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INFLUENCE OF GROWTH AND DEVELOPMENT INDICATORS OF HOLSTEIN HEIFERS ON THEIR PRODUCTIVITY AFTER THE FIRST CALVING

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The study analyzed the impact of growth and development parameters of Holstein heifers on their subsequent productivity after the first calving. The material was based on records of first-calf cows (n = 570) raised at STOV "Promin" (Mykolaiv region).

It was found that the live weight of heifers at birth had a statistically significant effect on the lactation duration (P = 0.047) and total milk yield per lactation (P = 0.002), whereas the relationship with the 305-day lactation yield was not significant (P = 0.162).

The analysis showed no statistically significant effect of the average daily gain of heifers from birth to 90 days of age on lactation duration (P = 0.161), total lactation yield (P = 0.700), or 305-day yield (P = 0.413).

The dependence of primiparous productivity indicators on live weight at 90 days of age also revealed no statistically significant influence on lactation duration (P = 0.826), total lactation yield (P = 0.487), or 305-day yield (P = 0.128).

According to the results, the average daily gain of heifers from birth to insemination had no significant effect on lactation duration (P = 0.306), total lactation yield (P = 0.907), or 305-day yield (P = 0.935).

The live weight of heifers at 250 days of age did not have a statistically significant effect on lactation duration (P = 0.141), total lactation yield (P = 0.220), or 305-day yield (P = 0.189).

The average daily gain of heifers from birth to insemination had no significant effect on the duration of the dry period (P = 0.167) or the calving interval (P = 0.868).

Similarly, the live weight of heifers at 250 days of age did not significantly affect the duration of the dry period (P = 0.278) or the calving interval (P = 0.374).

Keywords: primiparous, live weight, average daily gain, lactation duration, milk yield per lactation, dry period, calving interval.

ВПЛИВ ПОКАЗНИКІВ РОСТУ ТА РОЗВИТКУ ТЕЛИЦЬ ГОЛШТИНСЬКОЇ ПОРОДИ НА ЇХ ПРОДУКТИВНІСТЬ ПІСЛЯ ПЕРШОГО ОТЕЛЕННЯ

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У дослідженні проаналізовано вплив показників росту та розвитку телиць голштинської породи на їх подальшу продуктивність після першого отелення. Матеріалом слугували дані з обліку первісток (n = 570 гол.), вирощених у СТОВ «Промінь» (Миколаївська область).

Встановлено, що жива маса телиць при народженні статистично достовірно впливає на тривалість лактації (P = 0,047) та загальний надій молока за лактацію (P = 0,002), тоді як зв'язок із надоями за 305 днів лактації був недостовірним (P = 0,162).

Проведений аналіз не виявив статистично достовірного впливу середньодобового приросту первісток від народження до 90-денного віку на тривалість лактації (P = 0,161), загальний надій за лактацію (P = 0,700) та надій за 305 днів лактації (P = 0,413).

Аналіз залежності продуктивних показників первісток від їх живої маси у віці 90 днів не виявив статистично достовірного впливу цього чинника на тривалість лактації (P = 0,826), загальний надій за лактацію (P = 0,487) і надій за 305 днів лактації (P = 0,128).

За результатами аналізу, середньодобовий приріст телиць від народження до запліднення не мав достовірного впливу на тривалість лактації (P = 0,306), надій за повну лактацію (P = 0,907) та надій за 305 днів (P = 0,935).

Жива маса телиць у віці 250 днів не мала статистично достовірного впливу ні на тривалість лактації (P = 0,141), ні на надій за лактацію (P = 0,220), ні на надій за 305 днів (P = 0,189).

Середньодобовий приріст телиць від народження до запліднення не мав достовірного впливу на тривалість сухостійного (P = 0,167) та міжотельного (P = 0,868) періодів.

Жива маса телиць у віці 250 днів не мала достовірного впливу на тривалість сухостійного (P = 0,278) та міжотельного (P = 0,374) періодів.

Ключові слова: корови-первістки, жива маса, середньодобовий приріст, тривалість лактації, надій за лактацію, сухостійний період, міжотельний період.

Introduction. The success of creating a highly productive herd depends on many factors, including the level of rearing replacement stock (Abd-El Hamed, Kamel, 2021; Tschopp et al., 2021).

