Comparison of calf rearing results and nursing cow performance in various beef breeds managed under the same conditions in north-western Poland

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ABSTRACT: We compared the results of calf maternal nursing and cow performance in 5 beef breeds managed under equal conditions in the region of West Pomerania. The study involved 549 cows and 1 979 calves (1 007 heifers and 972 bulls) of the following breeds: Red Angus, Salers, Hereford, Limousin, and Simmental. The cows and their calves were managed outdoors for one year. Feeding and management systems were the same for all the breeds during the studied period. The calves remained with their mothers until 6 to 9 months of age. Under intensive feeding, we recorded very good calf rearing parameters with very good or good milk performance of the cows. The best results were achieved by the Simmental cows and calves. Both the heifers and calf-bulls of this breed exhibited significantly ($P \leq 0.01$) higher weaning weights adjusted to 210 days of age as well as daily gains from birth to weaning. The weaning weights of the calves were higher from 37 to 93 kg and daily gains from 45 to 280 g. The Hereford cows and calves also achieved very good parameters. Relatively poorer in terms of production performance were Red Angus, as compared with the other breeds, and Limousin cows whose calves produced the lowest body weights and had the lowest daily gains as well.

Keywords: beef cattle; breeds; maternal nursing; body weight; gains

Beef production in Poland is mostly based on breeds that are used in dairy or dual-purpose production. The farming of typically beef cattle breeds did not really start until the beginning of the 1990s, when the "Programme of Beef Cattle Production Development for Poland" was enforced, which involved state financial aid offered to producers in the form of subsidies or low-interest loans. Such a situation at that time resulted in increased import of purebred breeding heifers, most often from European countries (France, Denmark, Germany, Czech Republic etc.) and, to a lesser extent, from the USA and Canada. First, small lots of bulls were imported for commercial crossing with dairy cows at the beginning of the 1970s. The breeders that currently wish to maintain the high breeding value of imported animals and their progeny systematically purchase the semen of the best polled bulls in leading beef-producing countries.

It is a rule in beef-cattle management that cows are used for reproduction and calf nursing only, usually for 6–7 months after calving. The number and weights of calves weaned at the end of the grazing season represent a measure of the beef cow performance (Stenzel et al., 2001). The bull-calves can be grown and finished for beef, while heifers can be used for the reproduction of own breeding stock.

Under Poland's climate it is possible to pasture cattle for nearly half a year. This is however possible only with correctly established calving dates, with their optimum period being from January to the beginning of April. In the rural areas of West Pomerania, which remain under a moderate climate and have lots of grasslands, the optimum management system of cattle consists in all-year outdoor housing with heavy pasture utilization, also during winters, and with the use of inexpensive bulky feeds (such as hay, haylage or grass silage). Such management conditions have been observed to guarantee very good performance in terms of reproduction, calf rearing, weight gains, and health of the animals (Wójcik et al., 2000; Pilarczyk and Wójcik, 2003).

The main factor affecting beef cattle farming and, in consequence, the key factor leading to increased production of high-quality beef, is to develop the stock of nurse cows – the source of both selection material and meat on the hoof; the bulls obtained from such herds could be used for commercial or displacement crossing with dairy, beef breeds or their crossbreds (Litwińczuk et al., 2002).

Identifying superior breeds would be simple if adequate life-cycle performance data were available on large representative samples of the breed of potential interest. It would be necessary to make comparisons of cattle breeds raised under the same conditions and preferably over a range of conditions in order to evaluate the possibility of genotype × environment interactions. Unfortunately, such ideal comparisons require a large input of financial resources (Jakubec et al., 2003).

Poland lacks comprehensive studies over a range of breeds and their calf rearing performance. Such studies that include usability for crossing with domestic cattle have already been carried out in some countries of Central and Eastern Europe (Czech Republic, Slovakia, Hungary), where intensive development of beef cattle production also started at the beginning of the 1990s (Říha et al., 2001; Voříšková et al., 2002; Jakubec et al., 2003; Přibyl et al., 2003; Krupa et al., 2005; Dákay et al., 2006).

Considering those aspects, this study was aimed at comparing the performance of five breeds of cows over the period of 6–7 years after their import, including the rearing of their calves, managed intensively under the same conditions in north-western Poland.

