Change of seed productivity of spermodonorous bulls belonging to the Bushuev breed by seasons of the year

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Abstract. Genetic productivity, feeding and maintenance conditions, and intra-herd characteristics are only a few of the variables that have an impact on the productivity of the cattle business. For coordinating production, several elements are essential [1–5]. Yet, it is also crucial to take into account the importance of current cattle in various economic farm categories around the nation. Personal assistants' and peasant farmers' individual family farms are smaller, more numerous, dispersed, have fewer financial and economic resources, and are run differently from bigger agricultural operations. Various factors have an impact on the productivity of the livestock industry. These include genetic productivity, feeding and maintenance conditions, and factors that are present within a herd. These factors play a crucial role in the organization of livestock production. The research project focuses on the study of five breeding bulls of the Bushuev breed, which are maintained at the state enterprise "Uznaslchilik", under the same conditions as five other breeding bulls of the same age (two years). According to the results, the spring season had a positive impact on the reproductive function of breeding bulls, resulting in an increase in the volume of ejaculates. This increase ranged from a minimum of 0.17 ml in Angus bulls to a maximum of 0.43 ml in Bushuev bulls, showing an increase of 105-116%. **Keywords.** Breeding bulls, semen, spermatozoa, concentrates, motility, morphology, evaluation

1 Introduction

The productivity of the livestock industry is affected by factors such as genetic productivity, feeding and maintenance conditions, and intra-herd factors. These factors are crucial for organizing production [1-5]. However, it is also important to consider the weight of existing cattle in different economic categories of farms within the republic. The individual family farms belonging to personal assistants and peasant farms are smaller, numerous, and scattered, with limited financial and economic resources, and are managed differently compared to larger agricultural enterprises [4-7, 11-14]. Despite this, these smaller farms have the largest share in the total cattle herd of the republic and the total volume of production of related livestock products [7-12]. Over the last 5 years, private farms have taken care of 92-93% of the total number of cattle in the republic, including 94% of cows. This implies that the majority of available opportunities for improving productivity are concentrated in these private farms (Table 1).

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Table 1. The structural share of the herd of cattle in the republic by economic categories (the indicators of the last 5 years are rounded on average)

Economic categories	Share in herd, %	
	Total cattle	Including cows
In farms	5.0	7.0
And other agricultural enterprises engaged in cattle breeding	1.0	1.0
Farmer (personal assistant) on farms	93.0	92.0

Table 1 shows that private farms have the largest internal potential reserve in terms of the number of cattle. However, the republic has mainly focused on dairy breeds suitable for industrial dairy farming, resulting in the use of breeding materials belonging to such breeds based on the composition of the herd formed over time. Private livestock farms are relatively small, mature, and require less feed, making them less sensitive to feed conditions. However, due to the lack of storage and feeding, preventive conditions against infectious and non-infectious diseases typical of hot regions, they are not well-suited for certain breeds. Nevertheless, breeds that are resistant to blood-parasitic diseases are more suitable, and although they produce relatively less milk, their milk fat content is high [1-7].

It is important to note that the Bushuev breed is the only breed of cattle created in our country that is highly suitable for local conditions. This breed is known for its high milk yield and fat content, as well as the vitality of its young cattle, rapid maturation, and meat-producing characteristics of its bulls. However, due to the limited number of cattle belonging to this breed, their effective use requires a scientific approach to breeding and innovative methods. One way to improve the breed is by taking care of high-quality spermatozoa bulls, obtaining high-quality sperm products from them, deep freezing and storing them, and using artificial insemination to impregnate female cows on private farms. This approach can achieve high results in terms of both quantity and quality of cattle production [2-6].

This approach is based on the decision of the President of the Republic of Uzbekistan dated January 29, 2020 No. PQ-4576 “On additional measures of state support for the livestock sector” “organization of the activities of all sectors of livestock farming on a scientific basis, the production of products based on the results of scientific research and innovative developments and “establishing introduction to breeding-selection practice” [3]. In this regard, certain works were carried out at the state enterprise “OZNASLCHILIK”, which occupies an important place in the cattle breeding of the Republic of Uzbekistan. In addition to dozens of breeding bulls belonging to the milk and meat sectors, breeding bulls of the Bushuev breed were also taken care of, seed collection, evaluation of the obtained seed, deep Freezing and delivery to places have been started.