Calf growth traits, which are quantitative characteristics determining the profitability of cattle breeding, vary depending on genetic and environmental factors. In other words, growth traits depend on the genetics of the individual and are influenced by farm management practices (Atashi, Asaadi, 2019; Baschenko et al., 2020).

Understanding the relationships between calf birth traits and their future performance would contribute to the development of management strategies aimed at optimizing calf growth and enable the selection of replacement heifers based on measurements taken at early life stages, which are relatively easy to record (Martín et al., 2018; Admin et al., 2024; Genena, Ebrahim, 2023).

However, the intensification of rearing replacement young stock does not always guarantee higher cow productivity, since body weight gain of heifers at different ages influences it differently. Therefore, it is important to study the relationship between animal growth and their future performance to provide a scientific basis for the selection of replacement heifers (Atashi, 2021; Klimkovetskyi, Nosevych, 2020; Freetly et al., 2021). Replacement heifers represent the future of the herd, and their effective management is a crucial factor for the sustainable development of farms and the dairy industry as a whole (Aseged et al., 2023; Kusaka et al., 2022; Luhovyi, 2023).

Research on the relationship between the birth weight of heifer calves and their subsequent productivity is essential for determining the optimal birth weight (Chester-Jones et al., 2017; Lopez et al., 2020; Dymchuk, Ponko, 2022).

Easa et al. (2022) indicated that selection for high milk yield is associated with

genetic improvement in birth weight. Eldawy et al. (2021) concluded that birth weight can be used as an auxiliary trait for improving reproductive and productive characteristics in breeding and management programs.

Although calf birth weight is often considered a cause of difficult calvings, it may serve as an early-life indicator of lifetime productivity as well as a selection criterion for replacement heifers that are more likely to remain in the herd and provide optimal milk yield (Kamal et al., 2014; Easa et al., 2022; Rahbar et al., 2024). The birth weight of heifer calves may be associated with their lifetime productivity and reproductive performance (Lopez et al., 2018; Kochuk-Yashchenko et al., 2021; Tahir et al., 2023).

According to Klimkovetskyi and Nosevych (2020), low birth weight of heifer calves (<28 kg) is not a disadvantage if intensive rearing is ensured with alternating phases of accelerated and moderate growth, particularly at 3 and 9-12 months of age. Such a strategy promotes earlier calving and higher milk productivity, with live weight at 3 months being an important selection criterion.

In the studies by Kramarenko et al. (2022), a significant effect of body weight during 9-15 months of age (i.e., the post-pubertal period) was observed on total milk yield in primiparous cows. A significant influence of body weight during 3-6 months of age (i.e., the pre-pubertal period) was also detected on milk yield and milk fat output in primiparous cows.

Costa et al. (2021) reported that heifers with higher birth weight exhibited superior reproductive performance and milk production compared to lighter animals.

López et al. (2018) demonstrated that an increase in body weight in Holstein heifers is associated with a reduction in age at first calving.

Other studies have reported a positive correlation between lifetime milk yield and body weight in Holstein cows (Van De Stroet et al., 2016; Handcock et al., 2019).

New Zealand researchers highlighted the potential to enhance milk productivity in primiparous cows during the first lactation by increasing heifer body weight, as well as the advantages of balanced feeding for lighter animals to achieve greater body weight prior to calving (Handcock et al., 2019; Handcock R. et al., 2020; Martín et al., 2018).

Over the past decades, substantial improvements in management, nutrition, veterinary care, and genetic selection have led to a remarkable increase in dairy cow productivity (Martens, 2023; Öztürk et al., 2021).

However, only a limited number of studies have investigated the influence of growth and developmental traits in Holstein heifers on their subsequent performance after first calving. Therefore, the aim of the present study was to determine the relationship between growth and developmental parameters of Holstein heifers and their productivity.

Materials and methods of research. The study analyzed primary records of growth and development of first-parity Holstein heifers (n = 570) maintained at the STOV "Promin" farm in the Mykolaiv region. Average daily gain (ADG) was calculated as the difference between body weights at the first and last weighing. Body weight at 250 days of age was estimated using linear interpolation between the closest weight measurements taken before and after this age.

For statistical analysis, the dependent variables included performance traits of first-parity heifers: lactation length, total milk yield per lactation, 305-day standardized milk yield, dry period length, and calving interval.

