

# POTENTIAL OF BLUE-GREY CATTLE MANAGED UNDER ORGANIC FARMING CONDITIONS OF CZECHIA

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## Abstract

The aim of this work was to evaluate growth potential of Blue-Grey cattle in Czech conditions as the compare its growth traits to initial population. Suitability of specific conditions was evaluated based on growth ability and daily weight gains (DWG). Tested breeds included Shorthorn, Galloway and their crossbred variation called Blue-Grey cattle. A total of 428 animals were evaluated over a period from 2010 until 2016. Birth weight, live weight at 120, 210 and 365 days of age was monitored for each animal. Also, DWG at 120, 210 and 365 days of age was part of the evaluation. Mixed model (SAS 9.3) was used for statistical evaluation. The influence of sex on growth ability was significantly ( $P < 0.05$ ) in favour of bulls throughout the evaluated period. Purebred Shorthorns achieved highest weights (from + 2.5 for birth weight to +82.65 kg in weight at 365 days of age) ( $P < 0.05$ ) and DWG (from + 147.26 g to + 300.37 g ( $P < 0.05$ ) compare to purebred Galloway throughout the evaluated period. Weight and DWG of Blue-Greys were significantly better in comparison with Galloway and were more comparable with Shorthorns. Therefore, growth ability was improved mainly by addition of Shorthorn blood. Good growth ability of Blue-Greys combined with better environmental endurance from Galloway blood makes them well suited for use in organic farming conditions of Czechia.

Keywords: growth, live weight, daily weight gain, Shorthorn, Galloway

## INTRODUCTION

Extensive breeding of beef cattle on pastures is one of the cheapest and most effective way to maintain the culture of a landscape. This should be preferred under organic farming management especially. One of promising genotypes used for this system is Blue-Grey (Shorthorn x Galloway) (The Whitebred Shorthorn Association, 2018),

Shorthorn x Aberdeen Angus (Wheeler *et al.*, 1996) or Wagyu x Aberdeen Angus (Toušová *et al.*, 2018). In recent years, new breeds have been introduced and imported into the Czech Republic for the first time, which further diversified Czech beef breeds population. These breeds can excel in specific conditions due to their particular traits, which could also be useful for Czech farmers. One of the freshly introduced breeds is shorthorn.

Originally, it was English dual-purpose breed, but since 1958 is bred solely as beef breed. Animals are well muscled and their high quality beef has good marbling (Shorthorn breeding program, 2016). Pariacote *et al.* (1998) observed average marbling score of 5.3 on ten-point scale for US shorthorns, however tested animals showed high individuality through wide range of marbling – from 2.9 to 9.2. One of Shorthorns' key traits is excellent weight gain on pasture, when they can achieve 1.5 kg of gains per day. Naturally, these gains can be higher in intensive breeding systems – up to 2.5 kg per day (Shorthorn breeding program, 2016). Shorthorn growth ability could be comparable to other beef breeds popular in Czech Republic like Aberdeen Angus (Toušová, *et al.* 2015).

On the other hand, Galloway cattle breeding is already well established in Czech Republic. Czech Galloway population achieved daily weight gain of only 831 g in 2016 (Deadline of performance control – Galloway, 2017), but this breed is mainly valued for its resistance to hard conditions like cold climate and poor forage. Therefore, they are used as extensive breed, which can easily handle winter on pasture. The meat is juicy, delicate with optimal marbling (Galloway breeding program, 2016). These two breeds have great prerequisite for use in extensive breeding in Czech Republic. Natural habitat of these breeds is fairly similar to Czech conditions, although climate is dryer with more extreme weather patterns during winter and summer (Olesen and Bindi, 2002).

In addition to purebred breeding, crossbreeding is also a suitable alternative, which can lead to better lactation traits (Jenkins *et al.*, 2000), offsprings with better vitality and growth ability (Arango *et al.*, 2004; Gosey J., 2005) or higher resistance to disease (Curone *et al.*, 2018). Better growth ability for crossbreds was also observed in studies of Rødbotten *et al.* (2002), and Pesonen *et al.* (2012). Calve growth ability is influenced by the genetics, mother's maternal traits, mother's living conditions and other environmental factors (Ducháček *et al.*, 2011). Significant influence of multiple factors like breed, sex, nutrition, used technology or year and season of birth has already been identified in previous studies (Koknaroglu *et al.*, 2005; Krupa *et al.*, 2005; Szabó *et al.*, 2006; Toušová *et al.*, 2015).

