteryzowała krowy użytkowane w stadach najliczniejszych (>50 szt.), a najmniejsza była u zwierząt ze stad najmniej licznych (≤ 20 szt.), dających mleko o największej zawartości tłuszczu (4,16%), ale najmniejszej zawartości białka (3,21%). W stadach o liczebności ponad 50 sztuk krowy o najdłuższym OMW (>525 dni) osiągały największą produkcję mleka za laktacje pełne (11 010 kg). Pod względem wydajności życiowej najbardziej efektywne były krowy użytkowane przez 3,44 lata w stadach najmniejszych (19 809 kg mleka). W stadach największych krowy użytkowane były najkrócej (3,31 lat), a ich życiowa wydajność wyniosła 17 185 kg mleka.

Introduction

Poland's accession to the European Union and the current economic conditions resulted in significant changes in farm structure. According to the data supplied by the *Rocznik statystyczny rolnictwa...* (2008), the total number of agricultural farms decreased by 354 000 (12%), compared with the results of a census of farms carried out five years earlier. The highest drop, at 21%, was noted in the group of farms covering an area of up to 1 ha, while the number of the largest farms, covering an area of 50 ha or more, increased by 7.6%. Changes in cattle herd size were followed by an increase in average milk yield per cow. As a result, commercial milk production is today higher than consumption. Therefore, creating new export opportunities for dairy products outside the EU internal market is an important consideration (OSTOJA-SOLECKI 2002).

Farm fragmentation remains a characteristic feature of Polish agriculture. In 2008, the average size of an individual farm was 10.02 ha (*Ocena i hodowla...* 2009), and over 85% barns housed less than ten cows.

Fragmentation affects also the process of milk cooling and collection from farms (JURCZAK 1999). The development of the dairy sector is dependent upon the presence of large-scale specialized dairy production farms raising cattle with a high proportion of HF genes. Such a trend can be also observed in highly developed countries. In the USA, Holstein-Friesian cattle herds are raised mostly in north- and south-eastern regions (OLEGGINI et al. 2001, ELY et al. 2003). The global HF cattle population continues to increase, and milk yield and composition continue to improve (MELENDEZ, PINEDO 2006), primarily because cows are kept in large herds, are fed well-balanced diets based on concentrated feed and supplemented with protein, minerals and vitamins.

The objective of this study was to determine the effect of herd size on the yield and proximate composition of milk in active cattle populations in farms in north-eastern Poland over a ten-year period (1997–2006), taking into account lactations of normal length and full lactations, inter-calving interval (ICI) duration and lifetime cow productivity.

Materials and Methods

The milk yield of 24 934 cows from herds monitored by the National Animal Breeding Center, Branch in Olsztyn, was analyzed. The data were collected in the years 1997–2006. The yield of milk, milk fat, milk protein, lactose and dry matter, and the content of milk fat, milk protein, lactose and dry matter were determined for each cow. The actual amount of produced milk was converted into the amount of fat-corrected milk (FCM) and energy-corrected milk (ECM), according to the following formula (ARBEL et al. 2001):

$$\text{FCM [kg]} = 0.4 \cdot \text{milk [kg]} + 15 \cdot \text{fat [kg]}.$$

$$\text{ECM (kg)} = \frac{\text{milk [kg]} \cdot (0.383 \cdot \text{fat (\%)} + 0.242 \cdot \text{protein (\%)} + 0.7832)}{3.14}$$

The cows were divided into three groups, based on herd size: group I of up to 20 cows, group II of 21–50 cows and group III of more than 50 cows. Additional criteria for the above division were the number of successive 305-day lactations and full lactations as well as the length of inter-calving intervals. The effect of herd size on lifetime cow productivity was also determined.

The results were processed statistically using Statistica 7.1 software. Least squares means (LSM) and standard errors (Se) were calculated for the analyzed parameters. The significance of differences between means was estimated by Duncan's test.