The arithmetic mean and standard error of the Mean ($\overline{X} \pm S_{\overline{X}}$) were calculated for each quantitative indicator.

To test the hypothesis of no effect of individual factors on the dependent variables, a one-way analysis of variance (ANOVA) was performed following R. Fisher's methodology, using fixed factors. F-values were calculated to determine the significance

(P) of differences.

Data processing was conducted according to the methodological recommendations outlined by Kramarenko et al. (2019), using the PAST software package (Hammer et al., 2001).

Research results. The results of variability in milk production traits of primiparous heifers depending on their birth weight are presented in Table 1.

Table 1.

Variability of milk productivity indicators of primiparous heifers depending on their live weight at birth

Birth weight, kg	Lactation length		Total milk yield per lactation		305 days milk yield	
	n	$\overline{X} \pm Sx$**, days**	***n***	$\overline{X} \pm Sx$**, kg**	***n***	$\overline{X} \pm Sx$**, kg**
25-28	11	343,6±18,11	11	10826,5±619,19	11	9636,3±366,02
29-32	62	326,7±5,75	61	10813,9±263,07	61	10051,6±127,59
33-36	185	316,9±2,67	182	9994,7±115,71	182	9656,9±86,38
37-40	168	328,7±3,53	166	10590,8±140,01	166	9835,3±84,50
41-44	83	326,0±4,68	76	10551,6±195,60	76	9929,6±128,80
45-48	46	333,9±6,82	45	10724,7±289,07	45	9767,1±157,69
>49	12	335,9±14,89	10	11523,6±799,67	10	10254,1±344,19
	F = (6; 560) = 2,15, *P* = 0,047		*F* = (6; 544) = 3,51, *P* = 0,002		*F* = (6; 544) = 1,54, *P* = 0,162	

Note: n – number of animals; X±Sx – estimate of the arithmetic mean and its errors; F – estimate of the Fischer criterion; P – significance level.

A statistically significant effect of birth weight on lactation length was established (P = 0.047). The highest mean value was recorded in the group of cows with a birth weight above 49 kg – 335.9 ± 14.89 days, while the lowest was observed in primiparous cows with a birth weight of 33-36 kg – 316.9 ± 2.67 days. At the same time, cows born with a birth weight of 25-28 kg had the longest lactation among the main sample – 343.6 ± 18.11 days; however, the number of animals in this group was the smallest (n = 11), which reduces the reliability of this result.

The effect of birth weight on first-lactation milk yield was statistically significant (P = 0.002). The highest total milk yield was observed in the group of heifers with a birth weight above 49 kg – 11,523.6 ± 799.67 kg, exceeding the yield of all other groups. Among the weight groups, relatively high yields were also recorded for animals with birth weights of 25-28 kg (10,826.5 ± 619.19 kg), 29-32 kg (10,813.9 ± 263.07 kg), and 45-48 kg (10,724.7 ± 289.07 kg). The lowest total milk yield was recorded for heifers with a birth weight of 33-36 kg – 9,994.7 ± 115.71 kg.

When analyzing the effect of birth weight on 305-day standardized milk yield, no statistically significant influence was found (P = 0.162). Nevertheless, the highest mean 305-day yield was observed in the group of heifers with a birth weight above 49 kg – 10,254.1 ± 344.19 kg. Groups with birth weights of 29-32 kg and 41-44 kg also showed relatively high yields – 10,051.6 ± 127.59 kg and 9,929.6 ± 128.80 kg, respectively. The

lowest 305-day yield was recorded in heifers with a birth weight of 25–28 kg – 9,636.3 ± 366.02 kg.

The results indicate that birth weight of first-calf heifers has a significant effect on lactation length and total milk yield per lactation. The highest productivity parameters were observed in animals with a birth weight exceeding 49 kg; however, the number of animals in this group was the lowest (n = 10-12), which requires cautious interpretation. The most consistent results across all parameters were recorded in heifers with birth weights of 29-32 kg and 45-48 kg, which may be considered the optimal range for future milk performance.

The study also analyzed the effect of average daily weight gain of heifers during the first 90 days of life on their subsequent milk productivity (Table 2).

Table 2.