The approach mentioned in the previous text is based on a decision by the President of the Republic of Uzbekistan (PD-4576), dated January 29, 2020, which aims to support the livestock sector by organizing activities on a scientific basis and introducing innovative developments to breeding and selection practices [3]. To implement this decision, work has been carried out at the state enterprise “OZNASLCHILIK”, which plays a significant role in cattle breeding in Uzbekistan. In addition to taking care of breeding bulls belonging to the milk and meat sectors, the enterprise has also focused on breeding bulls of the Bushuev breed, collecting and evaluating their seed, and deep freezing and delivering it to various locations.

The reproductive characteristics of animals are influenced by seasonal changes in air temperature, light, and humidity, regardless of favorable microclimatic conditions. The duration of the spermatogenesis process, which lasts for 61 days during a single season, is also impacted by these climatic changes [4-7]. In addition, the regulation of body

temperature in animals affects the central nervous system's response to reproductive hormones, resulting in seasonal fluctuations in reproductive activity.

The impact of seasonal changes on animal reproductive characteristics has been studied by several researchers. N.A. Malygina, A.V. Bulaeva, and D.K. Romanova's research in 2017 found that the Red-Ola breed had the highest reproductive indicators, while the Simmental bulls had the lowest [9]. V. M. Shestakov's data from 1981 showed that all animals had accelerated sexual activity in the spring and summer seasons, which was attributed to increased light exposure, physical activity, and a vitamin-rich diet. L.N. Sharygina's 2003 [11] data indicated that the volume of ejaculate in breeding bulls was 10-12% higher in summer than in other periods, and this finding was corroborated by EM Murphy, A.K. Kelly, CO Meara, and B. Eivers. Additionally, EMMurphy et al. in 2018 noted that Holstein-Friesian bulls had lower semen volume and concentration in winter and early spring compared to other periods [11-17].

The quality of sperm production is as important as its volume. E.V. Chetvertakova's 2012 data showed that 22.1% and 21.4% of the semen obtained from Black-Ola and Black-Ola Holstein bulls, respectively, during the winter season were of poor quality, and the volume of semen was 15.17 ml less than that of Simmental bulls. L.V. Khalturina's research on this breed supported these findings [13,14]. The impact of seasonal changes on sperm quality varies across different breeds, as noted by Russian scientist Yu. V. Anbaza in 2019. N.W. Sidorova's 2014 study on the influence of care conditions on breeding bulls' sperm productivity at the Kurskoe breeding enterprise in Russia found that the decrease in sperm quantity and quality began in November and was more pronounced in February-March, which the author attributed to a decrease in the amount of vitamins in the animals' feed and their biological rhythms [14-17].

Bulls' activity increases with an extension in the light period of the day. This is reflected in the average number of ejaculates, which is 1.5-2.0 during the spring season in all milk, milk-meat, and meat breeds. The decline in activity during the summer season occurs earlier in bulls belonging to meat breeds, according to the same author [19-23]. H. Swaiwe and E. Brus's 1986 data demonstrated that the fertilization rate of summer sperm is generally higher than that obtained during the winter season, but a sharp decrease in seed quality occurs during very hot summers that last for a short period. V.A. Malenkix et al.'s 2011 research revealed that a significant change in air temperature and humidity affects seed activity. V.S. Antonyuk's information suggested that an increase in humidity during the cold season and a decrease in the hot season negatively affects the spermatogenesis process [19-22, 25-27].

The decrease in semen concentration mainly depends on the individual characteristics of bulls rather than the seasons of the year [1]. The author notes that while the volume of ejaculate decreases in autumn and winter, the concentration tends to increase. Additionally, the volume of sperm per ejaculate is lowest in young bulls during winter and gradually increases, reaching a peak in autumn [19-20]. This increase in volume is attributed to the age of the bulls. Therefore, it can be concluded that sperm concentration is influenced by individual characteristics rather than age or season.