Results and Discussion

Table 1 presents milk yield and composition in 305-day lactations of cows in herds of different size. Average milk yield in the analyzed herds was 6579 kg (6723 kg FCM). The produced milk contained 4.15% fat, 3.24% protein, 4.70% lactose and 12.78% dry matter. Compared with the statistical data collected by the Polish Federation of Cattle Breeders and Dairy Farmers in the Province of Warmia and Mazury in 2008 (*Ocena i hodowla...* 2009), the above milk yield values are similar, while milk fat and protein content values are lower.

Table 1

The effect of herd size on milk yield in 305-day lactations

Parameter	Statistical measure	Groups of cows			
		group I ≤ 20	group II 20.1–50	group III > 50	Mean
Number of cows	N	15959	4054	4921	24934
Milk (kg)	LSM	6105^{A}	6389^{B}	7242^{C}	6579
	Se	6.453	15.502	18.382	13.443
FCM (kg)	LSM	6252^{A}	6514^{B}	7405^{C}	6723
	Se	7.881	18.943	21.273	16.032
ECM (kg)	LSM	6131^{A}	6412^{B}	7297^{C}	6614
	Se	7.881	18.943	21.273	16.032
Protein-to-fat ratio	LSM	0.772^{A}	0.787^{B}	0.788^{B}	0.782
	Se	0.0005	0.0010	0.0012	0.0009
Fat (kg)	LSM	254^{A}	264^{A}	301^{B}	273
	Se	0.314	0.738	0.745	0.559
Protein (kg)	LSM	196^{A}	208^{B}	237^{C}	213
	Se	0.220	0.531	0.634	0.462
Lactose (kg)	LSM	298^{A}	302^{B}	337^{C}	309
	Se	0.803	1.898	2.100	1.601
Dry matter (kg)	LSM	781^{A}	816^{B}	926^{C}	841
	Se	2.173	5.088	5.256	4.172
Fat (%)	LSM	4.16^{a}	4.13^{b}	4.15^{a}	4.15
	Se	0.002	0.005	0.006	0.004
Protein (%)	LSM	3.21^{a}	3.25^{a}	3.27^{b}	3.24
	Se	0.001	0.002	0.002	0.002
Lactose (%)	LSM	4.83^{a}	4.75^{a}	4.66^{b}	4.73
	Se	0.002	0.004	0.003	0.003
Dry matter (%)	LSM	12.80	12.77	12.78	12.78
	Se	0.009	0.018	0.017	0.015

$A, B, C - p \leq 0.01$; $a, b, c - p \leq 0.05$

Cows in the largest herds (>50 head) were characterized by the highest productivity, manifested in milk yield per cow of 7242 kg in 305-day lactation and the highest protein-to-fat ratio. The lowest values of the above parameters were noted in the smallest herds. The differences between the groups were validated by a statistical analysis ($p \leq 0.01$).

BOJARSZCZUK and KSIĘŻAK (2008) studied diary farms in the Province of Lublin and found that an increase in herd size was followed by an improvement in productivity. Milk yield in the smallest herds (less than 20 head) was by approximately 64% lower than in the largest herds (above 41 head). The cited authors pointed to significant difference in milk production levels between the smallest-scale and largest-scale cattle farms. OLEGGINI et al. (2001), who studied Holstein-Friesian cattle herds in the eastern part of the USA (the Dairy Belt), demonstrated that there were no statistically significant differences in milk yield between herds of 20–49 head and herds of 50–99 head. A significant difference ($p \leq 0.05$) of 1515.63 kg was noted between the smallest and the largest herds (more than 450 head). Similar trends were observed with respect to the yield of milk fat and milk protein – the differences between the smallest and the largest herds were statistically significant ($p \leq 0.05$) and reached 63.27 kg and 54.70 kg respectively.

As regards milk composition, cows in the smallest herds produced milk with the highest fat content (4.16%) and the lowest protein content (3.21%). The values recorded by the Polish Federation of Cattle Breeders and Dairy Farmers in the Province of Warmia and Mazury in 2008 (*Ocena i hodowla...* 2009) were higher, at 4.22% fat and 3.33% protein.