Variability of milk production parameters in primiparous heifers depending on their average daily weight gain from birth to 90 days

Average daily gain from birth to 90 days, g	Lactation length		Total milk yield per lactation		305 days milk yield	
	n	$\overline{X} \pm Sx$, **days**	***n***	$\overline{X} \pm Sx$, **kg**	***n***	$\overline{X} \pm Sx$, **kg**
500-600	13	343,8±17,69	12	10586,2±703,10	12	9379,5±430,72
601-700	49	326,5±5,89	45	10243,4±271,36	45	9655,2±186,12
701-800	102	333,1±4,99	100	10698,9±195,81	100	9836,5±111,80
801-900	214	324,0±2,86	210	10384,1±123,01	210	9760,7±73,99
901-1000	154	320,5±3,19	151	10422,8±137,94	151	9914,1±88,66
1001-1100	35	324,7±6,10	33	10565,2±295,41	33	9959,4±198,86
	F = (5; 561) = 1,59, P = 0,161		F = (5; 545) = 0,6, P = 0,700		F = (5; 545) = 1,00, P = 0,413	

The longest average lactation length was observed in heifers with an average daily gain (ADG) from birth to 90 days of 500-600 g/day – 343.8 ± 17.69 days, whereas the shortest lactation (320.5 ± 3.19 days) occurred in animals with an ADG of 901-1000 g/day. Overall, however, the variation in lactation length was minimal, and analysis of variance did not reveal a significant effect of ADG on this trait (P = 0.161).

The highest total lactation yield was recorded in heifers with an ADG of 701-800 g/day (10,698.9 ± 195.81 kg), and the lowest in those with an ADG of 601-700 g/day (10,243.4 ± 271.36 kg). Nevertheless, the difference between groups was not statistically significant (P = 0.700), indicating no systematic effect of early growth intensity on total lactation yield.

The highest average 305-day milk yield was observed in heifers with an ADG of 1001-1100 g/day – 9,959.4 ± 198.86 kg, while the lowest was in the group with an ADG of 500-600 g/day (9,379.5 ± 430.72 kg). However, in this case as well, the effect was not statistically significant (P = 0.413).

The analysis of the obtained data showed that the average daily gain (ADG) of heifers from birth to 90 days did not have a statistically significant effect on lactation length (P = 0.161), total lactation yield (P = 0.700), or 305-day milk yield (P = 0.413).

Despite some differences in mean values between groups, a clear relationship between early body weight gain and future milk performance could not be established. This indicates that while early growth is important for sexual maturity and reproduction, its impact on subsequent lactation performance requires further clarification or a more comprehensive analysis taking into account additional factors such as genetics, housing conditions, and adult feeding.

The analysis of the effect of heifers' body weight at 90 days of age on lactation length and milk performance is presented in Table 3.

Table 3.

Variability of milk productivity indicators of primiparous heifers depending on their live weight at the age of 90 days

Body weight at 90 days, kg	Lactation length		Total milk yield per lactation		305 days milk yield	
	n	$\overline{X} \pm Sx$, **days**	***n***	$\overline{X} \pm Sx$, **kg**	***n***	$\overline{X} \pm Sx$, **kg**
80-90	17	327,5±12,82	16	10221,2±428,52	16	9508,2±299,08
91-100	44	324,8±7,50	42	9978,2±313,25	42	9460,5±183,18
101-110	129	330,2±4,05	127	10601,4±166,89	127	9800,8±100,24
111-120	228	323,4±2,75	221	10497,6±123,49	221	9900,9±77,07
121-130	128	324,5±3,72	125	10475,5±152,05	125	9861,0±91,60
131-140	24	326,5±7,30	23	10242,6±292,00	23	9530,2±160,43
	F = (5; 564) = 0,43, P = 0,826		F = (5; 548) = 0,89, P = 0,487		F = (5; 548) = 1,72, P = 0,128	

The lactation length of the experimental heifers ranged from 323.4 ± 2.75 to 330.2 ± 4.05 days. The highest value was observed in heifers with a body weight of 101-110 kg at 90 days, whereas the shortest lactation was recorded in animals weighing 111-120 kg. However, according to the results of the analysis of variance, body weight at 90 days had no statistically significant effect on lactation length (P = 0.826).

The highest average milk yield for the entire lactation was recorded in cows with a 90-day body weight of 101-110 kg (10,601.4 ± 166.89 kg), while the lowest was in animals weighing 91-100 kg (9,978.2 ± 313.25 kg). Despite these variations, body weight at 90 days did not have a statistically significant effect on total lactation yield (P = 0.487).