The quantity and quality of semen production in bulls are influenced by various factors, including seasonal changes. An increase in sperm count and ejaculate volume is more commonly observed in spring due to seasonal biological androgenic activity in bulls during that time [23,33]. However, winter semen production is of relatively high quality, and recommend reducing the frequency of seed collection in the summer season to achieve similar results [27, 28]. Meanwhile, Brito's research indicates that neither air temperature nor humidity significantly affect sperm volume and quality. On the other hand, the amount of light, which varies across different geographic latitudes, has a decisive impact on spermatogenesis due to the differences in the duration and intensity of daylight.

Extending the duration of light to 15 hours per night can result in early sexual maturation of bulls and satisfactory seed quantity and quality at 8 months of age [16]. This finding is supported by A.I. Nauk, who noted the positive effects of extended light duration on ejaculate volume [28]. The best seed quality is achieved at an air temperature range of +15 to +20°C.

It is important to note that the quality of spermatozoa is maintained by keeping the temperature in the testicles of animals 2-5°C lower than the body temperature, as it is a crucial feature for ensuring the quality of spermatozoa.

The objective of this study is to investigate the specific characteristics of young breeding bulls of the Bushuev breed as sperm donors and to analyze their changes in seed productivity based on seasonal variations. The research aims to examine the seed productivity indicators of young breeding bulls of the Bushuev breed in comparison to other breeds.

2 Materials and methods

The research project focuses on the study of five breeding bulls of the Bushuev breed, which are maintained at the state enterprise "Uznaslchilik", under the same conditions as five other breeding bulls of the same age (two years). The latter bulls have been selected as analogues based on the principle of similarity [1-7, 9-15]. The study aims to analyze the sperm productivity indicators of these bulls during four different seasons, namely spring (April), summer (July), autumn (November), and winter (January), using the ejaculate volume (ml), sperm concentration (billion/ml), and the total number of sperm per ejaculate (billion/e) as quantitative parameters [18-21].

The evaluation of sperm products follows the international standards set by the Interstate Council for Standardization, Metrology, and Certification (MGS) of the Commonwealth of Nations. The sampling methods for sperm are based on Clause 5 of the international standard GOST - 32222-2013, "General requirements," and the samples are collected using the "Sperm sampling procedure" outlined in Clause 7. The sperm evaluation is carried out using fresh, undiluted semen of bulls in accordance with the technical conditions of the international standard (GOST - 23745-2014), which specify the measurement of the ejaculate volume (ml), sperm concentration (mlrd/ml), and the total number of sperm (billion) in the ejaculate [1-11]. The volume of sperm is determined using a measuring tube, while the concentration and number of sperm are assessed using a special "MINITUB" (ANDROVISION) equipment made in Germany, which includes an electronic microscope and a counting camera [4-7, 25]. The statistical analysis of the data is performed using Mf Office and EXCEL software.

3 Results and discussion

During the winter season, the semen productivity of breeding bulls increased steadily, reaching its highest level in April. However, when analyzing these indicators by breed, it was observed that although the volume of ejaculate of breeding bulls of all breeds was relatively small during the winter season, it was found that the volume of ejaculate of bulls of the Bushuev breed, which are best adapted to local conditions, was higher compared to the average volume of ejaculate of bulls of large-bodied breeds imported from abroad, such as Angus and Holstein bulls. These imported breeds had an average volume of ejaculate of 0.11 ml or 5% in Angus bulls and 0.9 ml or up to 10% in Holstein bulls. However, when it comes to the concentration of sperm in ml of sperm, the foreign bred bulls showed lower values compared to domestic Bushuev bulls. For instance, the Angus breed had a lower concentration of 0.05 billion or 7%, while the Angler breed had 0.11 billion or 15%. In terms of the total amount of sperm in one ejaculate, Holstein bulls had lower values of up to 0.04 billion or 1.4%, whereas Angler bulls showed low values of up to 0.23 billion or 9.2% (Table 2).

Table 2. Breeding bulls in the experiment are fertile average indicators ((X ±S x),p = 5, E = 30).