BRZOZOWSKI (1999) reported that cows in the smallest herds produced milk with a higher content of fat and protein, while according to LITWIŃCZUK et al. (1994) herd size had no significant effect on the chemical composition of milk in individual farms in the Province of Lublin. In a study by OLEGGINI et al. (2001), the protein-to-fat ratio in milk was not affected by herd size, but it was substantially higher (0.883) than in the present experiment.

The average lactose content of milk was lowest in the largest herds (4.66%) and highest (4.83%) in the smallest herds. In a study by STANEK et al. (2004), the average lactose content of milk in herds comprising around 30 cows was 4.76%, and it was comparable with the value noted in our study in herds of 21–50 cows (4.75%).

Table 2 shows the effect of herd size on milk yield and composition in successive 305-day lactations. In every lactation, cows in the smallest herds (≤20 head) were characterized by the lowest productivity. Milk production levels increased in consecutive lactations, ranging from 5363 kg in the first lactation to 6869 kg in the fourth and subsequent lactations. Similar values were noted in herds of 21–50 cows, where milk yield ranged from 5935 kg to 7352 kg. Such a tendency was not observed in the largest herds (>50 head). In this group, primiparous cows were marked by the

Table 2

The effect of herd size on milk yield and composition in lactations of normal length

Parameter	Statistical measure	1st lactation			2nd lactation			3rd lactation			4th lactation and subsequent lactations		
		Groups of cows											
		group I ≤ 20	group II 21–50	group III > 50	group I ≤ 20	group II 21–50	group III > 50	group I ≤ 20	group II 21–50	group III > 50	group I ≤ 20	group II 21–50	group III > 50
Number of cows	N	15860	4171	4903	12276	2805	2995	7357	1439	1088	6097	1058	596
Milk (kg)	LSM	5653^{A}	5935^{B}	6706^{C}	6333^{D}	6768^{C}	7882^{E}	6693^{C}	7179^{F}	7430^{G}	6869^{C}	7352^{F}	7711^{E}
	Se	995.52	1124.95	1523.97	1284.57	1448.42	1994.82	1387.71	1625.5	1670.58	1423.73	1727.43	1782.8
FCM (kg)	LSM	5729A	5988B	6746C	6523D	6870C	7894E	6834C	7308F	7575F	7096C	7606F	7873E
	Se	895.50	1223.90	1728.07	1386.52	1848.32	2094.12	1285.21	1329.54	1276.50	1482.74	1925.42	1684.81
ECM (kg)	LSM	5611^{A}	5915^{B}	6662^{C}	6420^{D}	6799^{E}	7808^{F}	6700^{F}	7219^{G}	7457^{H}	6959^{E}	7486^{H}	7731^{F}
	Se	1033.72	1141.11	1469.84	1325.73	1510.05	1864.74	1446.72	1703.23	1712.01	1470.8	1819.98	1733.12
Fat (kg)	LSM	231^{a}	241^{b}	271^{c}	266^{c}	277^{c}	320^{d}	277^{c}	296^{d}	307^{d}	290^{d}	311^{d}	319^{d}
	Se	48.42	51.27	61.57	61.75	69.28	76.51	68.41	77.18	78.56	69.35	83.85	76.07
Protein (kg)	LSM	179^{a}	194^{b}	219^{c}	207^{c}	224^{c}	258^{d}	214^{c}	236^{d}	241^{d}	222^{c}	241^{d}	248^{d}
	Se	34.32	39.22	53.85	43.21	49.5	68.25	46.27	55.17	56.6	47.5	58.77	57.9
Lactose (kg)	LSM	267^{a}	273^{a}	328^{b}	304^{c}	321^{b}	364^{d}	326^{b}	341^{d}	349^{d}	330^{b}	347^{d}	361^{d}
	Se	54.6	57.72	66.09	64.48	72.63	94.03	68.12	78.01	77.01	70.22	76.24	86.57
Dry matter (kg)	LSM	717^{a}	750^{b}	864^{c}	821^{d}	869^{c}	1003^{e}	861^{c}	922^{c}	950^{c}	886^{c}	942^{c}	988^{c}
	Se	144.15	149.24	170.27	169.96	190.73	230.27	184.3	210.99	215.63	189.84	206.67	225.55
Fat (%)	LSM	4.09^{a}	4.06^{a}	4.04^{a}	4.20^{b}	4.10^{b}	4.06^{a}	4.14^{b}	4.12^{b}	4.13^{b}	4.22^{b}	4.23^{b}	4.14^{a}
	Se	0.46	0.48	0.56	0.49	0.52	0.58	0.5	0.48	0.54	0.49	0.47	0.522
Protein (%)	LSM	3.17^{a}	3.27^{b}	3.26^{b}	3.27^{b}	3.31^{b}	3.27^{b}	3.20^{a}	3.29^{b}	3.25^{b}	3.23^{b}	3.28^{b}	3.32^{c}
	Se	0.21	0.21	0.23	0.23	0.24	0.23	0.23	0.23	0.25	0.22	0.23	0.249
Lactose (%)	LSM	4.72^{a}	4.76^{a}	4.69^{b}	4.80^{b}	4.75^{a}	4.62^{a}	4.83^{b}	4.75^{a}	4.65^{a}	4.80^{b}	4.75^{a}	4.68^{a}
	Se	0.14	0.12	0.12	0.017	0.14	0.14	0.15	0.014	0.16	0.017	0.15	0.145
Dry matter (%)	LSM	12.68^{a}	12.63^{a}	12.89^{b}	12.97^{c}	12.84^{b}	12.72^{a}	12.87^{b}	12.84^{b}	12.78^{b}	12.90^{b}	12.81^{b}	12.81^{b}
	Se	0.66	0.65	0.75	0.75	0.73	0.78	0.71	0.74	0.86	0.72	0.66	0.723