Similarly, 305-day milk yield varied from 9,460.5 ± 183.18 kg (91-100 kg) to 9,900.9 ± 77.07 kg (111-120 kg), with higher values observed in heifers weighing 111-130 kg at 90 days. However, the effect of body weight on this parameter was not statistically significant (P = 0.128).

Thus, body weight of first-parity cows at 90 days of age had no significant influence on lactation length (P = 0.826), total lactation yield (P = 0.487), or 305-day milk yield (P = 0.128). Although certain groups, particularly heifers weighing 101-110 kg, showed higher average milk productivity, the differences were not statistically significant. This indicates relative stability of milk performance regardless of 90-day body weight, provided that subsequent rearing and feeding are adequate.

Within the study, the effect of average daily gain (ADG) of heifers from birth until the time of first insemination on lactation length, total lactation yield, and 305-day milk

yield was analyzed (Table 4).

The lactation length ranged from 314.3 ± 7.23 days (group with an average daily gain of 700-799 g/day) to 335.4 ± 7.79 days (group with a gain of 800-899 g/day). Overall, although the mean values varied slightly, the analysis of variance showed no statistically significant effect of first-calf heifers' average daily gain from birth to conception on lactation length (P = 0.306).

Table 4.

Variability of primiparous heifers milk production parameters depending on their average daily gain from birth to conception

Average daily gain of primiparous heifers from birth to conception, g	Lactation length		Total milk yield per lactation		305 days milk yield	
	n	$\overline{X} \pm Sx$, **days**	***n***	$\overline{X} \pm Sx$, **kg**	***n***	$\overline{X} \pm Sx$, **kg**
700-799	11	314,3±7,23	11	10163,5±450,29	11	9841,8±304,36
800-899	60	335,4±7,79	59	10618,4±267,68	59	9671,0±151,53
900-999	138	329,5±4,08	135	10506,3±157,94	135	9733,2±94,31
1000-1099	224	325,3±2,91	216	10464,6±134,09	216	9815,3±76,98
1100-1199	111	319,0±3,34	108	10287,6±143,13	108	9855,7±110,19
1200-1299	29	329,0±6,61	28	10474,2±261,89	28	9808,4±234,68
>1300	5	322,8±23,48	5	9960,1±799,92	5	9488,3±764,62
	F = (6; 571) = 1,20, *P* = 0,306		*F* = (6; 555) = 0,35, *P* = 0,907		*F* = (6; 555) = 0,30, *P* = 0,935	

The highest total lactation yield was observed in heifers with an average daily gain of 800-899 g/day – 10,618.4 ± 267.68 kg, and the lowest was in the group with gains above 1,300 g/day – 9,960.1 ± 799.92 kg. However, these differences were not statistically significant (P = 0.907), indicating a weak or absent relationship between pre-conception growth and milk production performance.

Yield for the standard 305-day period varied from 9,488.3 ± 764.62 kg in heifers with gains above 1,300 g/day to 9,855.7 ± 110.19 kg in the group with 1,100-1,199 g/day. Similarly, these differences were not statistically significant (P = 0.935).

These results indicate that the average daily gain of first-calf heifers from birth to conception does not have a significant effect on any milk production indicators: neither on lactation length (P = 0.306), total lactation yield (P = 0.907), nor 305-day yield (P = 0.935). Despite minor fluctuations in mean values among groups, these differences are not statistically meaningful, suggesting that with proper feeding and management after conception, early body weight gains have a limited influence on lactation performance.

The effect of heifers' body weight at 250 days of age on lactation length and milk

production is presented in Table 5.

Table 5.