MATERIAL AND METHODS

The analyses included cows of five beef breeds: Red Angus (pregnant heifers imported from Canada in December 1995), Salers (pregnant heifers imported from Canada in December 1995), Hereford (pregnant and non-pregnant heifers imported from Denmark in January 1997), Limousin (pregnant and yearling heifers imported from France in January 1997), and Simmental (pregnant heifers imported from the Czech Republic in December 1996), managed on a commercial farm (Agrofirma "Witkowo") in north-western Poland.

The analysed breeds remained in separate herds, except for Red Angus and Salers, which where kept together. The management system of the farm consisted in the year-round outdoor housing of animals with heavy use of pastures and maternal nursing of calves until 6–9 months of age. Both feeding and management of the cows and their calves was equal for all the breeds.

The applied system of farming and breeding was based on an assumption that cows should calve during winter or early spring, hence oestrus was synchronised in the cows and heifers in the first days of April. Insemination took place from April to July. The semen of the best bulls was used to inseminate all breeding cows that showed normal heat symptoms. Red Angus, Hereford, and Simmental cows were sired by polled bulls from Canada and USA, Salers by Canadian bulls, while Limousin cows were inseminated using the semen of polled bulls from Canada, USA, and France. From June to mid-July, bulls were included in the herds in order to service the cows yet not in calf. Calving took place from December to the end of April in the following year, under wooden shelters surrounded by bales of straw from three sides. The age composition of the cows was similar in all the analysed herds, calves were from calving 1 to 7. The distributions of births during winter and early spring were very similar in all the herds, with a majority of calves born in winter and early spring (from January to April).

After calving the cows with their calves were grouped in enclosures with a shed against snow and rain. The cows were fed haylage and mineral supplement; feeding took place outdoors, where deep wooden mongers and waterers had been placed. The calves were allowed to take the concentrate and crushed oats from the moment of grouping, and they also ate hay fed to the cows. From May to the end of October, the cows remained with their calves on pastures during the day, returning freely to enclosures for the night. Calf feeding was based on maternal milk, pasture, and concentrates. From November to calving, the cows

Table 1. Number (*n*) of animals included in the study

Breed	Cows	Calves	
		heifers	bulls
Red Angus	144	266	216
Salers	57	116	96
Hereford	70	113	102
Limousin	105	200	212
Simmental	173	312	346
Total	549	1 007	972

Table 2. Cow performance parameters

Breed	Estimated milk yield of cows (kg)		Cow's body weight at calf weaning (kg)		Production efficiency index (%)	
	mean	SD	mean	SD	mean	SD
Red Angus (1)	1 921.5	278.4	614.1	63.2	44.0	8.7
Salers (2)	2 096.8	366.7	628.3	78.4	44.9	9.9
Hereford (3)	2 121.1	324.0	628.1	72.7	46.6	9.0
Limousin (4)	1 983.4	204.6	634.1	65.9	43.2	9.5
Simmental (5)	2 318.0	316.1	627.1	49.9	55.6	10.9
Multiple range test	5:1,2,3,4**, 2,3:1,4**				5:1,2,3,4**, 3:1,4**, 3:2*	

*P ≤ 0.05; **P ≤ 0.01

remained in enclosures without sheds, except for wind shelters built of bales of straw. The animals daily visited neighbouring oilseed rape and ryegrass fields. Their diet was supplemented with hay, straw, silage made of conditioned green forage with addition of mineral feed; salt licks were also provided.

The study involved 549 cows and 1 979 calves, including 1 007 heifers and 972 bull-calves. The distribution of cows and calves by breed is presented in Table 1.

The cows' performance parameters as well as the results of calf rearing were analysed for the period from 1997 (arrival to Poland) to 2002. Based on the herd records, personal communication, and own weighing of the cows and calves, we calculated estimated milk yield of mother cows, calf mortality rate, and the production efficiency index. We also determined the body weights of mother cows at the moment of calf weaning. The estimated milk yield of mother cows (MYC) and production efficiency index (E_{prod}) were calculated according to the following formulas (Journal of Saws, 1999):

$$MYC = \frac{WW \times 1\,700}{A_W}$$

$$E_{prod} = \frac{WW}{BWC_W} \times 100$$

where:
WW = calf weaning weight
A_W = calf age at weaning
BWC_W = cow body weight at calf weaning

The cows were weighed after each calf weaning, whereas the calves were weighed at birth and at weaning. Weaning weights adjusted to 210 days of age (210-day weights, W_{210}) as well as daily gains between birth and weaning (DG) were calculated to compare calf rearing results between the analysed breeds. The following formulas were applied:

$$W_{210} = \frac{WW - BW}{A_W} \times (210 - A_W) + WW$$

$$DG = \frac{WW - BW}{A_W} \times 1\,000$$

where:
BW = calf weight at birth
WW = calf weight at weaning
A_W = calf age at weaning

The resulting data were processed statistically using the Statistica PL software package. Means and standard deviations were calculated. Significance of differences was tested using one-way ANOVA and Duncan's multiple range test.