Studies about freshly introduced breeds are needed so farmers can pick suitable breed, resp. cross-breed, for their needs. Each breed is best-suited for specific, mainly native domestic, conditions. Therefore, testing their growth ability after introduction to new conditions is important

to further popularize breed among farmers and to evaluate suitability of the new environment. Therefore, the aim of this work was to evaluate growth potential of Blue-Grey cattle in Czech conditions as the compare its growth traits to initial population.

## MATERIALS AND METHODS

### Breeding management

This study was conducted on 1 farm (425–460 m.n.m. Roupov – 49.5365644N, 13.2471097E) managed under organic farming conditions in the period from 2010 to 2016. Production herd consisted out of approximately 130 Galloway animals (GA), 90 Shorthorn animals (SS) and 60 SS x GA crossbreds called Blue-Grey during the course of the experiment. Animals were bred in semi-intensive system. The vast majority of calving were carried out spontaneously and without complications. Pasture period was spent on pasture only with addition of salt lick. During winter (from November to March), cattle were housed inside the stall with deep bedding. Feeding consisted out of straw, hay and haylage. Post-partum cows received additional grain feed two times a day (cca 1 kg per head per day). Water was supplied during summer period with water tanks and during winter with anti-freezing waterers.

Reproduction management was in form of natural breeding, which was carried out during the months of April, May and first half of June. Naturally, calving took place mostly during winter and majority of calves (80%) were born until the end of March. Young bulls that were not chosen as breeding bulls were fattened up until two years of age (approximately 750 kg of live weight).

### Statistical evaluation

A total 428 animals of Shorthorn breed (SS), Galloway (GA) and Blue-Grey cattle as their half-blood crossbreds (SS x GA) were part of the evaluation. Weight of tested animals were mediated by czech beef performance control, which was carried out according to current methodology (Methodology for beef performance control, 2018). Birth weight (BW), weight at 120 (W120), 210 (W210) and 365 days of age (W365), and daily weight gains within these periods (daily weight gains up to 120 days of age – DWG120, daily weight gains up to 210 days of age – DWG210, daily weight gains up to 365 days of age – DWG365) were monitored and evaluated.

Naturally, some of the tested animals were culled or left the herd sooner for other reasons during the course of the experiment, therefore some of the measurements are missing for several animals.

Statistical evaluation was performed in SAS 9.3 (SAS/STAT® 9.3, 2011). The MEANS and UNIVARIATE procedures were used for calculation of basic statistics. The REG procedure (STEPWISE method) was used to select suitable effects for model equation. Subsequently, detailed evaluation of selected parameters was done by MIXED procedure. Influence of multiple effects on growth ability was tested as a part of the evaluation. Model equation consisted out of fixed effects of breed, sex and their interactions. Effect of animal were chosen as a random effect. Month and year of birth were used as random joint effect. Effect of calving order was discarded from the evaluation because of an insignificant relation to evaluated parameters. Tukey-Kramer test was used for detailed evaluation of the differences.

Model equation:

$$y_{ijk} = \mu + \text{BREED}_i + \text{SEX}_j + \text{BREED} \times \text{SEX}_{ij} + b1 \cdot \text{PAR} + b2 \cdot \text{ANIM} + b3 \cdot \text{YS} + e_{ijk}$$

where:

- $y_{ijk}$  - the value of the dependent variable (BW, W120, W210, W365, DWG120, DWG210, DWG365),
- $\mu$  - value of general dependent variable,
- $\text{BREED}_i$  – fixed effect of breed ( $i$  = Blue-Grey,  $n$  = 121;  $j$  = Galloway,  $n$  = 256;  $j$  = Shorthorn 100,  $n$  = 51);
- $\text{SEX}_j$  – fixed effect of sex ( $i$  = bulls,  $n$  = 217;  $i$  = heifers,  $n$  = 211);