Variability of milk production parameters of primiparous heifers depending on their body weight at 250 days of age

Body weight of primiparous at 250 days, kg	Lactation length		Total milk yield per lactation		305 days milk yield	
	n	$\overline{X} \pm Sx$, **days**	***n***	$\overline{X} \pm Sx$, **kg**	***n***	$\overline{X} \pm Sx$, **kg**
225-249	44	332,0±7,45	44	10365,8±322,28	44	9510,2±192,25
250-274	80	328,0±5,28	80	10771,3±214,61	80	10020,3±120,26
275-299	210	322,6±2,68	202	10251,1±118,79	202	9706,1±76,22
300-324	133	317,2±3,05	127	10180,2±140,08	127	9823,8±101,43
325-349	29	320,2±6,60	28	10356,0±295,31	28	9851,0±219,44
>350	5	348,4±20,04	5	10878,2±523,67	5	9612,4±598,44
	F = (5; 495) = 1,67, P = 0,141		F = (5; 480) = 1,41, P = 0,220		F = (5; 480) = 1,50, P = 0,189	

The longest lactation duration was observed in first-calf heifers with a body weight over 350 kg at 250 days of age (348.4 ± 20.04 days), while the shortest was recorded in the group with a body weight of 300–324 kg (317.2 ± 3.05 days). In the groups of heifers weighing 225-274 kg, the lactation duration was slightly higher than in those with average body weight. However, revealed no statistically significant differences between groups (P = 0.141), indicating a weak influence of body weight at 250 days on this parameter.

The highest total lactation yield (10,878.2 ± 523.67 kg) was recorded in heifers with body weight over 350 kg at 250 days, whereas the lowest values were observed in groups weighing 275-299 kg (10,251.1 ± 118.79 kg) and 300-324 kg (10,180.2 ± 140.08 kg). Despite some differences in mean values, the effect of body weight at 250 days on total milk yield was not statistically significant (P = 0.220).

A similar pattern was observed for the 305-day milk yield: the highest yields were in heifers weighing 250-274 kg (10,020.3 ± 120.26 kg) and 325-349 kg (9,851.0 ± 219.44 kg), while the lowest were in the groups with the lowest (9,510.2 ± 192.25 kg) and highest (9,612.4 ± 598.44 kg) body weights. Variance analysis showed no statistically significant effect (P = 0.189).

Thus, body weight of first-calf heifers at 250 days had no significant influence on lactation duration (P = 0.141), total milk yield (P = 0.220), or 305-day yield (P = 0.189). Despite fluctuations in mean values across groups, these differences were not statistically significant, suggesting that with proper feeding and management in later growth stages, the impact of body weight at 250 days on subsequent milk production is limited.

Within the study, the relationship between the length of the dry period and calving interval in first-calf heifers and their average daily gain from birth to conception was also analyzed (Table 6).

The duration of the dry period in cows ranged from 53.4 ± 3.31 to 58.4 ± 0.61 days. The shortest dry period was observed in cows with the highest growth rates (>1300 g/day), while the longest was in animals with gains of 800-899 g/day. However,

according to the results of the analysis of variance, the average daily gain of first-calf heifers from birth to conception did not have a statistically significant effect on the duration of the dry period (P = 0.167).

Table 6.

Variability of dry period and calving interval in primiparous depending on their average daily gain

Average daily gain of primiparous from birth to conception, g	Dry period		Calving interval	
	n	$\overline{X} \pm Sx$**, days**	***n***	$\overline{X} \pm Sx$**, days**
700-799	11	57,3±1,75	11	371,5±6,86
800-899	59	58,4±0,61	54	380,7±5,70
900-999	138	57,0±0,76	127	376,8±3,47
1000-1099	224	56,2±0,40	208	374,3±2,45
1100-1199	111	55,9±0,56	107	372,6±3,19
1200-1299	29	55,5±0,91	26	378,8±6,27
>1300	5	53,4±3,31	5	376,2±25,09
	F = (6; 570) = 1,53, P = 0,167		F = (6; 531) = 0,416, P = 0,868	

Analysis of the calving interval also showed no significant effect of growth intensity. The interval varied from 371.5 ± 6.86 days (group with 700-799 g/day gain) to 380.7 ± 5.70 days (group with 800-899 g/day gain), with no statistically significant differences between groups (P = 0.868).

Thus, the average daily gain of heifers from birth to conception has no significant effect on either the dry period or the calving interval. This indicates that growth rates in young cows, despite their important role in reducing age at first conception and calving, do not affect the duration of physiological stages between lactations under proper feeding and management conditions.

The study also analyzed how the live weight of Holstein first-calf heifers at 250 days of age influences the duration of physiologically important stages – the dry period and the calving interval (Table 7).