RESULTS

Cow performance parameters are presented in Table 2. The highest milk yield was recorded in the Simmental cows (2 318 kg), and it was significantly ($P \leq 0.01$) higher than that achieved by the remaining breeds. Moreover, Salers and Hereford cows produced significantly ($P \leq 0.01$) higher milk yield compared with Red Angus and Limousin cows.

The cows of all the breeds had similar body weights at calf weaning. Analysing the production efficiency index, it was the highest in the group of Simmental cows (55.6%), which was significantly ($P \leq 0.01$) higher than those in the other four breeds. We also observed that this index was significantly higher in Hereford cows (46.6%), as compared with the index values in the Limousin (43.2%), Red Angus (44%), and Salers (44.9%) breed. The percentage of calving difficulties ranged from

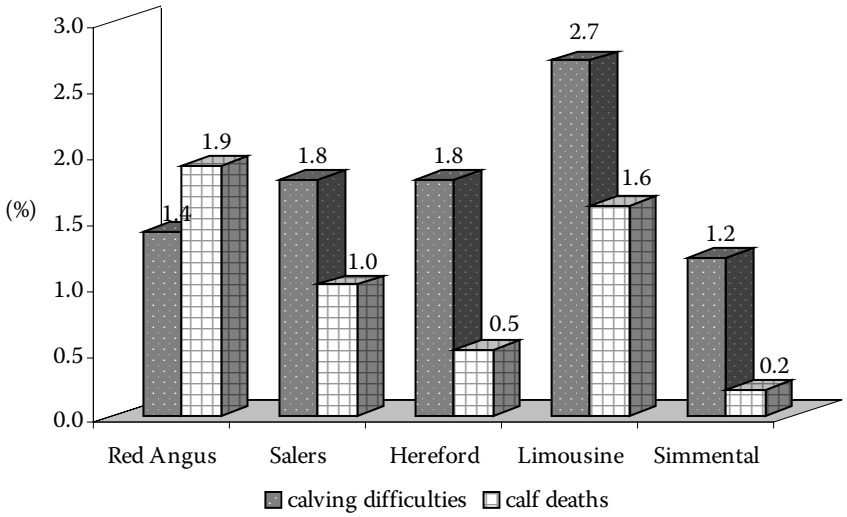

Figure 1. Percentage of calving difficulties and deaths of calves

1.2 in Simmental to 2.7 in Limousin cows, whereas the mortality of calves during maternal nursing ranged between 0.2 for Simmental and 1.9 for Red Angus. The data on calving difficulties and calf mortality are presented in Figure 1.

Mean body weights and daily gains from birth to weaning are given for heifers and bull-calves in Table 3. The highest mean birth weights were achieved by Hereford and Simmental and were significantly ($P \leq 0.01$) higher than for the calves of the remaining breeds. The lowest body weight was found in the Red Angus heifers and bull-calves.

The analysis of heifer rearing showed that the highest weaning weights, 210-day weights and birth-to-weaning daily gains were attained by the Simmental heifers. The differences proved significant ($P \leq 0.01$). The lowest body weights and daily gains were found in Limousin and Red Angus heifers, being also significantly ($P \leq 0.01$) lower compared with those recorded for Salers and

