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EFFECT OF COW GENOTYPE BY SNPS *L127V/GH*, *F279Y*, *A257G/GHR* AND BIRTH DATE ON CALF GROWTH PERFORMANCE OF ABERDEEN-ANGUS

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Summary. Our study was aimed to evaluate effect of genetic and non-genetic factors and their combination on calf growth rate in Aberdeen-Angus cattle. There were 52 cows genotyped by SNPs *L127V*, *F279Y*, *A257G* of growth hormone and growth hormone receptor genes. Calves (n = 430) were assessed with average daily gain during milk period (ADG, g/day) and were weighted at birth, at weaning (210 days), 8, 12, 15, and 18 months. SNP genotyping of cows included *L127V*, *F279Y*, *A257G* of GH and GHR genes. The data were analyzed using a multiple regression model and ANOVA. There were strong differences between bulls and heifers for all parameters being at least 1.5–2 kg at birth or 5–8%, 7–10 kg at weaning or 4–6%, 6–11 kg at 8 month or 3–6%, 12–18 (45) kg at 1 year or 4–6% (13%), 15–50 kg at 15 month or 5–16% and 30–80 kg at 18 month or 8–18. The highest birth weight at autumn season for both bulls and heifers and ADG was higher for summer-born calves due to better forage regimen of dams. The calving effect was observed for birth weight slightly decrease from first to later calving presenting difference at least 5–6% for 2nd and 3rd calving then 8–12% — for 4th to last calving for both sexes. The effect of parity stay to be evident for bulls of all ages, the difference between calves slightly decreased. Female calves were significantly affected by calving interval, where longer calving intervals produced heavier newborns and weaners, at least 3 and 30 g/day of CI, accordingly. When evaluating the reproductive and productive performance of breeding cows we should consider effect of season, date of previous calving and actual weaning weight of previous calves either.

Keywords: Aberdeen-Angus breed, SNPs, *GH L127V*, *GHR F279Y*, *GHR A257G*, season effect, parity number, calving interval

Introduction. Issues of calf growth, development and safety during the milking period are relevant problems in zootechnical practice. Within one breed, they mostly depend on sex of calf, feeding regimen (weaning or nursing), season of birth, mentor cow diet and naturally genetic background (Gangnat et al., 2017; Rege and Moyo, 1993). To these factors, some authors add mother age (Ahunu and Makarechian, 1987) or parity number (Bayou et al., 2015) and calving interval (MacGregor and Casey, 2000).

In dairy cattle, long stay of calves with their mothers influences their growth positively, but it may depress the milk production of mothers (Kišac et al., 2011). Age at weaning of beef cattle is traditionally 210 days but may vary from 90 to 270 days (Goyache et al., 2003).

In beef cattle different genotypes by one SNP can be associated with benefits for opposite breeding purposes — livestock breeding or production (Fedota et al., 2017). Therefore, effect of well-studied SNPs associated with production traits on reproductive traits or calf parameters may become vagarious. SNPs *L127V* of growth hormone (GH) gene, *F279Y* and *A257G* of growth hormone receptor (GHR) gene affect both milk and growth parameters due to effect of growth hormone that regulates metabolic reactions via interaction with its receptor. In beef calves, milk parameters can be indirectly assessed via growth rate and average daily gain. Controversial effect on meat productive/reproductive traits can be illustrated with benefits of *CC* genotype by SNP *L127V* to the calving interval, birth weight but pitfalls to increased risk of dystocia/stillbirth and decreased quality of milk, as well as in dairy or beef-dairy populations this genotype is rare (Fedota et al., 2016). The frequency of *CC*-genotype in most Aberdeen-Angus herds does not exceed 30–35%, which supports traditional using this breed in crossbreeding to reduce likelihood of dystocia.

Therefore, **the objectives of this study** were to estimate calf growth in Aberdeen-Angus cattle breed and evaluate effect of genetic (SNPs *L127V*, *F279Y*, *A257G*) and non-genetic factors and their combination on calf growth rate in livestock breeding management condition.