The longest dry period was observed in first-calf heifers with a live weight of 225-249 kg at 250 days of age – 58.3 ± 0.81 days, while the shortest occurred in animals weighing over 350 kg – 54.2 ± 3.09 days. In most groups (275-349 kg), the dry period remained relatively stable at approximately 56 days. However, according to the analysis of variance, the live weight of heifers at 250 days did not have a statistically significant effect on the duration of the dry period (P = 0.278).

The calving interval varied from 370.1 ± 2.69 days (in the group of heifers weighing 300-324 kg at 250 days) to 392.8 ± 22.77 days (in the group with live weight >350 kg). Although some variation in mean values was observed, particularly in the extreme groups, no statistically significant relationship was found (P = 0.374).

Thus, the live weight of first-calf heifers at 250 days of age does not have a significant effect on either the duration of the dry period or the calving interval. This indicates that these reproductive indicators are relatively independent of early-life body weight under proper management. Despite minor fluctuations in mean values, the differences were not statistically significant, suggesting that these periods remain stable under optimal technological management.

Table 7.

Variability of indicators of the duration of dry period and calving interval in primiparous heifers, depending on their live weight at the age of 250 days

Body weight of primiparous at 250 days, kg	Dry period		Calving interval	
	n	$\overline{X} \pm Sx$**, days**	***n***	$\overline{X} \pm Sx$**, days**
225-249	44	58,3±0,81	39	378,7±6,48
250-274	80	57,3±1,21	76	379,6±5,11
275-299	210	56,1±0,37	201	374,4±2,33
300-324	133	56,1±0,50	128	370,1±2,69
325-349	29	56,0±1,12	27	371,7±6,30
>350	5	54,2±3,09	4	392,8±22,77
	F = (5; 495) = 1,27, P = 0,278		F = (5; 469) = 1,07, P = 0,374	

Discussion. Increased birth weight in heifers is associated with improved performance indicators, such as higher milk yield and increased calf birth weight, but it is also accompanied by a higher risk of dystocia and a longer calving interval. No significant associations have been found with milk fat and protein content or body condition score (Atashi Hadi, 2021).

According to Luhovyi S. (2023), both birth weight and weight at 18 months are significant factors for future milk productivity. Higher birth weight was associated with greater milk fat content, while weight at 18 months correlated with increased milk yield and total milk fat. An optimal weight of at least 350 kg at 18 months was recommended to ensure high productivity.

Early-life body weight has a strong impact on the age at first calving and subsequent lactation performance (Atashi, 2021; Freetly et al., 2021). Achieving a weight above 127 kg at 3 months of age reduces the age at first calving by 2.7-3.5 months. The highest milk yields were observed in heifers with a 3-month weight of 117-127 kg and average daily gains of 902-1037 g/day, as well as in animals born with the lowest birth weight (<28 kg), highlighting the importance of early postnatal growth for developing a high-producing herd (Klimkovetskyi, Nosevych, 2020).

Hoka et al. (2019) reported that calves with higher birth weights (31-39 kg) achieved significantly greater milk yields (P<0.001) compared to lighter calves. Similarly, Hamed and ElMoghazy (2015) confirmed a significant effect of birth weight ranging from 25 to >55 kg on 305-day milk yield (305MY).

In contrast, Van Eetvelde et al. (2017) indicated that heifer birth weight was not associated with first-lactation milk productivity. Birth weight was linearly correlated with gestation length (GL) (Atashi, Asaadi, 2019); however, Hoka et al. (2019) reported only a minor influence of calf birth weight on gestation length.

The results of our study are consistent with other researchers who identified a positive relationship between heifer birth weight and subsequent productivity (Aseged et al., 2023; Kusaka et al., 2022; Luhovyi, 2023). Birth weight significantly affected lactation length and total milk yield, with the highest performance observed in heifers exceeding 49 kg at birth. The most stable results were found in animals weighing 29-32 kg and 45-48 kg, suggesting that optimizing growth within these categories can

enhance milk productivity.

Intensive rearing of heifers requires adherence to optimal growth rates. For Holstein heifers, an average daily gain of approximately 700 g is considered optimal, resulting in first-lactation milk yields of 8,300-8,500 kg. Both excessively low (<400 g) and excessively high (>800 g) gains before puberty were associated with a 10-40% reduction in milk productivity in primiparous cows (Klimkovetskyi, Nosevych, 2020), emphasizing the importance of monitoring growth rates to achieve high lactation performance.