Table 3. Body weights and daily gains of heifers and bull-calves

Breed	Birth weight (kg)		Weaning weight (kg)		Daily gains from birth to weaning (g)		Weight at 210 days (kg)	
	mean	SD	mean	SD	mean	SD	mean	SD
Heifers								
Red Angus (1)	30.0	2.5	274.9	48.2	992	156	238.4	32.9
Salers (2)	30.7	2.7	287.0	39.5	1 088	190	260.5	44.9
Hereford (3)	34.8	5.2	280.9	38.9	1 040	147	253.1	30.8
Limousin (4)	31.2	3.9	273.9	45.2	984	97	237.9	20.3
Simmental (5)	34.4	2.9	324.3	56.3	1 142	152	274.3	32.7
Multiple range test	3,5:1,2,4**, 4:1**		5:1,2,3,4**, 2:1,4*		5:1,2,3,4**, 3:1,2,4**, 2:1,4**		5:1,2,3,4**, 3:1,4**, 2:1,4**	
Bulls								
Red Angus (1)	30.7	2.4	264.3	47.1	1 011	150	243.0	32.0
Salers (2)	31.8	2.8	272.1	45.2	1 107	218	264.3	45.8
Hereford (3)	35.8	5.9	296.2	49.2	1 147	180	276.6	37.0
Limousin (4)	33.5	5.0	271.1	44.0	1 061	104	256.2	22.7
Simmental (5)	35.4	2.6	357.2	72.7	1 291	174	306.5	36.8
Multiple range test	3,5:1,2,4**, 4:1,2**, 1:2**		5:1,2,3,4**, 3:1,2,4**		5:1,2,3,4**, 3:1,4**, 2:1**, 2:3,4*, 4:1**		5:1,2,3,4**, 3:1,2,4**, 2:1**, 2:4*, 4:1**	

*$P \leq 0.05$; **$P \leq 0.01$

Hereford heifers. Salers heifers achieved significantly ($P \leq 0.01$) higher daily gains than Hereford heifers.

Similar relationships were found as a result of bull-calf rearing analysis. The highest weaning weights, 210-day weights and birth-to-weaning daily gains were achieved by Simmental bull-calves, with significant differences ($P \leq 0.01$). The lowest 210-day weights and daily gains were observed for the Red Angus and Limousin bull-calves, and they were significantly lower than those for Hereford and Salers; the results attained by Red Angus bull-calves were also significantly lower than those for Limousin bull-calves. Hereford bull-calves achieved very good results with significantly ($P \leq 0.01$) higher weaning body weights compared with Red Angus, Salers, and Limousin bull-calves.

DISCUSSION

Under intensive feeding, the cows of the analysed breeds showed variable milk yields with similar body weights at calf weaning; this resulted in different results of rearing and production efficiency between the herds. Milk yield remains one of the most important factors of calf body weight at weaning, which has a consequence for the farm profitability. Clutter and Nielsen (1987) as well as Minick et al. (2001) observed that the milk production of cows was responsible for 60% of the calf's daily gains and that high-yielding cows nursed calves that were heavier at weaning. Higher feeding intensity results in higher milk yields; hence the cows in our studies were characterised by higher milk yields compared with the results reported by other Polish authors. According to Litwińczuk and Król (2002), the average milk yield of Simmental cows was 2 125.3 kg, that of Limousin 1 965.4 kg, whereas definitely the lowest milk yields were recorded in Hereford cows, 1 700.8 kg. Moreover, the milk of the Simmental cows was characterised by a higher level of dry matter and fat. In the studies by Stenzel et al. (2001), Hereford cows also exhibited the lowest milk yield, 1 288.6 kg, with Angus and Limousin cows producing more milk, 1 555.6 kg and 1 893.6 kg, respectively. Our studies revealed that Simmental cows had the highest milk yield, followed by Hereford and Salers. Numerous studies have shown that Simmental cows are characterised by the highest milk yield, whereas Hereford cows reach definitely poorer results (Fiss and Wilton, 1992; Gregory et al., 1992). The results reported by Minick et al. (2001) as well as by Jenkins and Ferrell (1992) imply that Hereford cows produce lower milk yield compared with Angus; this was not however confirmed in our studies.

The body weight of a cow has a significant effect on the birth weight of its calf as well as on the weight of a calf at 120 and 210 days of age. Przysucha et al. (2002a) reported that the cows with the lowest body weights (less than 500 kg) gave birth to calves by 6.3 kg lighter than the cows with the highest body weight. The calves delivered by cows of the largest weight were also characterised by higher daily gains. Our analyses also revealed that the weights of the cows of the studied breeds were very even, which implies also equalisation of this trait. Similar values of body weights of cows were reported by Piasecki et al. (2000) as well as by Pogorzelska and Szarek (2002). The index of production efficiency represents the ratio of calf's weaning weight to cow's body weight at calf's weaning. With similar body weights of cows, the value of this index is mostly determined by calf's weaning weight. The best parameters in terms of this index were found for the Simmental cows, followed by Hereford and Salers, which means that the calves of those cows had higher weaning weights. This index is considered "good" if ranging from 40 to 44.9%; when it ranges between 45 and 49.4%, it is referred to as "very good", while more than 50% is "excellent".