Material and methods. The investigation was undertaken on Aberdeen-Angus cows (n = 52) and their calves (n = 430, where 222 bulls and 208 heifers) bred at PE 'Agrofirma Svitanok' (Kharkiv Region, Ukraine). Cows were born in 2003–2005; therefore, up to analysis date there were data on the average of 8 to 10 calves for each dam (at least 5 calves per dams born after 2005). During the summer period, cows with calves were on free grazing, in winter — on dry food — hay, silage. The calves were conceived as a result of natural mating, more than 50% of calves were born in the spring months from March to May, all of calves were nursed *ad libitum*, at least for 210 days. Calf growth rate was monitored monthly; some of them were culled before 210 days or at weaning. Calves were assessed with average daily gain during milk period (ADG, g/day) and were weighted at birth, at weaning (210 days), 8, 12, 15, and 18 months.

SNP genotyping of cows included *L127V*, *F279Y*, *A257G* of GH and GHR genes. DNA was extracted from blood samples using DNA extraction kits 'Diatom DNA Prep 100' ('Isogene', RF). For the SNP genotyping, PCR-RFLP methods were set up, using amplification regimen characterized by Lee et al. (2013) and Viitala et al. (2006) and restriction endonucleases *AluI* and *VspI* ('Fermentas', Lithuania). The PCR mix (25 µl) contained 1.5 mM $MgCl_2$. The digested fragments were electrophoresed on 2% agarose gel, stained with ethidium bromide and visualized under UV light.

Descriptive statistics used include values are expressed as means ± standard deviation of the mean ($\bar{x} \pm s_x$) and coefficient of variation (CV, %). The data were analysed using a Multiple regression model and ANOVA. Traits were analyzed by least square procedure. The dependent variables were: birth weight (BW), weaning weight (WW), weight at 8 (W8), 12 (W12), 15 (W15), 18 months (W18) and average daily gain (ADG). These variables were stratified by sex of calf and analyzed against genetic and non-genetic parameters as main effects. Genetic predictors were SNPs *L127V*, *F279Y*, *A257G* of GH and GHR genes, non-genetic predictors were season of birth, parity and calving interval as main effects. All values were tested at the significance level of 0.1, 0.05, 0.01, and 0.001.

Results and discussions. Allele and genotypes frequency for cows studied were published earlier (Fedota et al., 2017). Generally, population and each line (subgroup) was in Hardy-Weinberg equilibrium by all SNPs studied, except GHR *F279Y* for total population which showed significant disequilibrium ($\chi^2_{act.} = 14.80$, $p < 0.001$) suggesting homozygotization, whereas both homozygous classes are generally superior by reproductive traits and weight dynamics than heterozygous one (Lysenko et al., 2016).

Our preliminary analysis found strong differences between bulls and heifers for all parameters; the sex of calf was found to interfere with main effects camouflaging their contribution. Many authors point out the importance to take into account the environmental conditions when the purpose is to make genetic improvement in both situations using a single genotype. The implication is to take into consideration crucial environmental factors that affect weaning weight (WW) and thus may adjust the WW-driven selection, where most productive cows in the herd may not be identified or retained for breeding purposes. The greatest contribution within environmental factors was made by season in temperate climate (MacGregor and Casey, 2000), when free grazing in spring/summer period positively affect milk parameters and subsequently calf growth. The data on calves stratified by sex and season are presented in Table 1, on bulls stratified by SNPs/genotype in Table 2, and on heifers stratified by SNPs/genotype in Table 3. As can be readily observed, effect of season in heifers was higher than in bulls, reaching significance $p < 0.05$ for most of parameters. Effect of season is even more essential than each of SNPs.

For all analyses we separated bulls and heifers, the stratified by season of birth average weight at each time point was significantly greater in bulls, than in heifers (see Table 1). Differences were at least 1.5–2 kg at birth or 5–8%, 7–10 kg at weaning or 4–6%, 6–11 kg at 8 month or 3–6%, 12–18 (45) kg at 1 year or 4–6% (13%), 15–50 kg at 15 month or 5–16% and 30–80 kg at 18 month or 8–18%. Higher variation after weaning and even more at 1 year and later is stipulated by culling. Percentage of culled calves was higher amongst calves born during summer/autumn season ≈ 95/95% of bulls and 95–75/100% of heifers. The herd studied is nucleus of livestock breeding, therefore total percentage of non-culled heifers is traditionally 2–4 times higher than bulls. Difference spring-born between calves for all parameters was the least between seasons, as far as free grazing regimen of dams is to be associated with improved quality of milk and increased ADG during summer period.

