

## **Study on the body conformation of breeding female cattle of the Rhodope Shorthorn Cattle breed**

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### **Abstract**

Malinova, R., & Nikolov, V. (2019). Study on the body conformation of breeding female cattle of the Rhodope Shorthorn Cattle breed. *Bulgarian Journal of Agricultural Science, 25(4), 756–761*

The present study involves 253 female animals of the autochthon Rhodope Shorthorn Cattle breed, reared in 4 regions of the breed main habitat – Central and Eastern Rhodope, and divided into 5 age classes – from 1 to 5 years of age. It has been ascertained that by 2 years of age, the heifers have body size and proportions close to those of the fully grown cows, and are thus with completed growth. The main body dimensions of the 2-year-old heifers – height at the withers, body length, chest girth and cannon bone girth are respectively 98.3%, 92.8%, 95.4% and 94.9% of those of the 5-year-old cows. The region has a significant effect on the animal growth and development, therefore, the breeding suitability of the animals needs to be assessed within the range of the respective region of rearing. The cows in Zlatograd region are the smallest, those in Kardzhali region – the largest, and those reared in Smolyan region have the best body proportions.

*Keywords:* cattle; autochthon breed; growth; development

### **Introduction**

The Rhodope Shorthorn Cattle (RSC) is an autochthon Bulgarian breed. Its main natural range of distribution is within the Rhodope Mountains. Describing the rearing conditions in the region, Hlebarov (1934) wrote that the scarce plain areas along the river valleys, having light, poor soil, are used as fields for tobacco planting and mowing meadows. The light and agile shorthorn cattle, which cannot be replaced by any other breed in these terrain and farming conditions, have been climbing, like goats, the extremely steep pastures so as to graze for ages. Nikolov (2012a) notes that the conditions described above have experienced insignificant changes, which is the reason why the breed has been preserved in its primitive state.

When it comes to indigenous breeds where the characteristics should be strictly observed on one hand, and the genetic diversity and the existing varieties to be maximally preserved on the other, a detailed description of the exterior

is necessary (Nikolov, 2012a). Therefore, the exterior and constitutional features, viability and reproductive capacity are the main controlled properties in the preservation of the Rhodope Shorthorn Cattle breeding programme (Nikolov, 2012b).

A many of authors examine the growth of the female animals and its relation to the period of reaching sexual and farming maturity, and the further productive life of the heifers (Heinrichs et al, 1992; Heinrichs & Hargrove, 1994). Heinrichs and Jones (2016) consider that the heifers should be used for breeding upon reaching a certain height at the withers and rump and a certain body weight. The authors recommend the heifers of the Holstein breed, at desirable breeding age from 13 to 15 months, to have reached 55% of the weight of the fully grown cows and 90% of the structural development (the height at the withers). After calving, the heifers must have reached 85-90% of the cows' body weight and 95% of their structural development. However, the heifers' growth must be com-

pared to the breed standards so as their normal development to be specified. According to Essein and Adesope (2003), the linear measurements provide an objective assessment regarding the growth and development of the cattle, and Bennett et al. (2008) consider that selection under certain exterior measurements, positively influences the percentage of difficult births in the herds, especially when it comes to heifers.

Data related to the exterior features of the RSC are reported by Slavov and Totev (1954), Tsonev and Vasilev (1962), Hinkovski et al. (1984), Nikolov (2012a), however, only study found in the available literature was that of Vasilev (1968), carried out in Agricultural and Stockbreeding Experimental Station in Smolyan. The same author (1970a,b) also examines the growth of crossbreeds with the Rhodope Shorthorn Cattle.

The present study aims at ascertaining the dynamics of the main exterior measurements of the female animals of the Rhodope Shorthorn Cattle breed in view of determining the optimal breeding age.

## Materials and Methods

The study is carried out with reference to female animals reared under conditions which are natural for the Rhodope Shorthorn Cattle breed. The body conformation measurements are collected from 253 animals divided into five age groups. Measurements of 177 cows from four regions – Smolyan (N-29), Kardzhali (N-19), Zlatograd (N-79) and Haskovo (N-50) are collected for the characterisation of the regional features of the cows. The animals included in the study are under selection control of the Association of Breeding Local Cattle Breeds (ABL CB).