$A\ldots - p \leq 0.01$; $a\ldots - p \leq 0.05$

lowest productivity (6706 kg milk), the highest milk production levels were noted in cows in their second lactation (7882 kg), followed by a drop in milk yield in subsequent lactations. An increase in the yield of milk and milk components from the first to third lactation was also reported by KAMIENIECKI et al. 2001a, MICIŃSKI (2009) and MICIŃSKI et al. (2009).

The above differences became more pronounced when the amount of produced milk was converted to FCM. When the percentage concentrations of fat and protein were taken into account and the amount of produced milk was converted to ECM, statistically significant differences were noted between the largest herds and the remaining groups. The investigated cattle populations were characterized by average concentrations of milk components. Herd size had no influence on the fat content of milk, which exceeded 4% in all groups. The lowest fat concentrations were recorded in primiparous cows (4.04–4.09%) and the highest – in the oldest cows (4.14–4.23%). Smaller differences were noted in the protein content of milk, which ranged from 3.2% to 3.3%. KUCZAJ (2002) studied the effect of breed and lactation on selected performance traits of dairy cows and reported a similar protein content of milk and a higher fat content (over 4.3%). Higher milk production levels in older cows, in comparison with primiparas, were also reported by GULIŃSKI and MŁYNEK (2003).

Cows in their second lactation, kept in the largest herds (>50 head), were characterized by the highest yield of milk, fat, protein, lactose and dry matter. The lowest values of the above parameters were noted in primiparous cows kept in the smallest herds (≤ 20 head). The observed differences were statistically significant ($p \leq 0.01$).

Table 3 illustrates the effect of herd size and inter-calving interval (ICI) duration on milk yield and composition in full lactations. Prolonged ICI resulted in an increase in milk yield in all groups. This is consistent with the findings of BERTILSSON et al. (1997) who observed the highest milk production levels in cows with the longest ICI, and the lowest – in cows with the shortest ICI.