Calf growth dynamic was analyzed with multiple regression model, the effects of genetic and non-genetic factors are summarized below (Table 4).

Genetic factors. *GH gene, SNP L127V.* In beef cattle *C*-allele is associated with higher body weight (Lee et al., 2013), and particularly higher birth weight (Hadi et al., 2015). Our results coincide with given in literature for both bulls and heifers, showing trend *CC* < *CG* < *GG*. *C*-allele is associated with increased birth weight in heifers approximately from 200 to 800 g ($p < 0.01$). ADG and resulting body weight at weaning depend on quality and quantity of milk. The one opinion about preferred L127V genotype for milk parameters does not exist, whilst even one breed in different herds demonstrate opposite results for given genotype (Fedota et al., 2017). Mykhailova, Belaya and Volchok (2011) describe better milk performance for cows with *CC*-genotype for early lactations, that decreases with next lactations. In our study calves had not significantly benefited from genotype, but trend observed was slightly seen in bulls, and not observed in heifers. Kišac et al. (2011) also describe early lactation as better then mid-lactations and absolutely netter than late lactations. At age 12 month and elder bulls stay to follow the trend *CC* < *CG* < *GG*, but heifers did not show any significant differences between genotypes.

GHR gene, SNP F279Y. Through the first year of life *TT*-bulls followed *TT* < *TA* < *AA*. At age of 15 month the pattern changed to opposite, but we would rather consider this as artifact resulting from stringent demands of culling. Therefore remained 11 bulls appear to have better parameters attributable to other gene combination. This speculation is supported by heifers following *TT* < *TA* < *AA* pattern during 18 month and being exposed to milder conditions of culling.

Table 1 — Calf growth parameters of Aberdeen-Angus herd in Kharkiv Region by sex and season of birth

Parameter	Descriptive statistics	Season				Season			
		Winter	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn
		Bulls				Heifers			
Birth weight, kg	n	54	130	19	19	55	107	24	22