Breed groups		Average volume of ejaculate, ml	Sperm concentration in 1 ml of sperm, billion/ml	Number of sperms in 1 ejaculate, billion
in winter (January)				
I	Bushuev	3.5 ±0.09	0.75±0.15	2.49±0.45
II	Holstein	3.59±0.13	0.68±0.11	2.45±0.52
III	Angler	3.53±0.14	0.64±0.13	2.26±0.55
IV	Schwitz	3.46±0.10	0.69±0.9	2.39±0.35
V	Simmental	3.56±0.10	0.66±0.08	2.35±0.60
VI	Angus	3.43±0.13	0.70±0.13	2.40±0.45
in spring (may)				
I	Bushuev	3.80±0.17	1.18±0.07	4.64±0.29
II	Holstein	3.96±0.25	0.85±0.21	3.38±0.17
III	Angler	3.81±0.11	0.77±0.16	2.93±0.20
IV	Schwitz	3.67±0.31	0.87±0.23	3.19±0.13
V	Simmental	3.89±0.22	0.84±0.30	3.26±0.19
VI	Angus	3.61±0.19	0.91±0.18	3.28±0.11
in summer (july)				
I	Bushuev	3.50±0.24	1.09±0.12	3.94±0.57
II	Holstein	3.36±0.27	0.68±0.22	2.30±0.65
III	Angler	3.28±0.29	0.65±0.18	2.14±0.69
IV	Schwitz	3.27±0.19	0.72±0.22	2.36±0.71
V	Simmental	3.50±0.20	0.70±0.24	2.43±0.75
VI	Angus	3.21±0.24	0.77±0.142	2.48±0.63
in autumn (October)				
I	Bushuev	3.60±0.14	1.13±0.8	4.07±0.33
II	Holstein	3.96±0.19	0.75±1.8	2.97±0.46
III	Angler	3.88±0.24	0.71±1.1	2.77±0.43
IV	Schwitz	3.8±0.18	0.78±1.0	2.97±0.42
V	Simmental	3.9±0.24	0.75±1.3	2.95±0.47
VI	Angus	3.78±0.17	0.85±0.9	3.22±0.39
Note: P≤ 0.995- 0.999				

The spring season had a positive impact on the reproductive function of breeding bulls, resulting in an increase in the volume of ejaculates. This increase ranged from a minimum of 0.17 ml in Angus bulls to a maximum of 0.43 ml in Bushuev bulls, showing an increase of 105-116%. However, due to the sudden rise in air temperature unique to Uzbekistan, a decrease in productivity indicators was observed. This decrease was the least in Bushuev breed bulls, with a decrease of 0.30 ml or up to 8.0%, and the most in Holstein bulls, with a decrease of 0.59 ml or up to 15% based on ejaculate volume of breeding bulls in that category. Additionally, the concentration of sperm in 1 ml of sperm by breed decreased from 0.09 billion or 8.0% to 0.17 billion or 20%, and the number of sperms in 1 ejaculate also decreased from 0.70 billion or 8.0% to 1.08 billion or 32%, respectively. This decrease was attributed to the negative effects of scorching heat (Fig. 1-3).

Following the cooling of air temperatures after the heat of the autumn season (October), an increase in ejaculate volume was observed in breeding bulls. The increase was the least in Bushuev breed bulls at 0.10 ml or 3.0% and the most in Angler breed bulls at 0.61 ml or 19%. The concentration of spermatozoa in 1 ml of sperm ranged from 0.04 billion or 4.0% (Bushuev) to 0.08 billion or 10% (Angus), while the number of sperms in 1 ejaculate increased from 0.13 billion or 3.0% (Bushuev) to 0.73 billion or 30% (Angus). Notably, the

clinical and seed productivity indicators of domestic Bushuev bulls were found to have significantly less negative changes in the seasons compared to imported breeding bulls, and even showed a sharp positive change in seed productivity during the spring season (Fig. 1-3).