All requirements for collecting exterior measurements are observed upon measurement. The measurements are performed by means of standard equipment – Lydtin's rod, measuring tape and a Wilkens' compass, at the points indicated by Nikolov and Stoyanov (2002).

The data are processed via ANOVA with the models having the following general statistical mode:  $Y_{ijk} = +AG_i + R_j + e_{ijk}$  (Model 1);  $Y_{ijk} = +AG_i + R_j + AR_{ij} + e_{ijk}$  (Model 2), where  $Y_{ijk}$  – exterior measurement, – overall average constant, AG and R are fixed effects of i-age group (i = 5 1-year-old calves, 2-year-old heifers, 3, 4, 5 and more-year-old cows) and j-region (n5) respectively; AR represents the random effect of the region on the age group;  $e_{ijk}$  – residual variance. One-way ANOVA with a factor – region (n-4) is used with reference to the cows above 5 years of age.

The data are statistically processed via specialized software IBM SPSS 21.

## Results and Discussion

Zootechnology literature recommends that the female animals be bred for the first time upon reaching 65-70% of the live body weight of the adults of the respective breed. Fricke (2003) advances the view that the heifers of the Jersey breed, which belongs to the Rhodope Shorthorn Cattle craniological group (*B. t. brahyceros*), should be bred for the first time at the age of 13-14 months, upon reaching body weight of 261 kg and height at the withers 114 cm, which is about 70% of the body weight and 90% of the height of the fully grown cows.

According to Vladimirov et al. (1986) the calves of the *Bulgarian Rhodope Cattle*, whose mother breed is the Rhodope Shorthorn Cattle, are born with a relatively small body weight (about 20 kg) but after that, they develop intensively to reach above 70% of the weight of the fully grown cows and at the age of 16-18 months, they can be subject to breeding. The studies of Gadzhev (2005), however, indicate a far higher age. He has ascertained that in the course of 25 years prior and after the breed recognition, the cows of the Bulgarian Rhodope Cattle breed calved at the average age of  $863.5 \pm 6.99$  days which means that the average first breeding age is 19.8 months.

Nikolov (2012a) claims that the early maturity of the Bulgarian Shorthorn Cattle myth is actually harmful due to the fact that the farmers tend to mistakenly go by the age and not by the animals' reaching the necessary body weight, and thus the heifers end up bred too early. According to author, the above-mentioned is probably one of the reasons for the subsequent low milk yield of the primiparous cows and the considerable difference in the first and second lactation milk yield.

Our study shows that the height at the withers of the one-year-old female calves of the Rhodope Shorthorn Cattle breed reaches 87.0% of that of the 5-year-old cows (Table 1), and the height at the back, loin, hook bone, tail base and the rump is respectively 86.5; 86.9; 86.7; 87.5; 88.3%. At 2 years of age, the height growth is practically completed; the above-mentioned heights but with reference to heifers are respectively 98.3; 99.2; 99.5; 98.5; 98.8; 98.2% of those of the cows. The height differences in the rest of the age groups are practically negligible.

Other breeds also indicate similar exterior linear parameters change tendencies. Karamfilov (2015), for example, indicates that the body height of the calves of the Montbeliard breed is completed by reaching the age of 24 months.

The individual height variation is low, with its highest index at one year of age. The dorsal line is relatively straight, slightly convex at croup in the animals of all ages exam-