	$\bar{x} \pm s_x$	30.46 ± 0.36	29.23 ± 0.22	30.58 ± 0.44	31.42 ± 0.40	28.38 ± 0.42	27.47 ± 0.25	29.67 ± 0.80	29.36 ± 0.32
	CV, %	8.71	8.81	6.29	5.54	11.09	9.43	13.29	5.10
	ANOVA	MR = 0.073; MS = 0.22; F = 0.037; p = 0.990				MR = 0.384; MS = 17.45; F = 3.344; p = 0.025			
Average daily gain, g/day	N	44	98	17	18	48	84	24	21
	$\bar{x} \pm s_x$	761.86 ± 14.26	761.75 ± 8.95	785.23 ± 17.12	771.61 ± 21.71	750.96 ± 13.81	706.32 ± 7.52	759.08 ± 11.57	706.48 ± 12.61
	CV, %	12.42	11.63	8.99	11.94	12.74	9.75	7.47	8.18
	ANOVA	MR = 0.547; MS = 10073.12; F = 2.994; p = 0.054				MR = 0.410 ; MS = 19486.55; F = 3.918; p = 0.013			
Weaning weight, kg (210 days)	n	44	98	17	18	48	84	24	21
	$\bar{x} \pm s_x$	189.50 ± 3.09	188.32 ± 1.80	195.18 ± 3.94	193.06 ± 4.65	187.08 ± 2.85	177.01 ± 1.54	188.33 ± 2.34	177.81 ± 2.35
	CV, %	10.80	9.47	8.32	10.21	10.56	7.96	6.09	6.06
	ANOVA	MR = 0.544; MS = 457.48; F = 2.948; p = 0.056				MR = 0.409; MS = 857.41; F = 3.881; p = 0.013			
Weight at 8 month, kg	n	21	73	10	10	38	71	18	12
	$\bar{x} \pm s_x$	213.52 ± 5.52	207.25 ± 2.85	213.80 ± 5.63	223.80 ± 4.18	209.39 ± 3.66	195.62 ± 1.96	207.78 ± 3.19	198.17 ± 3.28
	CV, %	11.86	11.77	8.33	5.91	10.77	8.44	6.52	5.73
	ANOVA	MR = 0.551; MS = 687.42; F = 3.050; p = 0.051				MR = 0.342; MS = 670.28; F = 2.563; p = 0.063			
Weight at 12 month, kg	n	14	55	5	3	27	56	14	9
	$\bar{x} \pm s_x$	303.21 ± 13.81	261.11 ± 5.04	288.20 ± 7.47	296.33 ± 3.67	285.41 ± 7.83	249.73 ± 3.38	276.14 ± 4.95	250.11 ± 8.98
	CV, %	17.04	14.33	5.79	2.14	14.25	10.14	6.71332	10.77
	ANOVA	MR = 0.035; MS = 11.91; F = 0.008; p = 0.999				MR = 0.396; MS = 2924.53; F = 3.598; p = 0.019			
Weight at 15 month, kg	n	13	26	2	2	23	41	11	1
	$\bar{x} \pm s_x$	344.31 ± 16.61	330.08 ± 6.00	359.00 ± 31.00	350.00 ± 20.00	322.04 ± 8.44	288.76 ± 4.26	314.27 ± 6.73	305.00
	CV, %	17.40	9.27	12.21	8.08	12.57	9.44	7.10	—
	ANOVA	MR = 0.030; MS = 1220.04; F = 0.678; p = 0.574				MR = 0.429; MS = 4272.79; F = 4.361; p = 0.007			
Weight at 18 month, kg	n	10	14	1	1	19	37	7	—
	$\bar{x} \pm s_x$	383.30 ± 17.43	398.86 ± 8.82	435.00	417.00	354.74 ± 6.91	333.78 ± 5.09	350.00 ± 3.93	—
	CV, %	14.38	8.28	—	—	8.49	9.27	2.97	—
	ANOVA	MR = 0.287; MS = 1242.94; F = 0.630; p = 0.603				MR = 0.329; MS = 2071.59; F = 2.347; p = 0.082			