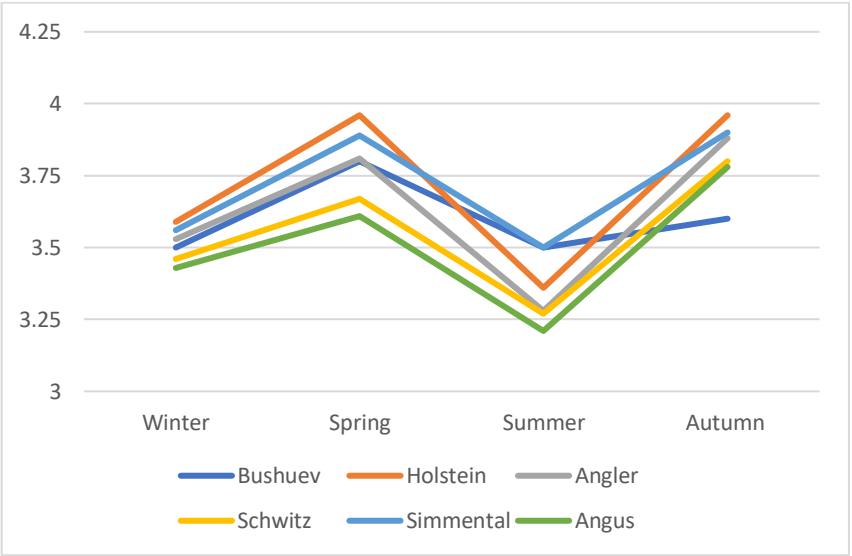

Fig. 1. Changes in the volume of ejaculate according to the seasons, ml.

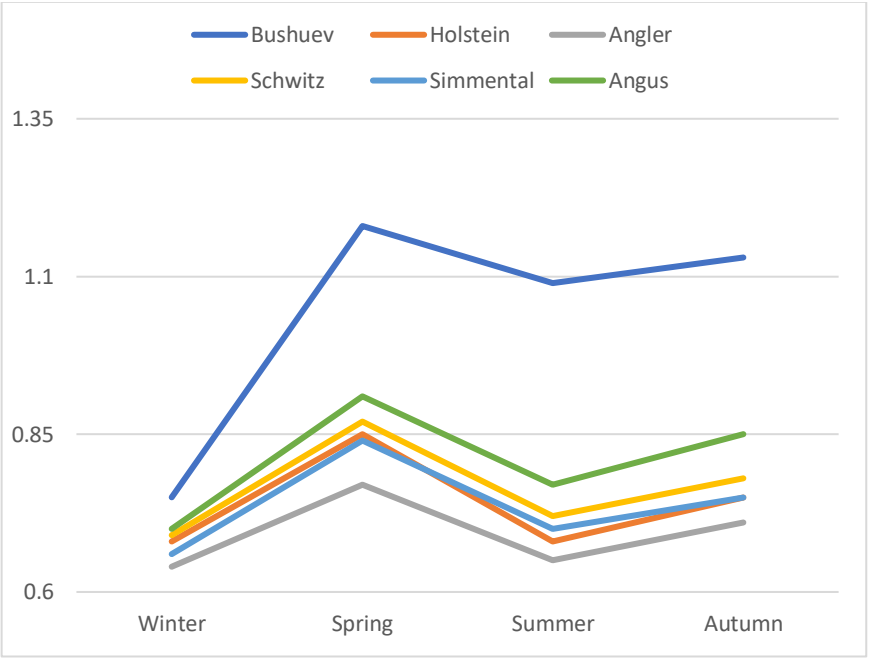

Fig. 2. Changes in sperm concentration according to the seasons, 1 ml/billion.

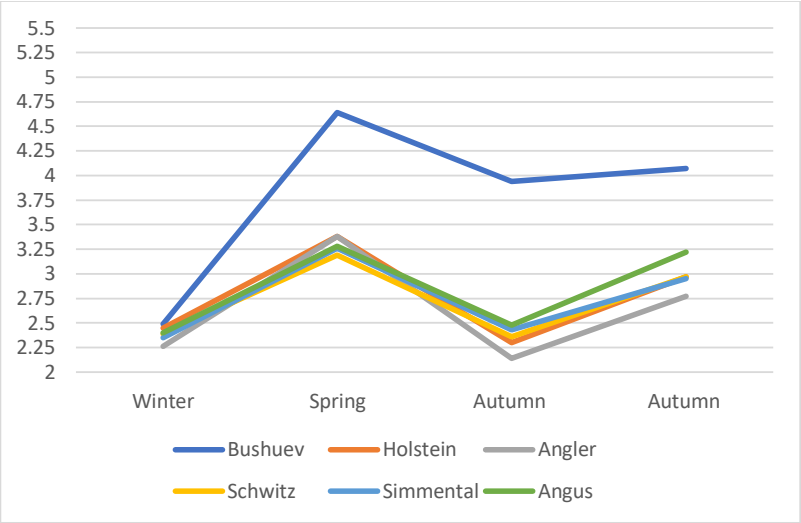

Fig. 3. Number of sperm in 1 ejaculate, billion.

