Agronomy Research **23**(X), xxx–ccc, 2025
https://doi.org/10.15159/AR.25.078

Milk productivity, reproductive performance, hematological and clinical indicators of holstein, brown swiss, simmental, and jersey breeds of cows under Armenian agro-climatic conditions

L.M. Minasyan[1], H.R. Vardanyan[1], Zh.T. Chitchyan[2], M.H. Zadayan[3,*], J.T. Simonyan[4], N.A. Shahazizyan[1], M.S. Mirzoyan[1] and L.L Simonyan[1]

[1]Scientific Centre for Risk Assessment and Analysis in Food Safety Area of the Ministry of Economy of the Republic of Armenia, 107/2 Masis Highway, Shengavit, AM0071 Yerevan, Republic of Armenia
[2]Armenian National Agrarian University, Yerevan, Teryan 74, AM0009 Yerevan, Republic of Armenia
[3]Center for Agricultural Research and Certification, State Non-Commercial Organization at the Ministry of Economy, Yerevanyan highway 2nd block, building 4, AM1139 Merdzavan, Republic of Armenia
[4]Ministry of Economy of the Republic of Armenia, Mher Mkrtchyan 5, AM0010 Yerevan, Republic of Armenia
[*]Correspondence**:** mhzadayan@gmail.com

Received: May 9th, 2025; Accepted: August 4th, 2025; Published: August 18th, 2025

Abstract. The research was conducted on the farms of 'Himnatavush' Foundation and 'Agroholding Armenia' LLC in the Tavush and Lori regions of the Republic of Armenia. This study aims to fill a research gap regarding the adaptability of elite dairy breeds in the South Caucasus under variable agro-climatic conditions. The scientific and practical goal of the work is to conduct, for the first time, a comparative study of the milk productivity, reproductive capacity, and hematological and clinical indicators of Holstein, Brown Swiss (Schwyz), Simmental, and Jersey cattle breeds imported into the Republic of Armenia from various European countries in recent years, as well as cows born and raised locally (local reproduction). The study is being carried out in two farms located in different agro-climatic zones of the Republic. At the farms of 'Agroholding Armenia' LLC and the 'Himnatavush' Foundation, the age at first calving of both imported full-grown cows of Holstein, Brown Swiss, Simmental, and Jersey breeds and their locally born and raised first-calf heifers corresponded to breed-specific norms. The service period for cows of all breeds exceeded the desirable range (80–90 days), ranging from 93.8 to 115.6 days. However, the reproductive capacity coefficient ranged between 92.9–97.3, which is considered a good indicator. Hematological and clinical parameters of all cows remained within physiological norms. Jersey cows exhibited slightly better adaptation markers. The study confirms the successful acclimatization of these breeds to Armenia's diverse agro-climatic zones and supports the continued use of these high-yielding breeds for sustainable dairy development.

Key words: adaptation traits, milk productivity, age at first calving, reproductive traits, breed comparison, physiological indicators.

INTRODUCTION

In Armenia, cattle breeding is the leading branch of animal husbandry. More than 95% of the milk and over 60% of the meat produced in the country come from cattle farming.

Primarily, the animals raised in the republic belong to the Caucasian Grey breed, which is used for dairy and meat production and accounts for over 90% of the total cattle population. However, the milk yield of this breed is not particularly high; in the best farms, it ranges from 3,000 to 3,500 kilograms per lactation.

In 2022, the average annual milk yield per cow in the country was 2,467 kilograms (Minasyan et al., 2024).

It should be noted that the low milk productivity of cows in the Republic is caused not only by the breeds raised but also by a number of other factors. For example, Armenia is a relatively small country (with a total area of 29.8 thousand km²), of which 2,041.4 thousand hectares, or 68.6% of the total area, are agricultural lands. These include 441.6 thousand hectares (21.6%) of arable land, 1,049.2 thousand hectares (51.4%) of pastures, and 121.3 thousand hectares (5.9%) of hayfields.

In fact, the feed base for cattle breeding remains weak. The productivity of hayfields and pastures is low, the potential for field-based feed production is limited, and arable lands are mainly used for cultivating other crops. As a result, the amount of feed available for livestock is insufficient, especially during the stall-feeding (winter) period.

In addition, cattle breeding in the country is still practiced extensively. Selective breeding programs and pedigree work are not properly implemented, artificial insemination of cows does not cover a large portion of the herd, and housing conditions require improvement, among other issues.