Notes: $\bar{x} \pm s_x$ — mean ± standard deviation of the mean; CV, % — coefficient of variation; MR — multiple correlation coefficient; MS — mean square.

Table 2 — Bull growth parameters of Aberdeen-Angus herd in Kharkiv Region by SNPs/genotypes

Parameter	Descriptive statistics	Growth hormone gene, SNP *L127V*			Growth hormone receptor gene, SNP *F279Y*			Growth hormone gene, SNP *L127V*		
		CC	CG	GG	TT	TA	AA	AA	AG	GG
Birth weight, kg	n	31	104	87	132	30	60	154	64	4
	$\bar{x} \pm s_x$	30.19 ± 0.48	29.80 ± 0.27	29.75 ± 0.25	29.68 ± 0.24	29.93 ± 0.54	30.12 ± 0.26	29.81 ± 0.21	29.78 ± 0.33	31.50 ± 1.66
	CV, %	8.90	9.23	7.91	9.24	9.88	6.56	8.55	8.86	10.53
	ANOVA	MR = 0.400; MS =9.81; F = 2.097; p = 0.147			MR = 0.391; MS = 9.41; F = 2.00; p = 0.156			MR = 0.124; MS = 5.32; F = 6.10; p = 0.421		
Average daily gain, g/day	n	26	81	70	107	24	46	121	52	4
	$\bar{x} \pm s_x$	769.69 ± 12.64	759.77 ± 9.75	769.41 ± 11.65	763.57 ± 8.93	766.25 ± 13.68	767.83 ± 13.37	774.40 ± 8.01	748.44 ± 12.17	697.75 ± 30.27
	CV, %	8.38	11.55	12.67	12.10	8.75	11.81	11.38	11.73	8.68
	ANOVA	MR = 0.248; MS = 3113.73; F = 0.723; p = 0.496			MR = 0.273; MS = 3768.86; F = 0.89; p = 0.426			MR = 0.124; MS = 7823.31; F = 9041.88; p = 0.424		
Weaning weight, kg (210 days)	n	26	81	70	107	24	46	121	52	4
	$\bar{x} \pm s_x$	191.92 ± 2.92	188.26 ± 2.01	190.67 ± 2.43	189.05 ± 1.83	190.50 ± 2.97	191.00 ± 2.91	191.41 ± 1.68	186.88 ± 2.59	177.00 ± 6.44
	CV, %	7.77	9.59	10.67	10.03	7.63	10.32	9.64	10.00	7.28
	ANOVA	MR = 0.237; MS = 129.74; F = 0.653; p = 0.530			MR = 0.274; MS = 173.60; F = 0.89; p = 0.424			MR = 0.109; MS = 263.16; F = 391.92; p = 0.513		
Weight at 8 month, kg	n	15	47	52	63	17	34	83	30	1
	$\bar{x} \pm s_x$	209.13 ± 4.21	209.57 ± 3.28	211.58 ± 3.67	209.75 ± 3.01	209.24 ± 4.30	212.29 ± 4.47	211.43 ± 2.70	207.67 ± 3.86	210.00
	CV, %	7.80	10.75	12.511	11.38	8.48	12.27	11.63	10.19	—
	ANOVA	MR = 0.165; MS = 92.17; F = 0.307; p = 0.740			MR = 0.191; MS = 125.00; F = 0.42; p = 0.662			MR = 0.071; MS = 156.44; F = 563.97; p = 0.758		
Weight at 12 month, kg	n	10	30	37	41	11	25	59	18	—
	$\bar{x} \pm s_x$	275.10 ± 11.14	277.73 ± 7.94	266.30 ± 7.06	271.15 ± 5.68	276.18 ± 11.90	271.24 ± 10.48	275.98 ± 5.31	258.50 ± 10.54	—
	CV, %	12.80	15.66	16.13	13.42	14.29	19.32	14.78	17.30	—
	ANOVA	MR = 0.218; MS = 702.04; F = 0.548; p = 0.586			MR = 0.349; MS = 1803.43; F = 1.53; p = 0.239			—		
Weight at 15 month, kg	n	5	16	22	20	8	15	35	8	—
	$\bar{x} \pm s_x$	362.00 ± 16.60	340.62 ± 8.47	328.00 ± 9.82	353.70 ± 6.54	308.13 ± 12.91	329.13 ± 12.65	339.89 ± 6.63	322.50 ± 17.98	—
	CV, %	10.25	9.94	14.05	8.27	11.85	14.89	11.54	15.77	—
	ANOVA	MR = 0.383; MS = 3031.32; F = 1.886; p = 0.175			MR = 0.846; MS = 4894.94; F = 3.40; p = 0.051			—		
Weight at 18 month, kg	n	2	9	15	11	4	11	21	5	—
	$\bar{x} \pm s_x$	441.50 ± 6.50	392.11 ± 12.83	390.47 ± 11.65	414.55 ± 9.85	378.50 ± 19.01	381.36 ± 14.40	398.71 ± 8.86	379.20 ± 23.09	—
	CV, %	2.08	9.82	11.56	7.88	10.045	12.52	10.18	13.62	—
	ANOVA	MR = 0.322; MS = 2340.88; F = 1.273; p = 0.300			MR = 0.404; MS = 3681.94; F = 2.14; p = 0.141			—		

Notes: $\bar{x} \pm s_x$ — mean ± standard deviation of the mean; CV, % — coefficient of variation; MR — multiple correlation coefficient; MS — mean square.

Table 3 — Heifer growth parameters of Aberdeen-Angus herd in Kharkiv region by SNPs/genotypes