**Table 1. Body height changes in Rhodope Shorthorn cattle breed females at different age**

Trait	Age group	N	LSM	± SE	SD	Min	Max
Height at the withers	1	5	92.2	2.48	13.18	73.0	106.0
	2	8	104.2	1.96	5.27	96.5	112.0
	3	43	104.5	0.84	3.84	95.0	112.0
	4	20	105.9	1.24	4.04	98.0	114.0
	5	177	106.0	0.41	5.74	89.0	118.0
Height at back	1	5	91.8	2.46	13.23	74.0	104.0
	2	8	105.3	1.94	4.42	98.0	111.0
	3	43	105.5	0.84	3.08	98.0	112.0
	4	20	106.3	1.23	3.42	98.0	114.0
	5	177	106.1	0.41	5.48	89.0	118.0
Height at the loin	1	5	94.5	2.31	11.91	78.0	106.0
	2	8	108.4	1.83	3.33	104.0	113.0
	3	43	108.5	0.79	3.61	98.0	116.0
	4	20	108.9	1.16	4.63	101.0	118.0
	5	177	108.9	0.39	5.36	93.0	122.0
Height at the hook bone	1	5	96.2	2.37	12.63	78.0	107.0
	2	8	109.3	1.87	2.76	106.0	114.0
	3	43	110.4	0.80	3.97	102.0	119.0
	4	20	110.1	1.18	4.53	102.0	117.0
	5	177	110.9	0.39	5.45	96.0	125.0
Height at the tail base	1	5	95.2	2.37	12.77	78.0	105.0
	2	8	107.5	1.88	3.38	103.0	112.0
	3	43	108.5	0.81	4.25	99.0	118.0
	4	20	108.3	1.18	4.54	99.0	116.0
	5	177	108.8	0.40	5.40	91.0	121.0
Height at the rump	1	5	86.1	2.64	11.83	70.0	96.0
	2	8	95.8	2.09	3.37	91.0	101.0
	3	43	96.9	0.90	4.93	87.0	106.0
	4	20	96.2	1.32	4.89	87.0	103.0
	5	177	97.5	0.44	6.10	80.0	115.0

**Table 2. Impact of the region and the age group on the body height changes in Rhodope Shorthorn cattle breed females**

Body height	F-criterion and confidence level				
	MDA 1		MDA 2		
	Region	Age group	Region	Age group	Region in age group
Height at the withers	7.772***	13.75***	52.44	171.7***	53.36*
Height at the back	8.369***	13.65***	11.282	170.2***	38.86
Height at the loin	4.888***	12.99***	9.689	154.0***	47.75*
Height at the hook bone	3.661**	12.59***	7.653	174.8***	49.14
Height at the tail base	3.503**	10.68***	24.76	138.8***	41.05
Height at the rump	2.978*	6.935***	65.55	123.3**	36.36

\*P < 0.05, \*\*P < 0.01, \*\*\*P < 0.001

ined. The croup looks sloped due to the height at the tail base which is low when compared to the height at the hook bone.

It can be seen that as a whole, the region and the age group affect significant of the body heights in the heifers of the Rhodope Shorthorn Cattle breed, however, the age

group like a sours of variation in the different regions only differ significantly in the heights at the withers and the loin. (Table 2)

During the postembryonic ontogenesis of the ruminants, length growth is more likely to occur than height growth.

**Table 3. Body length and bone development in Rhodope Shorthorn cattle breed females at different age**

Trait	Age group	N	LSM	± SE	SD	Min	Max
Oblique length of body	1	5	111.3	5.035	15.85	83.00	123.0
	2	8	120.3	3.243	8.598	106.0	130.0
	3	43	120.0	2.551	8.812	102.0	144.0
	4	20	127.8	2.774	7.388	115.0	139.0
	5	174	129.6	0.783	10.60	107.5	162.0
Length of body	1	5	86.88	3.311	8.295	72.00	94.00
	2	8	94.28	2.133	3.926	89.00	100.0
	3	43	98.52	1.677	5.761	86.00	123.0
	4	20	100.4	1.824	4.322	94.00	110.0
	5	174	105.0	0.515	6.300	87.00	122.0
Cannon bone girth	1	5	13.00	0.547	1.204	11.00	14.00
	2	8	14.00	0.352	0.535	13.00	15.00
	3	43	14.35	0.277	0.851	13.00	16.00
	4	20	14.51	0.302	0.907	13.00	16.00
	5	174	14.75	0.085	1.022	12.00	18.00

Table 3 clearly indicates that the oblique body length of the 5-year-old cows is 14.8 % larger than that of the one-year-old calves, which in turn is comparable and even lower than the height at the withers change. A more significant body proportions change may be observed in the preceding period but between 1 and 5 years of age, the female species of the Rhodope Shorthorn Cattle breed exhibit a proportional change in length and height of the body.