In the present study, the highest milk yield was recorded in the largest herds (> 50 head). Differences between those herds and smaller ones were statistically significant ($p \leq 0.01$). A rise in milk production per cow along with an increase in herd size was also reported by ALLORE et al. (1997, SMITH et al. (2000), KUCZAJ and BLICHARSKI (2005).

The highest milk yield was observed in cows with the longest ICI (over 525 days), kept in the largest herds (> 50 head). The production results of cows in this group were as follows: 11 010 kg milk, 11 225 kg FCM, 11 008 kg ECM, 455 kg fat, 352 kg protein, 517 kg lactose and 1402 kg dry matter. The above results differ significantly ($p \leq 0.01$) from the average values noted in the remaining groups. GULIŃSKI et al. (1996) also found that herd size considerably affected the correlation between ICI length and FCM yield. An increase in herd size, productivity and the age of animals caused a rise in milk yield related to extended ICI.

Table 3

The effect of herd size and inter-calving interval (ICI) duration on milk yield and composition in full lactations

Parameter		ICI < 365 days			ICI 405–445 days			ICI > 525 days		
		Groups of cows								
		group I (≤ 20)	group II (21–50)	group III (> 50)	group I (≤ 20)	group II (21–50)	group III (> 50)	group I (≤ 20)	group II (21–50)	group III (> 50)
Milk (kg)	LSM	6446^{A}	6668^{B}	7452^{C}	7283^{D}	7501^{C}	8531^{E}	9493^{F}	10182^{G}	11010^{H}
	Se	1045.18	1207.59	1563.03	1433.72	1569.13	2032.8	2366.29	2765.96	3084.72
FCM (kg)	LSM	6630A	6778A	7631B	7425C	7659D	8672E	9821F	10503G	11225H
	Se	1083.05	1254.12	1473.07	1483.57	1605.48	1931.46	2499.08	2818.07	3056.13
ECM (kg)	LSM	6492^{A}	6650^{A}	7489^{B}	7338^{C}	7549^{D}	8528^{E}	9614^{F}	10342^{G}	11008^{H}
	Se	1083.05	1254.12	1473.07	1483.57	1605.48	1931.46	2499.08	2818.07	3056.13
Fat (kg)	LSM	270^{A}	274^{A}	310^{B}	301^{B}	311^{B}	351^{C}	402^{D}	429^{E}	455^{F}
	Se	51.18	57.76	60.81	68.58	70.3	78.48	111.57	119.83	121.88
Protein (kg)	LSM	206^{A}	213^{A}	240^{B}	240^{B}	245^{B}	276^{C}	305^{D}	334^{E}	352^{E}
	Se	36.8	41.56	54.87	50.55	54.56	70.88	87.75	98.07	111.09
Lactose (kg)	LSM	304^{A}	307^{A}	364^{B}	350^{B}	356^{B}	394^{C}	462^{D}	484^{E}	517^{F}
	Se	330.78	352.28	421.87	465.1	393.17	472.44	409.3	444.35	490.16
Dry matter (kg)	LSM	831^{A}	848^{A}	952^{B}	942^{B}	961^{B}	1095^{C}	1228^{D}	1312^{E}	1402^{F}
	Se	191.67	215.19	239.67	245.73	274.52	329.68	272.47	304.92	237.37
Fat (%)	LSM	4.19^{a}	4.11^{b}	4.16^{c}	4.13^{b}	4.14^{b}	4.11^{b}	4.23^{d}	4.21^{d}	4.13^{b}
	Se	0.37	0.39	0.48	0.39	0.4	0.45	0.42	0.4	0.48
Protein (%)	LSM	3.20^{a}	3.20^{a}	3.22^{a}	3.30^{b}	3.27^{b}	3.23^{a}	3.21^{a}	3.28^{b}	3.20^{a}
	Se	0.19	0.20	0.21	0.2	0.19	0.2	0.22	0.2	0.21
Lactose (%)	LSM	4.72^{a}	4.75^{a}	4.89^{b}	4.80^{b}	4.75^{a}	4.62^{a}	4.87^{b}	4.75^{b}	4.70^{a}
	Se	0.14	0.12	0.12	0.02	0.14	0.14	0.15	0.01	0.16
Dry matter (%)	LSM	12.89	12.71^{a}	12.78^{a}	12.93^{b}	12.81^{a}	12.84^{a}	12.94^{b}	12.89^{b}	12.73^{a}
	Se	0.73	0.71	0.76	0.73	0.63	0.76	0.71	0.68	0.86