Parameter	Descriptive statistics	Growth hormone gene, SNP *L127V*			Growth hormone receptor gene, SNP *F279Y*			Growth hormone gene, SNP *L127V*		
		CC	CG	GG	TT	TA	AA	AA	AG	GG
Birth weight, kg	n	26	104	78	132	26	50	152	52	4
	$\bar{x} \pm s_x$	28.96 ± 0.56	28.23 ± 0.31	27.81 ± 0.31	28.07 ± 0.26	28.12 ± 0.71	28.44 ± 0.33	28.08 ± 0.25	28.35 ± 0.36	29.00 ± 1.00
	CV, %	9.84	11.03	9.72	10.75	12.82	8.23	10.93	9.27	6.90
	ANOVA	MR = 0.257; MS = 11.70; F = 2.083; p = 0.133			MR = 0.110; MS = 2.15; F = 0.361; p = 0.698			MR = 0.217; MS = 9.35; F = 1.738; p = 0.183		
Average daily gain, g/day	n	22	89	66	108	24	45	130	44	3
	$\bar{x} \pm s_x$	702.45 ± 15.05	730.02 ± 8.88	727.35 ± 8.72	717.56 ± 7.17	727.29 ± 17.33	744.00 ± 11.86	724.16 ± 6.97	727.05 ± 10.04	766.67 ± 91.39
	CV, %	10.05	11.47	9.74	10.39	11.67	10.70	10.98	9.16	20.65
	ANOVA	MR = 0.155; MS = 4163.23; F = 0.725; p = 0.488			MR = 0.324; MS = 18235.96; F = 3.465; p = 0.038			MR = 0.255; MS = 14160.05; F = 2.428; p = 0.095		
Weaning weight, kg (210 days)	n	22	89	66	108	24	45	130	44	3
	$\bar{x} \pm s_x$	176.86 ± 3.12	182.49 ± 1.85	181.36 ± 1.74	179.65 ± 1.45	181.08 ± 3.60	185.67 ± 2.49	180.94 ± 1.43	181.95 ± 2.06	191.67 ± 19.22
	CV, %	8.27	9.55	7.78	8.36	9.73	9.01	9.00	7.49	17.37
	ANOVA	MR = 0.162; MS = 202.63; F = 0.798; p = 0.455			MR = 0.332; MS = 848.73; F = 3.658; p = 0.032			MR = 0.300; MS = 886.62; F = 3.469; p = 0.037		
Weight at 8 month, kg	n	16	70	53	91	19	29	101	35	3
	$\bar{x} \pm s_x$	195.37 ± 4.60	201.76 ± 2.30	202.17 ± 2.47	200.63 ± 1.85	198.32 ± 5.15	204.79 ± 3.60	200.84 ± 1.92	201.63 ± 2.69	207.33 ± 18.76
	CV, %	9.42	9.55	8.88	8.78	11.32	9.48	9.61	7.89	15.66
	ANOVA	MR = 0.166; MS = 237.18; F = 0.838; p = 0.438			MR = 0.341; MS = 1001.49; F = 3.894; p = 0.026			MR = 0.290; MS = 940.82; F = 3.214; p = 0.046		
Weight at 12 month, kg	n	10	58	38	68	14	24	76	27	3
	$\bar{x} \pm s_x$	260.40 ± 13.29	262.10 ± 4.59	263.21 ± 4.64	259.24 ± 3.84	263.93 ± 9.26	270.21 ± 7.46	262.86 ± 3.67	262.07 ± 6.89	251.67 ± 30.60
	CV, %	16.14	13.33	10.87	12.23	13.13	13.53	12.16	13.65	21.06
	ANOVA	MR = 0.083; MS = 191.04; F = 0.203; p = 0.817			MR = 0.304; MS = 2577.33; F = 2.996; p = 0.058			MR = 0.194; MS = 1291.92; F = 1.365; p = 0.262		
Weight at 15 month, kg	n	8	45	23	51	9	16	53	22	1
	$\bar{x} \pm s_x$	293.75 ± 7.60	305.84 ± 5.77	299.78 ± 6.01	300.67 ± 4.40	303.00 ± 10.67	309.19 ± 11.25	300.04 ± 4.33	308.23 ± 8.77	325.00
	CV, %	7.32	12.66	9.62	10.45	10.56	14.56	10.51	13.34	—
	ANOVA	MR = 0.099; MS = 342.08; F = 0.293; p = 0.747			MR = 0.215; MS = 1614.94; F = 1.435; p = 0.246			MR = 0.141; MS = 893.58; F = 0.723; p = 0.489		
Weight at 18 month, kg	n	7	36	21	45	7	12	45	19	—
	$\bar{x} \pm s_x$	339.00 ± 8.83	340.92 ± 5.85	344.00 ± 5.12	336.60 ± 4.23	342.57 ± 10.13	360.42 ± 9.70	339.16 ± 4.43	347.79 ± 7.20	—
	CV, %	6.89	10.30	6.81	8.44	7.83	9.32	8.77	9.02	—
	ANOVA	MR = 0.072; MS = 148.32; F = 0.153; p = 0.858			MR = 0.310; MS = 2752.48; F = 3.129; p = 0.051			—		

Notes: $\bar{x} \pm s_x$ — mean ± standard deviation of the mean; CV, % — coefficient of variation; MR — multiple correlation coefficient; MS — mean square.