- $\text{BREED} \times \text{SEX}_{ij}$  – interaction fixed effect breed  $\times$  sex ( $ij$  = Blue-Grey  $\times$  bull,  $n$  = 65;  $ij$  = Blue-Grey  $\times$  heifer,  $n$  = 56;  $ij$  = Galloway  $\times$  bull,  $n$  = 134;  $ij$  = Galloway  $\times$  heifer,  $n$  = 122;  $ij$  = Shorthorn  $\times$  bull,  $n$  = 18;  $ij$  = Shorthorn  $\times$  heifer,  $n$  = 33);
- $b1, b2, b3$  – fixed regression coefficients;
- $\text{PAR}$  – cows parity;
- $\text{ANIM}$  – random repeated effect of animal;
- $\text{YS}$  – combined random effect of month and year of birth;
- $e_{ijk}$  - random residual error
- Significance level  $P < 0.05$  was used to evaluate the differences between groups.

## RESULTS

Basic statistics for tested parameters are presented in Tab. I. Average calving order during the test was 3.99 ( $V = 60.63\%$ ), with an average BW of 30.29 kg, although, BW showed wide range, from 10 kg to 50 kg. Calves showed fastest growth in period from birth to 120 days of age, with daily weight gains (DWG) of 928.50 g. Average live weight at the end of this period was 141.85 kg. DWG slightly increased from 120 to 210 days (+ 16.62 g) of age and then continually decreased on level 818.40 g in 365 days of age. Average weight of animals at the end of the tested period was 329.81 kg with standard deviation 58.38 kg. Evaluation of individual traits can be found in Tab. I.

Basic statistics for used model can be found in Tab. II. Model equation was statically significant for all tested growth ability parameters ( $P < 0.05$ ), explaining variability from 21.3% (BW) to 58.8 % (W365). Combined effect of the year and month of

I: Basic statistics for selected parameters.

Selected parameters	n	$\bar{x}$	s	min.	max.	s.e.	V (%)
calving order	428	3.99	2.42	1	12	0.12	60.63
BW (kg)	428	30.29	4.61	10	50	0.22	15.23
W120 (kg)	176	141.85	25.69	69	208	1.94	18.11
W210 (kg)	223	229.70	39.65	120	356	2.66	17.26
W365 (kg)	236	329.81	58.38	179	502	3.80	17.70
DWG120 (g)	176	928.50	194.80	383.33	1441.67	14.68	20.98
DWG210 (g)	223	945.12	183.34	447.62	1542.86	12.28	19.40
DWG365 (g)	236	818.4	155.24	419.18	1282.19	10.11	18.97

$n$  – number of observations;  $\bar{x}$  – arithmetic means,  $s$  – standard deviation; min. – minimal value; max. – maximum value; s.e. – standard error of arithmetic mean; V (%) variance coefficient; BW – birth weight; W120 – weight at 120 days of age; W210 – weight at 210 days of age; W365 – weight at 365 days of age; DWG120 – daily weight gain up to 120 days of age; DWG210 – daily weight gain up to 210 days of age; DWG365 – daily weight gain up to 365 days of age.

calving was part of the model equation, however results for this effect are not presented. Tab. II shows that all observed growth ability parameters were significantly ( $P < 0.05$ ) influenced by sex and breed. Effect of breed x sex interaction was significant only for W365 and DWG365. Finally, effect of calving order was significant only for W365 and DWG365.

Subsequently, influence of fixed effects (breed, sex, and their interactions) on growth ability of tested animals is reported in tables 3, respectively 4. Weight differences based on sex were lowest at birth (+1.27 kg in favour of bulls) and continually deepened until the end of tested period (+76.02 kg in favour of bulls). Naturally, DWGs were significantly higher ( $P < 0.05$ ) for tested bulls as well. Similarly to weight, DWGs development kept the same trend, when differences between sexes increased towards the end of the tested period compared to the beginning (206.63 g vs. 123.13 g).