The individual variation in the body length is higher than that in the body height, and again it is the highest at youngest age.

Bone development has a lower change intensity than that of the height change; the cannon bone girth in the 5-year-old cows is 13.5 % bigger than that of the one-year-old calves. The greatest difference can be observed between 1 and 2 years – 1 cm, it decreases to 0.35, 0.16 and 0.24 each following year.

Considerable age differences may be observed with reference to chest and croup development (Table 4). The length of the chest of the 1-year-old calves is 74.4% of that of the fully developed cows. Between 1 and 2 years of age, the chest length increases by 11 cm (20.8%). During the third year, the increase pace slows down and only a 3 cm (6.4%) difference can be seen. The same tendency is retained during the fourth and the fifth year. The chest length of the 2-year-old heifers is 89.8% of that of the cows, and at 3 years of age – 95.5%. In the Montbeliard breed (Karamfilov, 2015), for example, the difference in the chest length between 2 and 1 years of age is 15.3% – at 1 year of age, the chest length was 83.7%, and at 2 years of age, it was 96.6% of that of the fully grown cows.

EBM (2013) examine the chest girth of the Montbeliard breed as it is considered the most objective indicator of reaching a suitable age for first breeding and first calving. Upon measurements, performed in Bulgaria, Karamfilov (2015) ascertained that at 18 months, the heifers of the Montbeliard breed had a chest girth of average  $180.16 \pm 2.80$  cm, which is within the scope of the French selection linear development requirements. The data provided above displays that the respective girth is 88% of the chest girth of the fully grown cows.

The chest girth of the 1- and 2-year-old animals studied by us is respectively – 82.4 and 95.4% of the chest girth of the fully grown cows. The above mentioned share but with reference to the Montbeliard at the ages indicated is respectively 72.0 and 100% (Karamfilov, 2015).

The chest girth difference during the periods indicated is on account to the width and the depth with the former being of greater importance. From 1 to 2 years of age, the chest width increases by 35.8%, and during the next 3 years – there is actually no change. Similar change can be seen in the chest depth – from 1 to 2 years of age, it increases by 22.5%, and during the next 2 years, it does not change. At 1 and 2 years of age, the width is respectively 72.8 and 97.8% of that in cows, and the depth is 79.1 and 97.3% respectively.

The croup development is an important trait as it provides an insight into the pelvic development, which is part of the pelvic cavity and predetermines the ease of calving. According to Nikolov (2008) one of the main reasons of difficult calving is the juvenile (immature) pelvic.

Unlike the chest whose development ends when the Rhodope Shorthorn Cattle reaches 2 years of age, when the croup is

**Table 4. Chest and croup measurements in Rhodope Shorthorn cattle breed females at different age**

Trait	Age group	N	LSM	±SE	SD	Min	Max
Chest length	1	5	53.0	2.54	7.84	43.0	64.0
	2	8	64.0	2.00	3.96	56.0	68.0
	3	43	68.0	0.86	5.66	54.0	79.0
	4	20	68.4	1.27	5.61	59.0	80.0
	5	176	71.2	0.42	5.69	55.0	92.0
Chest width	1	5	20.8	1.55	7.25	13.0	28.0
	2	8	28.2	1.22	2.43	26.0	32.0
	3	43	28.5	0.53	3.13	21.5	35.0
	4	20	28.5	0.77	2.53	24.0	32.0
	5	176	28.8	0.26	3.54	19.0	38.0
Chest depth	1	5	44.4	1.49	8.01	33.0	53.0
	2	8	54.3	1.18	2.06	51.0	57.0
	3	43	54.5	0.51	1.94	48.0	59.0
	4	20	54.6	0.74	2.61	50.0	60.0
	5	176	56.1	0.25	3.54	36.0	65.0
Chest girth	1	5	124.4	3.43	13.14	106.0	136.0
	2	8	144.1	2.71	4.15	137.0	150.0
	3	43	145.1	1.17	5.49	132.0	155.0
	4	20	148.0	1.71	5.17	138.0	159.0
	5	176	151.0	0.57	8.27	130.0	176.0
Croup length	1	5	36.8	1.33	4.38	30.0	41.0
	2	8	41.1	1.05	1.55	38.0	43.0
	3	43	41.3	0.45	1.98	38.0	45.0
	4	20	42.4	0.66	1.79	39.0	45.0
	5	176	42.8	0.22	3.26	31.0	53.0
Hook bone width	1	5	31.4	1.20	5.41	25.0	38.0
	2	8	36.7	0.94	1.66	34.0	39.0
	3	43	38.7	0.40	2.22	34.0	46.0
	4	20	40.1	0.60	1.55	37.0	43.0
	5	176	41.2	0.20	2.81	32.0	49.0
Width at the hip joints	1	5	28.8	1.10	4.60	23.0	35.0
	2	8	33.3	0.87	1.30	32.0	36.0
	3	43	34.8	0.37	1.74	29.0	38.0
	4	20	35.4	0.55	1.90	32.0	39.0
	5	176	36.3	0.18	2.64	28.0	45.0