Table 4 — The regression coefficients (B ± sB) of genetic and non-genetic factors for the calf growth traits

Parameter	Genetic factors			Non-genetic factors		
	GH gene, SNP *L127V*	GHR gene, SNP *F279Y*	GHR gene, SNP *L127V*	Season of birth	Parity number	Calving interval
Birth weight, kg						
Bull	0.18 ± 0.25	−0.22 ± 0.20	−0.18 ± 0.34	−0.40 ± 0.11‡	−0.27 ± 0.06‡	−0.001 ± 0.001
Heifer	0.53 ± 0.31*	−0.18 ± 0.24	−0.32 ± 0.41	−0.36 ± 0.16**	−0.33 ± 0.08‡	0.003 ± 0.002*
Average daily gain, g/day						
Bull	−2.18 ± 9.62	−2.16 ± 7.72	29.40 ± 12.67**	−0.55 ± 5.20	−2.73 ± 2.95	−0.008 ± 0.057
Heifer	−8.11 ± 8.85	−14.53 ± 6.73**	−7.40 ± 12.02	−12.56 ± 4.47†	1.62 ± 2.48	0.130 ± 0.051**
Weaning weight, kg (210 days)						
Bull	−0.09 ± 2.02	−0.01 ± 1.62	5.27 ± 2.67**	−0.61 ± 1.09	−0.82 ± 0.62	0.002 ± 0.012
Heifer	−1.28 ± 1.82	−3.21 ± 1.38**	−2.09 ± 2.47	−2.89 ± 0.091†	0.36 ± 0.51	0.028 ± 0.011**
Weight at 8 month, kg						
Bull	−1.44 ± 3.19	−1.19 ± 2.50	3.35 ± 4.73	−3.04 ± 1.83*	−0.65 ± 0.96	−0.382 ± 0.021
Heifer	−2.46 ± 2.43	−2.21 ± 1.94	−1.51 ± 3.17	−4.22 ± 1.17‡	−0.04 ± 0.64	0.025 ± 0.014*
Weight at 12 month, kg						
Bull	6.37 ± 6.88	−0.23 ± 5.35	17.48 ± 11.23	−14.49 ± 3.75‡	−6.99 ± 1.82‡	−0.034 ± 0.057
Heifer	−1.29 ± 5.24	−6.90 ± 3.83*	2.48 ± 6.22	−10.67 ± 2.31‡	−2.35 ± 1.28†	0.083 ± 0.031†
Weight at 15 month, kg						
Bull	15.63 ± 9.01*	13.18 ± 6.86*	17.39 ± 16.24	−4.96 ± 4.64	−6.15 ± 2.64**	−0.035 ± 0.62
Heifer	−0.14 ± 6.54	−4.10 ± 4.83	−8.97 ± 8.00	−10.96 ± 2.71‡	−2.61 ± 1.66	0.060 ± 0.041
Weight at 18 month, kg						
Bull	15.29 ± 13.02	16.59 ± 8.61*	19.51 ± 21.22	5.00 ± 5.86	−2.77 ± 3.77	−0.081 ± 0.112
Heifer	−2.68 ± 6.10	−11.37 ± 4.60**	−8.63 ± 8.27	−6.82 ± 2.72**	−2.25 ± 1.63	0.029 ± 0.678

Notes: * — significant at 0.1 level, ** — significant at 0.05 level,† — significant at 0.01 level, ‡ — significant at 0.001 level.

Better ADG for *AA*-genotype indicating on milk quality corresponds to results obtained by Rahmatalla et al. (2011), that *A*-allele is associated with higher fat and protein content.

GHR gene, SNP A257G. There were observed similar growth trends as for SNP *F279Y*, but *AA*-bulls started to demonstrate better growth traits after weaning, where heifers stayed to follow the trend *AA* < *AG* < *GG*. Genotype desired for milk traits has shown negative association with growth dynamic. *A*-allele associated with higher fat and protein content (Oleński, Suchocki and Kamiński, 2010) was related to significantly higher ADG in bulls, resulting in additional 6 kg at weaning.