$A, B - p \leq 0.01$; $a, b - p \leq 0.05$

The relationship between herd size and milk yield, as dependent on the number of days from calving to effective insemination, was also investigated by DOMECQ et al. (1997). The cited authors demonstrated that in large herds characterized by high milk production the effectiveness of the first insemination was comparable in primiparous and multiparous cows (47% and 46% respectively), but a tendency towards extended inter-pregnancy intervals was observed in large herds.

The productivity of high-yielding cows was also studied by SAWA et al. (2004) who reported that milk yield related to ICI duration ranged from 9 941 kg to 11 552 kg. According to the above authors, even if the rest period is limited to 60 days, it is impossible to maintain 12-month ICI in cows producing more than 10 000 kg milk over lactation because insemination effectiveness in such cows is considerably reduced, which extends ICI. In a study by STRZAŁKOWSKA et al. (2004), milk yield in 305-day lactation ranged from 8963 kg in cows with 378-day ICI to 9376 kg in cows with 397-day ICI. ICI longer than 411 days resulted in a drop in milk production to 8855 kg.

The effect of herd size on selected performance parameters of cows is presented in Table 4. The largest herds (> 50 head) were characterized by the highest milk production per cow in all lactations (Table 2) and by the lowest lifetime productivity of cows, at 17 185 kg milk. This resulted from

Table 4

The effect of herd size on selected performance parameters of cows

Parameter	Statistical measure	Groups of cows			
		group I ≤ 20	group II 21–50	group III > 50	Mean
Number of lactations	LSM	2.67^{A}	2.62^{A}	2.55^{B}	2.61
	Se	0.092	0.093	0.092	0.092
Herdlife (years)	LSM	3.44^{A}	3.45^{A}	3.31^{B}	3.40
	Se	37.49	37.73	37.50	37.57
Lifespan (years)	LSM	5.67^{A}	5.66^{A}	5.59^{B}	5.64
	Se	37.70	37.93	37.70	37.78
Milk (kg)	LSM	19809^{A}	19023^{B}	17185^{C}	18672
	Se	120.50	240.09	191.90	184.16
FCM (kg)	LSM	20434^{A}	19624^{B}	17539^{C}	19199
	Se	141.81	285.48	227.47	218.25
Milk yield (kg) per day of cows' life	LSM	9.56^{Aa}	9.20^{ab}	8.41^{Ab}	9.06
	Se	0.22	0.22	0.22	0.22
Milk yield (kg) per day of cows' productive life	LSM	15.75^{AB}	15.13^{AC}	14.20^{BC}	15.02
	Se	0.30	0.31	0.30	0.30
Protein-to-fat ratio	LSM	0.771^{A}	0.794^{B}	0.793^{B}	0.786
	Se	0.012	0.012	0.012	0.012

$A, B, C - p \leq 0.01$; $a, b, c - p \leq 0.05$

the shortest productive life of cows and the lowest number of lactations (2.55). The highest lifetime productivity, reaching 19 809 kg milk and 20 434 kg FCM, was noted in the smallest herds.