The calves of the studied breeds exhibited low birth weights (30.0–34.8 kg heifers and 30.7–35.8 kg bulls), hence the small proportion of calving difficulties (up to 2.7%). This may however have additionally resulted from the housing system, which allows the cows a lot of movement. Studies carried out on Polish herds show that calving difficulties, depending on the breed and management system, may reach up to 8% of parturitions (2–4% most frequently), while the mortality rate may range from 6% up to 14% under very extensive conditions (Piasecki et al., 2000; Litwińczuk et al., 2001; Stenzel et al., 2001). According to Bennett and Gregory (2001), low birth weights of calves are associated with a reduced number of calving difficulties and the necessity for human assistance at labour decreases. The calves of larger-size breeds are also larger at birth, which poses a higher risk of both difficulties during parturition and lower survival rate of the calves and, thus, higher mortality (Roughsedge et al., 2001). Calving difficulty needs to be reduced

in beef cattle because it greatly affects the animal welfare and profitability of herds via increased labour and veterinary costs, calf mortality, and time to rebreeding of the cow. Reductions are necessary mainly in breeds with the highest incidence of calving difficulty, such as Charolais and Simmental breeds (Phocas and Laloe, 2003).

The opinion about considerable variations between the breeds in terms of calving ease did not find a confirmation in our studies, which reflects great changes in selection efficiency for this trait that have taken place over the recent years in the world. Núñez-Dominguez et al. (1993) reported that during the period 1970–1984 in the USA the selection within the large-body-size cattle breeds (Simmental, Charolais) focused on reducing the birth weight, which finally resulted in a reduced incidence of calving difficulties – without a decrease in either the weight at weaning or 365-day weight. Similar birth weights of calves were reported by Roughsedge et al. (2001). In those studies, carried out in the USA, the birth weights were as follows: 30.7 kg for Angus, 30.5 kg for Hereford, 31.7 kg for Limousin, 33.2 kg for Salers, and 37.2 kg for Simmental. Earlier studies by Lamb et al. (1993), Núñez-Dominguez et al. (1993), as well as Notter and Cundiff (1991) revealed higher birth weights for the same breeds. Simmental calves were also heaviest, with their weights ranging form 36.2 to 39.4 kg. According to the results reported from the Czech Republic (Jakubec et al., 2003) Hereford calves had the lowest birth weights (24.03 kg), Angus (29.22 kg) and Limousin calves (29.19 kg) had similar weights at birth, whilst Simmental had slightly lower weight (28.29 kg). Slovak studies (Krupa et al., 2005) reported the highest birth weights for Blonde d'Aquitaine, Charolais, and Simmental calves, followed by Aberdeen Angus (from 40.57 to 36.31 kg, respectively), and the lowest for Limousin and Hereford (28.84 and 29.33 kg, respectively).

Our analysis of the maternal performance of calf rearing under intensive feeding revealed considerable differences between the breeds in growth rate. Intensive feeding resulted in the weights higher than those recorded in other herds in Poland. Beef cattle management in Poland is, however, mostly of extensive character, with no concentrates fed, with heavy pasture utilisation and bulky feeds, and with hardly any cost involved in the housing or husbandry. Depending on the housing system, mean 210-d weights of heifers and bull-calves for Limousin, Hereford, Salers, and Angus range, according to various authors, between 170 and 250 kg, with the respective daily gains ranging from 647 to 1 006 g (Goszczyński and Witkiewicz, 1995; Litwińczuk et al., 2001; Pogorzelska and Szarek, 2002). Scarce comparative analyses of the results for calves of the 2 or 3 most popular breeds, mostly Limousin, Hereford, and Angus, reveal that under semi-intensive and extensive feeding the best weaning weights, 210-day weights and daily gains were achieved by Limousin heifers and bull-calves, closely followed by Angus calves; Hereford calves attained the poorest performance (Litwińczuk et al., 2001, 2002).