Non-genetic component. *Season of birth.* Amongst all factors analyzed season had the highest impact on birth weight and ADG. We coded spring with 4 points, summer as 3 points, autumn (rainy season) as 2 points and winter as 1 point. As the summer comprises the best forage conditions for pregnant dams we observe the highest birth weight at autumn season for both bulls and heifers (+ 1 kg or 4% compared to other seasons). ADG was higher for summer-born calves ($p < 0.1$ and $p < 0.05$ for bulls and heifers), due to better forage regimen of dams. The effect of season persists for later ages and is more apparent in dams than bulls.

In literature, the effect of season is controversial, and depends on breed and region. The African Sheko cattle (Southwestern Ethiopia) demonstrate significant seasonal variations ($p < 0.01$) being conditioned by feed and fodder availability as well as disease incidence. Calves born in dry season had higher birth weights compared to those born in both main rainy and short rainy seasons, whereas combinations of short rainy and main rainy season very often result in excess forage leading to high milk production of cows for calf consumption. Season of calving had also a strong significant ($p < 0.01$) Calves born during short rainy season had higher preweaning daily weight gain than the other two seasons, which could be due to favorable feeding conditions of dams during this and the latter seasons, though had higher milk yield (Bayou et al., 2015). Rahman, Bhuiyan and Bhuiyan (2015) reported that winter-born calves had higher birth weight due to abundant availability of green fodder during this season (Bangladesh) which increases nutritional status of cows.

Parity number. The effect of mother age or parity number was observed on birth weight, whereas young mother were more likely to produce heavier calve of each sex. The birth weight slightly decreases from first to later calving presenting difference at least 5–6% for 2nd and

3rd calving then 8–12% — for 4th to last calving for both sexes. The effect of parity stay to be evident for bulls of all ages, the difference between calves decreased to 2–5%, but in 12 and 18 month it results to difference between 1st parity calves and other to 20–40 and 30–70 kg of body weight. These differences were not observed in dams of age 7 month and older.

Our results are controversial to observed for African crossbred cattle (Horro/Zebu × Holstein Friesian and Jersey) (Abera, Abegaz and Mekasha, 2012). These calves born from first parity were significantly lighter at birth than those born from adult cows. In Czech Charolais, the higher parity, the higher live birth weight was determined, with maximum values in cows from the fourth calving, whereas the parity effect on the average daily weight gain was statistically insignificant (Tousova et al., 2014). On other hand, Echternkamp (1993) speculates about placenta effect on calf birth weight and further growth dynamics. Our data are supported by his findings that first parity heifers would rather have higher placental weights and circulating concentrations of estrone sulfate correlating positively with birth weight of their calves.

Calving interval. Unlike bulls, female calves were significantly affected by calving interval, where longer calving intervals produced heavier newborns and weaners, at least 3 and 30 g/day of CI, accordingly.

MacGregor and Casey (2000) support our data, their findings for African Bovelder cattle suggest that one-day increase in calving interval was associated with a decrease of 0.29 ± 0.01 kg in weaning weight and a decrease of 0.54 ± 0.01 kg in the heifer pre-breeding weight. Even weaning weight of the previous calf influences calving interval, in that higher weaning weights were associated with longer calving intervals (Doren, Long and Cartwright, 1986). Therefore, the calf weight at first calving can be maximum or close to maximum due to absence of previous weaning period and pregnancy effects.

Conclusions. There were strong differences between bulls and heifers for all parameters and sex of calf was found to interfere with main effects camouflaging their contribution. The greatest contribution within environmental factors was made by season in temperate climate, being even more essential than effect of each SNP. The differences due to non-genetic factors were conditioned by forage regimen during seasons, parity effect that was consequence of lactation quality and calving interval, showing positive correlation with body weight and ADG. Last two parameters were related to reproductive performance associated with previous calving.

Therefore, we can conclude that planning heifer pregnancy (by season and calving interval) is likely to have greater contribution than selection by genotype for productive and reproductive traits. When evaluating the reproductive and productive performance of breeding cows we should take into account effect of season, date of previous calving and actual weaning weight of previous calves either.

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