As expected, effect of breed showed significant ( $P < 0.05$ ) influence on growth ability parameters (Tabs. III and IV). The poorest growth performance was observed for very extensive Galloway breed, significantly differencing ( $P < 0.05$ ) to Shorthorn (from +6.53 kg BW to +82.65 kg W365, resp. from +207.9 g DWG365 to +300.37 g DWG120) and Blue-Grey (from +2.5 kg BW to +58.29 kg W365, resp. from +147.26 g DWG365 to +227.59 g DWG210) cattle. Contrary, purebred Shorthorns achieved best growth ability, but in several occasion the differences were very close to Blue-Grey. The differences between these animals were even more obvious in breed x sex interaction evaluation (Tab. III and Tab. IV), when no significant differences between Blue-Grey and Shorthorn bulls as well as Blue-Grey and Shorthorn heifers were detect throughout of the observed period (W120–W365; DWG120–DWG365). Interestingly, only BG showed accelerated DWG210 compared to DWG120 for both sexes, while SSxB, SSxH and GAxH slowed in growth in period from 120 to 210 days of age.

## DISCUSSION

Only few studies were focused on growth ability analysis for SS breed. With introduction of this breed to Czechia, more research is needed to compare growth ability performance in conditions of central Europe. Most of the research focused on SS growth was done in US conditions (Pariacote *et al.*, 1998; Thallman *et al.*, 1999; Arango *et al.*, 2004). SS and their crossbreds' growth performance was even evaluated in

Ghana (Ahunu *et al.*, 1997), but mentioned studies only gives us evaluation of various genetical and phenotypical parameters influencing the growth ability, not actual growth rate.

Growth ability of calves and young cattle of a lot of breeds, which are already established in Czechia, is already well documented. Extent of influence for various effects were already identified in previous studies e.g. Dadi *et al.*, 2002; Toušová *et al.*, 2015; Lengyel *et al.*, 2003; Karhula and Kässi, 2010. For example, influence of year and season of birth were confirmed in the studies of Lengyel *et al.* (2003) and Karhula and Kässi, (2010). Calving order proved to be significantly influential in the study of Szabó *et al.* (2006) and Jakubec *et al.* (2000), although in our study this effect was statistically insignificant. Tendency for better growth ability with increasing calving order is evident for mothers until they reach 5 years of age. This could be related to mothers' maturity and continually easier calvings (Szabó *et al.*, 2006; Jakubec *et al.*, 2000). Insignificance of this effect in our test may suggest, that tested breeds had great maternal traits, which they kept to much higher age. We think that this parameter was mainly improved by addition of Galloway blood.

Effect of sex is well documented, and results of our study are in compliance with previous works. For example, studies of Jakubec *et al.* (2000) and Lengyel *et al.* (2003) also observed better growth ability for bulls. Similarly, to our study, these differences only deepened with age.

Effect of breed proved to be significantly influential, same as in studies of Arango *et al.* (2002) and Goyache *et al.* (2003). According to Gosey (2005), the growth ability of crossbreds is mainly influenced by heterosis effect, which was not proven in our study. Although, crossbreeding Galloway cattle with Shorthorn is viable way to improve growth ability of Galloway crossbreds. Comparable, although still slightly lower, growth ability between purebreds and crossbreds was also observed in study of Ahunu *et al.* (1997).

According to Říha (1999) growth ability is influenced by various factors and it is important to continuously weigh the calves and calculate daily weight gains. This observation is supported by our results, in which we also observed higher DWGs for period DWG120 compared to DWG365. Wolcott *et al.* (2010) adds that DWGs and beef quality in this period are mostly dependant on pasture period, pasture quality, weaning age and other factors. Interestingly, only BG showed significant increase in DWG210. W210 is of the most importance, because it represents