4 Conclusions

The findings of the study suggest that local climatic conditions have a significant influence on the seed productivity of breeding bulls of the Bushuev breed in comparison to foreign breeding bulls. Notably, there were no marked adverse effects observed across seasons. On the contrary, a positive upswing in seed productivity indices was distinctly observed in the spring season in comparison to other imported bulls. Our interpretation is that this favorable trend could be attributed to the retention of certain traits from their relatively untamed, zebu-like indigenous forebears.

These results offer a basis for the efficient use of Bushuev breeding bulls in terms of both quantity and quality in the spring and autumn seasons. Scientific predictions of changes in seed productivity should be leveraged to organize their judicious utilization throughout the year. However, greater emphasis ought to be placed on the quality of seed, particularly for imported bulls, during the winter and summer seasons.

References

1. Rakhimov A. (2021). Importance of suitability of cattle breed characteristics to different categories of farms in increasing the economic efficiency of the cattle breeding sector in Uzbekistan *"Agroilm" journal* **3** (73), pp. 51-53.
2. Amirov Sh. Q., Boybulov B. Sh. (2020). Productivity of B ushuev breed improvement - the demand of the times *"Livestock and breeding work"* journal, **1** (12), pp. 10-13.
3. Presidential Decree, PD-4576, (2020) "On additional measures of state support for the livestock sector".
4. Al-Kanaan, A., König, S., & Brügemann, K. (2015). Effects of heat stress on semen characteristics of Holstein bulls estimated on a continuous phenotypic and genetic scale *Livestock Science* **177** pp. 15-24. Doi: 10.1016/j.livsci.2015.04.003
5. Bhakat, M., Mohanty, T. K., Gupta, A. K., & Abdullah, M. (2014). Effect of season on semen quality of crossbred (Karan Fries) bulls *Adv. Anim. Vet. Sci* **2**(11) pp. 632-637. Doi: 10.14737/journal.aavs/2014/2.11.632.637
6. Malama, E., Zeron, Y., Janett, F., Siuda, M., Roth, Z., & Bollwein, H. (2017). Use of computer-assisted sperm analysis and flow cytometry to detect seasonal variations of

bovine semen quality *Theriogenology* **87** pp. 79-90. Doi: 10.1016/j.theriogenology.2016.08.002