**Table 5. Main exterior measurements in cows of the Rhodope Shorthorn Cattle breed reared in different regions, cm**

Trait	F-criterion and confidence level	With reference to the breed N = 177	Smolyan N = 29	Kardzhali N = 19	Zlatograd N = 79	Haskovo N = 50
		LSM ± SE				
Height at the withers	10.346***	107.2 ± 0.462	106.7 ± 0.992	112.2 ± 1.225	105.2 ± 0.601	104.6 ± 0.755
Oblique body length	3.670**	129.3 ± 0.894	126.2 ± 1.917	135.5 ± 2.372	127.5 ± 1.163	128.1 ± 1.462
Chest width	2.524*	28.94 ± 0.303	29.45 ± 0.650	28.26 ± 0.803	28.23 ± 0.394	29.81 ± 0.496
Chest depth	1.922	56.46 ± 0.303	57.28 ± 0.651	57.00 ± 0.804	55.70 ± 0.395	55.85 ± 0.496
Chest girth	10.659***	152.5 ± 0.664	157.4 ± 1.426	152.7 ± 2.949	148.2 ± 0.864	151.2 ± 1.086
Cannon bone girth	1.719	14.74 ± 0.088	14.81 ± 0.188	14.90 ± 0.233	14.47 ± 0.114	14.78 ± 0.143

\*P < 0.05, \*\*P < 0.01, \*\*\*P < 0.001

gradually changing during all periods examined (Table 4). The croup length gradually increases from 1 to 5 years of age by 11.8, 0.5, 2.72 and 1%; the hook bone width increases by 17.0, 5.5, 3.4 and 2.9% and that at the hip joints by 15.9, 4.3, 1.7 and

2.8%. The croup length of the one-year-old calves is 85.9% of that of the cows, and the one of the two-year-olds- 96.0%. The hook bone width at the same age is respectively 78.3 and 91.6 % and the width at the hip joints- 79.1 and 95.7%.

To large extent, the influence of the region on the body proportions changes dynamics is related to the variations in the size of the cows of the breed, reared in the different regions of the range. It is also possible the conditions in the region to be the cause for the above mentioned variations. The region is significant source of variation with reference to the height at the withers, the oblique body length, chest width and girth (Table 5). The cows of the Kardzhali region are the tallest, and those reared in Haskovo – the shortest. Kardzhali is also the region where the cows have largest oblique body length, and Smolyan is the one where it is the smallest. The cows reared in Smolyan region indicated the best developed chest. As a whole, the cows reared in Zlatograd region showed the lowest values in all parameters examined.

## Conclusions

By reaching 2 years of age, the heifers of the Rhodope Shorthorn Cattle breed have size and body proportions similar to those of the fully grown cows which proves them suitable for breeding. The main body measurements – height at the withers, oblique body length, chest girth and cannon bone girth of up to 2-year-old heifers are respectively 98.3, 92.8, 95.4 and 94.9% of the same parameters of fully grown cows.

The region has significant influences on the body proportion of the animals. Therefore, their breeding suitability must be assessed within the scope of the respective region of rearing. The cows reared in Zlatograd region are the smallest, those reared in Kardzhali are the largest, and those in Smolyan region have the best body proportions.

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