## II: Basic statistics for used model.

Growth ability parameters	MODEL		breed		sex		breed x sex		calving order	
	r <sup>2</sup>	P	F-test	P	F-test	P	F-test	P	F-test	P
BW	0.213	<0.001	57.7	<0.001	7.91	0.005	1.74	0.176	0.09	0.769
W120	0.566	<0.001	82.73	<0.001	17.7	<0.001	0.6	0.551	0.78	0.378
W210	0.477	<0.001	64.23	<0.001	54.86	<0.001	1.57	0.211	2.64	0.106
W365	0.588	<0.001	76.85	<0.001	119.24	<0.001	8.43	<0.001	9.84	0.002
DWG120	0.49	<0.001	58.25	<0.001	16.12	<0.001	0.22	0.801	1.69	0.196
DWG210	0.45	<0.001	56.26	<0.001	52.01	<0.001	1.23	0.296	2.73	0.1
DWG365	0.572	<0.001	66.36	<0.001	119.94	<0.001	8.39	<0.001	10.09	0.002

BW – birth weight; W120 – weight at 120 days of age; W210 – weight at 210 days of age; W365 – weight at 365 days of age; DWG120 – daily weight gain up to 120 days of age; DWG210 – daily weight gain up to 210 days of age; DWG365 – daily weight gain up to 365 days of age.

## III: Effect of breed, sex and their interactions on weight development using MIXED procedure.

effect	BW	W120	W210	W365
	LSM ± SELSM	LSM ± SELSM	LSM ± SELSM	LSM ± SELSM
<b>breed</b>				
Blue-Grey	31.77 ± 0.484 <sup>a</sup>	156.23 ± 4.697 <sup>a</sup>	251.36 ± 4.628 <sup>a</sup>	367.75 ± 7.349 <sup>a</sup>
Galloway	29.27 ± 0.434 <sup>b</sup>	130.67 ± 2.239 <sup>b</sup>	201.46 ± 4.112 <sup>b</sup>	309.46 ± 2.899 <sup>b</sup>
Shorthorn	35.80 ± 0.663 <sup>c</sup>	173.96 ± 3.265 <sup>c</sup>	257.15 ± 5.929 <sup>a</sup>	392.11 ± 6.911 <sup>c</sup>
<b>sex</b>				
bull	32.91 ± 0.487 <sup>a</sup>	161.38 ± 2.803 <sup>a</sup>	254.05 ± 3.980 <sup>a</sup>	394.45 ± 4.698 <sup>a</sup>
heifer	31.64 ± 0.461 <sup>b</sup>	145.86 ± 3.188 <sup>b</sup>	219.26 ± 4.432 <sup>b</sup>	318.43 ± 5.154 <sup>b</sup>
<b>breed x sex</b>				
Blue-Grey x bull	32.04 ± 0.567 <sup>a</sup>	162.83 ± 5.833 <sup>a</sup>	263.15 ± 4.983 <sup>a</sup>	412.90 ± 8.516 <sup>a</sup>
Galloway x bull	29.55 ± 0.482 <sup>b</sup>	137.23 ± 2.556 <sup>b</sup>	219.33 ± 4.033 <sup>b</sup>	331.76 ± 3.998 <sup>b</sup>
Shorthorn x bull	37.14 ± 0.951 <sup>c</sup>	184.09 ± 4.422 <sup>c</sup>	279.68 ± 8.048 <sup>a</sup>	438.69 ± 10.622 <sup>a</sup>
Blue-Grey x heifer	31.50 ± 0.614 <sup>a</sup>	149.64 ± 7.116 <sup>d</sup>	239.56 ± 6.872 <sup>b</sup>	322.60 ± 12.039 <sup>c</sup>
Galloway x heifer	28.99 ± 0.503 <sup>b</sup>	124.11 ± 3.105 <sup>b</sup>	183.60 ± 6.065 <sup>c</sup>	287.16 ± 4.191 <sup>b</sup>
Shorthorn x heifer	34.45 ± 0.742 <sup>a</sup>	163.84 ± 4.168 <sup>a</sup>	234.62 ± 7.381 <sup>b</sup>	345.53 ± 8.606 <sup>c</sup>

Different letters in columns means statistical significance  $P < 0.05$ .