KAMIENIECKI et al. (2001b) analyzed the effect of milking method and herd size on the performance parameters of dairy cattle and found that cows kept in the smallest herds had the longest average productive life. SAWA and BOGUCKI (2002) observed an increase in daily milk yield and a decrease in milk quality along with an increase in herd size. In their study, cows in herds comprising 10.1–20.0 head showed the lowest productivity, while the highest milk yield was reported for cows in the largest herds (100.1–200.0 head), and the noted differences were statistically significant.

Conclusions

The results of this study, which investigated the effect of herd size on milk yield in active cattle populations kept in farms in the region of Warmia and Mazury in the years 1997–2006, show that:

1. The average yield over 305-day lactations was 6579 kg milk (6723 kg FCM), 273 kg fat (4.15%), 213 kg protein (3.24%), 309 kg lactose (4.70%) and 841 kg dry matter (12.78%).

2. Cows in the largest herds (>50 head) were characterized by the highest productivity, and cows in the smallest herds (≤ 20 head) – by the lowest. The latter produced milk with the highest fat content (4.16%) and the lowest protein content (3.21%).

3. In herds comprising more than 50 animals, cows with the longest ICI (>525 days) were marked by the highest milk production in full lactations (11 010 kg).

4. As regards lifetime productivity, the highest values were noted in cows used for 3.44 years in the smallest herds (19 809 kg milk). In the largest herds cows were used for the shortest period of time (3.31 years), and their lifetime productivity reached 17 185 kg milk.

Translated by Aleksandra Poprawska Accepted for print 23.02.2010

References

ALLORE H.G., OLTENACU P.A., ERB H.N. 1997. *Effects of season, herd size, and geographic region on the composition and quality of milk in the northeast*. Journal Dairy Science, 80: 3040–3049.

ARBEL R., BIGUN Y., EZRA E., SZTURMAN H., HOJMAN D. 2001. *The effect of extended calving intervals in high lactating cows on milk production and profitability*. Journal of Dairy Science, 84: 600–608.

BERTILSSON J., BERGLUND B., RATNAYAKE G., SVENNERSTEN-SJAUNJA K., WIKTORSSON H. 1997. Optimising lactation cycles for the high-yielding dairy cow. A European perspective. Livestock Production Science, 50: 5–13.

Bojarszczuk J., Księżak J. 2008. *Wydajność mleczna krów w zależności od wielkości stada w wybranych rejonach woj. Lubelskiego.* Roczniki Naukowe Stowarzyszenia Ekonomistów Rolnictwa i Agrobiznesu, t. XI(1): 28–32.

Brzozowski P., Ludwiczuk K., Zdziarski K. 1999. *Liczba komórek somatycznych w mleku krów objętych oceną użytkowości mlecznej w Polsce Centralnej*. Zeszyty Naukowe Przeglądu Hodowlanego, 44: 83–89.

Domecq J.J., Skidmore A.L., Lloyd J.W., Kaneene J.B. 1997. *Relationship between body condition scores and conception at first artificial insemination in large dairy herd of high yielding Holstein cows*. Journal Dairy Science, 80: 113–120.

Ely L.O., Smith J.W., Oleggini G.H. 2003. *Regional production differences*. Journal Dairy Sciences (suppl.): E28–E34.

Guliński P., Litwińczuk Z., Młynek K. 1996. *Wpływ wybranych czynników genetycznych i środowiskowych na związek pomiędzy długością okresu międzywycieleniowego a użytkowością mleczną krów*. Roczniki Naukowe Zootechniki, t. 23(4): 9–19.

Guliński P., Młynek K. 2003. *Próba określenia czynników warunkujących produkcję mleka w przebiegu laktacji u krów*. Zeszyty Naukowe Przeglądu Hodowlanego, 68(1): 263–272.

Jurczak M. 1999. *Informacje ogólne o mleczarstwie. Mleko produkcja, badanie, przerób*. Wydawnictwo SGGW, Warszawa.

Kamieniecki H., Czerniawska-Piątkowska E., Sablik P., Wójcik. 2001a. *Badania nad produkcyjnością mleczną i rozrodczą w stadzie krów holsztyńsko-fryzyjskich importowanych z Niemiec jako jałowice cielne*. Zeszyty Naukowe Przeglądu Hodowlanego PTZ, 59: 145–151.