7. Snoj, T., Kobal, S., & Majdic, G. (2013). Effects of season, age, and breed on semen characteristics in different Bos taurus breeds in a 31-year retrospective study *Theriogenology* **79**(5) pp. 847-852. Doi: 10.1016/j.theriogenology.2016.08.002
8. Menegassi, S. R. O., Barcellos, J. O. J., Dias, E. A., Koetz, C., Pereira, G. R., Peripolli, V., ... & Lopes, F. G. (2015). Scrotal infrared digital thermography as a predictor of seasonal effects on sperm traits in Braford bulls *International journal of biometeorology* **59** pp. 357-364. Doi: 10.1016/j.theriogenology.2016.08.002
9. Malygina, N.A., Bulaeva A.V., Romanova D.K. (2017). Evaluation of qualitative and quantitative indicators of sperm of bulls of different breeds and the impact of ecogenesis *Bulletin of the Altai State Agricultural University* **2** (148) pp. 118-126.
10. Shestakov, V.M., Zhebrovsky L.S. (2001). On the possibility of selection of sires on the basis of tolerant ability to cosmic geophysical factors *Breeding, selection, genetics and reproduction of agricultural animals* pp. 82-85.
11. Sharygina, L.N. (2003). Comparative characteristics of bulls of Ayrshire and Holstein breeds by sperm production. Kolos, Moscow pp. 23.
12. Murphy, E. M., Kelly, A. K., O'Meara, C., Eivers, B., Lonergan, P., & Fair, S. (2018). Influence of bull age, ejaculate number, and season of collection on semen production and sperm motility parameters in Holstein Friesian bulls in a commercial artificial insemination centre *Journal of animal science* **96**(6) pp. 2408-2418. Doi: 10.1093/jas/sky130
13. Anbaza, Yu.V. (2018). Influence of age on native sperm production of bulls-sperm donors *Proceedings of II International scientific and practical conferences, Krasnoyarsk* pp. 50-54.
14. Sidorova, N.V. (2014). Influence of conditions of feeding and maintenance of sires on sperm productivity and sperm quality *Bulletin of the Kursk State Agricultural Academy* **5** pp. 59-60.
15. Swalwe, H., Brus E. (1986). Considering relationship and genetics growth-ping in mixed model sire evaluation *Philosophical Transactions of The Royal Society B Biological Sciences* **2** pp. 123-138.
16. Basovsky, N.Z., Degtyareva S.P. (1982). Evaluation of the genotype of bulls by reproductive ability, taking into account the influence of genetic factors *XXXIII annual conference of the European Association for Livestock* pp.6.
17. Dyakevich, O.N. (1996). Seasonal depression of the reproductive function and hematological indicators of the stress state of bulls. *Agricultural biology Animal biology series* **5** pp. 79-83.
18. Nauk, V.A. (1984). The effect of external factors on the sperm production of bulls *Animal husbandry* **6** pp. 46-48.
19. Fominykh, G.I., Ivanova G.I. (1984) The quality of sperm of bulls of the black-and-white breed and its fertilizing ability according to the seasons of the year *Improvement of breeds and pedigree qualities of cattle* pp. 70-72.
20. Kononov, V.P., Dyakevich O.N. (2007). Sexual activity of bulls by seasons of the year *Zootechnics* **5** pp.20-22.
21. Brito, L. F. C., Silva, A. E. D. F., Rodrigues, L. H., Vieira, F. V., Deragon, L. A. G., & Kastelic, J. P. (2002). Effect of age and genetic group on characteristics of the scrotum, testes and testicular vascular cones, and on sperm production and semen quality in AI bulls in Brazil *Theriogenology* **58**(6) pp.1175-1186. Doi: 10.1016/s0093-691x(02)00921-4
22. Godfrey, R. W., Lunstra, D. D., Jenkins, T. G., Berardinelli, J. G., Guthrie, M. J., Neuendorff, D. A., ... & Randel, R. D. (1990). Effect of season and location on semen

quality and serum concentrations of luteinizing hormone and testosterone in Brahman and Hereford bulls *Journal of animal science* **68**(3) pp.734-749. Doi: 10.2527/1990.683734x

23. Porfiriev, I.A., Rabinovich I.E. (2003). Reproductive qualities and adaptive ability of bulls-producers of the Holstein and Red Danish breeds in the conditions of the Altai Territory *Agricultural biology* **4** pp. 62-68.
24. Fuerst-Waltl, B., Schwarzenbacher, H., Perner, C., & Sölkner, J. (2006). Effects of age and environmental factors on semen production and semen quality of Austrian Simmental bulls *Animal reproduction science* **95**(1-2) pp. 27-37. Doi: 10.1016/j.anireprosci.2005.09.002
25. Gredler, B., Fuerst, C., Fuerst-Waltl, B., Schwarzenbacher, H., & Sölkner, J. (2007). Genetic parameters for semen production traits in Austrian dual-purpose Simmental bulls *Reproduction in Domestic Animals* **42**(3) pp. 326-328. Doi: 10.1111/j.1439-0531.2006.00778.x
26. Murray, M. T. (1997). Male infertility: a growing concern *Am J Natural Med* **4** pp.9-16.
27. Saacke, R. G. (2001). What is a BSE–SFT standards: the relative importance of sperm morphology: an opinion *Proc Soc Theriogenol* pp. 81-87.
28. Waites, G. M. H. (1970). Temperature regulation and the testis *The testis* **1** pp.241-279.