BW – birth weight; W120 – weight at 120 days of age; W210 – weight at 210 days of age; W365 – weight at 365 days of age; b – bulls; h – heifers; GA – Galloway, SS – Shorthorn, BG – Blue-Grey type cattle = 50% of Galloway and 50% of Shorthorn.

rearing weight. According to Jenkins (2000), weaning weight is very dependent on cows' maternal traits. Therefore, it is possible to compare differences in milk production between tested breeds based on W210. Also, growth ability was comparable to other beef breeds bred

in Czech organic farming conditions (Aberdeen Angus, Charolais, Hereford) (Voříšková *et al.*, 2010). This suggest, that these breeds are well suited for Czech conditions, with a future possibility to improve growth ability traits even further with continual breeding.

## IV: Effect of sex, breed and interaction of them on daily weight gains using MIXED procedure.

effect	DWG120	DWG210	DWG365
	LSM ± SELSM	LSM ± SELSM	LSM ± SELSM
<b>breed</b>			
<b>Blue-Grey</b>	1020.46 ± 38.529 <sup>a</sup>	1045.4 ± 21.410 <sup>a</sup>	913.77 ± 19.916 <sup>a</sup>
<b>Galloway</b>	848.31 ± 17.522 <sup>b</sup>	817.81 ± 18.875 <sup>b</sup>	766.51 ± 7.856 <sup>b</sup>
<b>Shorthorn</b>	1148.68 ± 26.378 <sup>c</sup>	1053.67 ± 27.635 <sup>a</sup>	974.41 ± 18.731 <sup>a</sup>
<b>sex</b>			
<b>bull</b>	1067.38 ± 22.555 <sup>a</sup>	1052.65 ± 18.276 <sup>a</sup>	988.21 ± 12.733 <sup>a</sup>
<b>heifer</b>	944.25 ± 25.740 <sup>b</sup>	891.93 ± 20.472 <sup>b</sup>	781.58 ± 13.967 <sup>b</sup>
<b>breed x sex</b>			
<b>Blue-Grey x bull</b>	1079.50 ± 48.150 <sup>a</sup>	1101.86 ± 23.167 <sup>a</sup>	1041.24 ± 23.080 <sup>a</sup>
<b>Galloway x bull</b>	901.94 ± 20.333 <sup>b</sup>	902.73 ± 18.480 <sup>b</sup>	827.10 ± 10.834 <sup>b</sup>
<b>Shorthorn x bull</b>	1220.68 ± 36.157 <sup>c</sup>	1153.37 ± 37.885 <sup>a</sup>	1096.30 ± 28.789 <sup>a</sup>
<b>Blue-Grey x heifer</b>	961.41 ± 58.751 <sup>b</sup>	988.95 ± 32.165 <sup>b</sup>	786.30 ± 32.628 <sup>c</sup>
<b>Galloway x heifer</b>	794.67 ± 24.861 <sup>d</sup>	732.88 ± 28.358 <sup>c</sup>	705.93 ± 11.358 <sup>c</sup>
<b>Shorthorn x heifer</b>	1076.68 ± 34.091 <sup>a</sup>	953.97 ± 34.632 <sup>b</sup>	852.52 ± 23.324 <sup>b</sup>

Different letters in columns means statistical significance  $P < 0.05$ .

DWG120 – daily weight gain up to 120 days of age; DWG210 – daily weight gain up to 210 days of age; DWG365 – daily weight gain up to 365 days of age; b – bulls; h – heifers; GA – Galloway, SS – Shorthorn, BG – Blue-Grey type cattle = 50% of Galloway and 50% of Shorthorn.

## CONCLUSION

Influences of various effects on growth ability were identified in this study. Naturally, bulls proven to have significantly better growth ability compared to heifers. Effect of breed was statistically significant and show significant differences between tested breeds. The best results were achieved by purebred Shorthorns, closely followed by Blue-Greys. These significant differences in growth ability were also reflected within the interaction between the effects of breed and sex. Our results indicate that Shorthorn breed is well-suited for Czech conditions and is viable for use in organic farming, semi-intensive beef production systems of Czech Republic. Our results also suggest that Blue-Grey type crossbreds can achieve growth ability comparable to purebred SS and could be better suited for extensive farming systems.

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