Kamieniecki K., Tietze M., Gnyp J., Pypeć M. 2001b. *Jakość mleka w zależności od metody doju i liczby krów w gospodarstwach sektora drobnotowarowego*. Zeszyty Naukowe PTZ, Warszawa, 59, 159–164.

Kuczaj M. 2002. *Wpływ rasy i laktacji krów mlecznych na wybrane cechy mleka*. Med. Wet., 58(8) 628–631.

Kuczaj M., Blicharski P. 2005. *Porównanie wydajności mlecznej krów rasy czarno- i czerwono-białej utrzymywanych w tych samych warunkach środowiskowych*. Med. Wet., 61(3): 293–296.

Litwińczuk A., Zamielska I., Gnyp. J., Tietze M. 1994. *Jakość mleka dostarczonego do punktu skupu z gospodarstw indywidualnych z uwzględnieniem liczby utrzymywanych krów*. Zeszyty Naukowe Przeglądu Hodowlanego, 14: 175–181.

Melendez P., Pinedo P. 2006. *The association between reproductive performance and milk yield in Chilean Holstein cattle*. Journal of Dairy Science, 90: 184–192.

Miciński J. 2009. *Cechy mleczności i wskaźniki reprodukcji wysoko wydajnych krów w standardowym oraz przedłużonym cyklu produkcyjnym*. Rozprawy i monografie. Wydawnictwo UWM w Olsztynie.

Miciński J., Pogorzelska J., Barański W., Kalicka B. 2009. *Effect of disease incidence on the milk performance of high-yielding cows in successive lactations*. Pol. J. Natur. Sci., 24(2): 102–112.

Ocena i hodowla bydła mlecznego. Dane za rok 2008. Polska Federacja Hodowców Bydła i Producentów Mleka, Warszawa.

Oleggini G.H., Ely L.O., Smith J.W. 2001. *Effect of region and herd size on dairy herd performance parameters*. Journal of Dairy Science, 84: 1044–1050.

Ostoja-Solecki J. 2002. *Szacunek możliwości produkcji mleka odpowiadającego unijnym wymogom jakościowym na podstawie liczebności stada i struktury chowu krów w Polsce.* Biuletyn Informacyjny IZ, r. XL. (2): 53–59.

Rocznik statystyczny rolnictwa i obszarów wiejskich. 2008. Główny Urząd Statystyczny, Warszawa.

Sawa A., Bogucki M. 2002. *Genetyczne i środowiskowe uwarunkowania wydajności dobowej i jakości mleka*. Acta Sci. Pol., ser. Zootechnika, 1(1–2): 129–138.

Sawa A., Jankowska M., Ziemiński M., Krężel S. 2004. *Okres spoczynku rozrodczego a efektywność użytkowania krów wysoko wydajnych*. Zeszyty Naukowe Przeglądu Hodowlanego, 72(1): 121–128.

Smith J.W., Ely L.O., Chapa A.M. 2000. *Effect of region, herd size, and milk production on reasons cows leave the herd*. Journal of Dairy Science, 83: 2980–2987.

Stanek P., Litwińczuk Z., Teter U., Jankowski P. 2004. *Skład chemiczny i jakość cytologiczna mleka krów czarno-białych utrzymywanych w gospodarstwach farmerskich Lubelszczyzny, z uwzględnieniem pory roku i ich dziennej produkcyjności*. Zeszyty Naukowe Przeglądu Hodowlanego, 72(1): 153–159.

Strzałkowska N., Krzyżewski J., Reklewski Z., Dymnicki E. 2004. *Zależność między wymuszonym wydłużeniem okresu międzyciążowego a wybranymi wskaźnikami reprodukcji i skorygowaną wydajnością mleczną krów*. Med. Wet., 60(12): 1312–1316.