The results of our study showed that the average daily gain (ADG) of heifers during the first 90 days of life did not have a statistically significant effect on milk production. However, there was a tendency for higher milk yields and longer lactation periods in animals with moderately high ADG (500-600 g and 701-1100 g), indicating a potential advantage of moderate early-life growth intensity.

Heifer body weight at 90 days of age also did not have a significant effect on milk productivity parameters. Nonetheless, there was a tendency for higher yields in animals weighing 101-120 kg, suggesting that maintaining this level of development may support better realization of productive potential.

Admin et al. (2024) confirmed that animals with the highest body weight gains had a significantly lower age at first insemination, the greatest body weight at first lactation, and higher milk productivity. At the same time, some reproductive challenges were observed in these animals, including a slightly extended service period.

The average daily gain (ADG) of heifers from birth to insemination did not have a statistically significant effect on milk production. However, a tendency toward decreased productivity was observed at excessively low or high gains, emphasizing the importance of maintaining an optimal growth rate for effective realization of genetic potential.

Heifer body weight at 250 days of age also did not have a significant effect on milk productivity, although there was a tendency for higher yields in animals weighing 250-274 kg. This suggests that maintaining an optimal growth rate without overfeeding may support efficient expression of productive potential.

In our study, the ADG of heifers until insemination had no significant effect on the length of the dry period or the calving interval, indicating that intensive rearing does not negatively affect the restoration of reproductive function after the first calving.

Body weight at 250 days did not show a statistically significant effect on the duration of the dry period or calving interval. Despite a slight increase in the mean calving interval in the group weighing over 350 kg, the small number of animals (n = 4-5) reduces the reliability of this observation. Thus, increased body weight at this age does not substantially affect the restoration of reproductive function after the first calving.

Conclusions.

1. The study revealed that the birth weight of primiparous heifers has a statistically significant effect on lactation duration (P = 0.047) and total milk yield over the entire lactation period (P = 0.002), while its effect on 305-day milk yield was not statistically significant (P = 0.162). The most stable productive performance was observed in heifers with birth weights of 29-32 kg and 45-48 kg, indicating the advisability of rearing replacement heifers within these weight categories to enhance dairy herd productivity.

2. Analysis showed no statistically significant effect of average daily gain from birth to 90 days of age on lactation duration (P = 0.161), total lactation milk yield (P = 0.700), or 305-day milk yield (P = 0.413). However, a tendency for higher productivity was observed in heifers with moderately high early growth rates, suggesting potential benefits of moderate growth intensity for developing a productive herd.

3. Body weight at 90 days of age did not have a statistically significant effect on lactation duration (P = 0.826), total lactation yield (P = 0.487), or 305-day milk yield (P = 0.128). Nevertheless, there was a tendency for higher milk productivity in heifers weighing 101–120 kg, indicating that maintaining this growth level may be important for the effective expression of genetic potential.

4. Average daily gain from birth to insemination did not have a statistically significant effect on lactation duration (P = 0.306), total lactation yield (P = 0.907), or 305-day milk yield (P = 0.935). At the same time, a tendency for reduced productivity was noted in heifers with either very low (<800 g) or excessively high (>1300 g) growth rates, emphasizing the importance of maintaining a moderate, controlled growth rate in replacement heifers for optimal expression of their productive potential.

5. The analysis of the obtained results showed that the body weight of primiparous heifers at 250 days of age did not have a statistically significant effect on lactation duration (P = 0.141), total lactation yield (P = 0.220), or 305-day milk yield (P = 0.189). Nevertheless, targeting a body weight range of 250-274 kg at this age appears reasonable for ensuring optimal productivity. Excessively high body weight does not confer additional benefits and may indicate a risk of overconditioning, which can negatively affect subsequent performance.

6. Average daily gain from birth to insemination did not statistically affect the duration of the dry period (P = 0.167) or the calving interval (P = 0.868). This suggests that intensified growth during the rearing period up to insemination did not negatively impact the recovery of reproductive function after the first calving.

7. Body weight of primiparous cows at 250 days of age also did not have a statistically significant effect on the duration of the dry period (P = 0.278) or the calving interval (P = 0.374). Therefore, increased body weight at this stage of development does not substantially influence the restoration of reproductive function after the first calving.

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