Apart from our studies (Wójcik et al. 2000; Pilarczyk and Wójcik, 2003) reports on Simmental cattle maternal nursing are missing in Polish cattle literature since this particular breed is not as common as Limousin, Charolais, Hereford or Angus, despite the fact that the breed achieves very good performance. In this study, the Simmental calves were outstandingly better than the calves of the other breeds. The weaning weights and daily gains of Simmental bull-calves were higher by 61 to 93 kg and 144 to 280 g, respectively, while in heifers these values were from 37 to 50 kg and 54 to 158 g. This has been confirmed by other authors. Notter and Mahrt (1991) found that Simmental calves were heaviest at weaning and at 365 days of age. According to Núñez-Dominguez et al. (1993), Simmental and Salers calves were characterised by the highest weights at 200 days, while the results of Angus and Limousin calves were poorer. Simmental calves reached the highest body weights at the analysed age also in the studies by Notter and Cundiff (1991) and Lamb et al. (1993). Studies carried out in some years later confirmed that the Simmental breed of cattle, besides Charolais and Blonde d'Aquitaine, attained the highest body weights along with the best growth rate (Jakubec et al., 2003; Přibyl et al., 2003; Krupa et al., 2005). According to Jakubec et al. (2003), who studied the eight most common beef breeds in the Czech Republic, Hereford calves reached the lowest 210-day weights and daily gains whereas Charolais, Simmental, and Blonde d'Aquitaine calves attained the best results; Aberdeen Angus calves also exhibited good results. Přibyl et al. (2003), who analysed differences between 14 breeds in the Czech Republic, observed the highest body weights in Charolais and Simmental reached at 120, 210, and 365 days of age. Also in Slovakia, Krupa et al. (2005)

found that Simmental calves reached the highest weaning weight and daily gains, while Hereford and Limousin calves exhibited the worst values of these parameters.

It should be stressed that the analyses carried out in Poland show very good performance of Hereford calves. This is particularly clear if we compare the results against those reported by other authors that were mentioned earlier. This breed is mostly managed in an extensive way since it is considered very resistant to adverse conditions. The studies have confirmed that Hereford cattle are also excellent for an intensive feeding system. Very good performance of this breed may also be a result of extensive selection carried out worldwide for many years. The farm we studied imports the semen of the best polled bulls from the USA and Canada, thus maintaining the high breeding value of previously imported animals. According to Notter and Cundiff (1991), EPD estimations carried out in 1970 and 1984 in the USA revealed the most rapid progress for birth weights, weaning weights, and 365-day weights achieved by Hereford and Angus cattle. Other breeds also proved positive effects, not so significant, however. On the other hand, for Simmental cattle a reduction in calving difficulties has been achieved through reduced calf body weights at birth, with positive trends maintained when it comes to weaning weight and 365-day weights. Sullivan et al. (1999) concluded that Hereford cattle body weights increased during 1985–1995, which currently results in a higher 365-day weight compared to Limousin calves; it has been anticipated that Angus cattle may reach superiority over Charolais or Simmental cattle in terms of 356-day body weights until the year 2017.

Simmental calves were characterised by the best rearing results compared with the remaining breeds, which had resulted mostly from a better milk performance of their mothers. Calf rearing performance is mostly determined by the milk yield of nursing cows as well as by their body weight (McMorris and Wilton, 1986; Arango et al., 2002). This linear relationship between the milk yield of cows and the rearing performance of calves has been proposed by many authors (Clutter and Nielsen, 1987; Litwińczuk et al., 2002; Przysucha et al., 2002b). The growth and development of calves are practically determined by the amount of maternal milk available; it is also true that the larger the cow, the heavier her calf at 210 days of age.

To recapitulate, one must agree that the all-year outdoors management of beef cows and their calves accompanied by intensive feeding has brought good results in terms of calf rearing. The Simmental cows and calves achieved unquestionably best results; the cows produced the highest milk yield while the heifers and bull-calves had significantly higher weaning weights, 210-day weights, and daily gains until weaning, as compared with the remaining breeds. As a result, the production efficiency index was excellent in the herd of this breed. It should also be stressed that the Hereford cows and calves also achieved very good results of production performance. Relatively poorer production parameters were attained by the Limousin and Red Angus cows, whose calves had the poorest body weights and daily gains. The analysed herds achieved good and very good production efficiency parameters, which allows farming all the studied breeds under similar conditions. However, Simmental is the most promising breed of beef cattle, followed by Hereford and Salers. Systematic insemination with the semen of high quality polled bulls from the USA and Canada will presumably allow the breeder to maintain the positive trends observed in the Polish developing beef production.

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