Considering the necessity of further developing cattle breeding in the republic, especially to increase the average milk yield per cow, several projects have been implemented in recent years aimed at expanding milk production. As part of these initiatives, heifers of various European breeds - mainly Holstein, Swiss (Schwyz), Simmental, and Jersey - have been imported.

Our studies have shown that both the imported heifers of these breeds and their locally born and raised offspring (local reproduction) demonstrate quite high milk productivity under the conditions of our republic. According to our data (Minasyan et al., 2023a), under the conditions of the ‘Depi Agro’ farm in Armavir Region, imported Holstein cows from Germany achieved an average first-lactation milk yield of 5,827 kilograms, with milk fat and protein contents of 3.82% and 3.27%, respectively.

According to the results of our studies (Muradyan et al., 2022), at the ‘Agroholding Armenia’ LLC farm, locally reproduced Brown Swiss breed cows had a 305-day lactation milk yield of 8,450 kilograms, with milk fat and protein contents of 4.0% and 3.12%, respectively.

Based on the above, we emphasize the importance of continuing research on Holstein, Swiss, Simmental, and Jersey cattle breeds - not only regarding their milk productivity but also their reproductive capacities and hematological clinical indicators - and presenting conclusions about their adaptability to the climatic conditions of our republic.

In modern cattle breeding, reproductive performance is recognized as a key economic trait, alongside breed improvement and technological advancements aimed at enhancing

productivity. Effective herd reproductive management significantly influences milk yield, animal longevity, utilization intensity, and overall production profitability.

Reproduction, as a fundamental biological function, ensures the continuity and survival of species. Suboptimal reproductive performance in cows leads to substantial economic losses for farmers. A shortage of calves contributes to herd size reduction, decreased milk and meat production, and limited opportunities for herd renewal and genetic improvement. Additionally, maintaining infertile animals imposes unnecessary costs related to feeding, care, and veterinary interventions.

According to Kozlo (1984), a 10% infertility rate in cows (with an average annual milk yield of 3,000 kg) can result in a 5% reduction in milk output and a 10% decline in calf production annually. Moreover, over 5% more feed units are required to produce every 100 kg of milk under such conditions.

Thus, optimizing reproductive function is essential for improving herd productivity, advancing breed development, and enhancing the economic sustainability of livestock systems.

Furthermore, reproductive efficiency is closely linked to an animal's adaptability to environmental conditions. In this context, clinical and hematological indicators serve as critical tools for evaluating animals' acclimatization and adaptation processes. These indicators provide insights into animals' physiological responses and their suitability for specific rearing environments.

Understanding the variability of these parameters under different ecological conditions is particularly important for assessing health status, metabolic function, and productive potential during the acclimatization period.

Accurate interpretation of adaptability traits requires reference to species-specific physiological norms. For cattle, normal ranges are as follows (Kudryavtsev & Kudryavtseva, 1974; Eidrigievich & Raevskaya, 1978):

- Pulse rate: 40–80 beats per minute
- Respiration rate: 17–30 breaths per minute
- Body temperature: 37.5–39.5 °C
- Erythrocyte count: 5.5–8 million mm^{-3}
- Leukocyte count: 5.0–9.4 thousand mm^{-3}
- Hemoglobin: 9–12 g $\%^{-1}$
- Alkaline reserve: 410–540 mg $\%^{-1}$
- Total serum protein: 6–8 g $\%^{-1}$.

Among clinical indicators, body temperature, pulse rate, and respiratory rate are considered primary markers of physiological condition. Literature indicates that body temperature is generally stable, except in cases of illness, and is not significantly influenced by age, gestation, or lactation. In contrast, pulse and especially respiration rates are more sensitive to age-related changes. For instance, from birth to maturity, pulse rate decreases by approximately 18%, and respiration rate by 35%.

The effect of age at first calving on milk productivity and reproductive qualities of Holstein cows has been studied in the USA by Meyer et al. (2004) and in China by Mao et al. (2010).

Environmental factors also play a crucial role in shaping animals' physiological and morphological traits during growth and development, especially by affecting blood composition. Hematological parameters are commonly used to assess animal health,

body condition, and productivity potential, given their close correlation with metabolic and physiological status.

In a large-scale study conducted in Southern China on 786 clinically healthy Holstein cows, hematological values were determined. The results varied significantly with age, number of calvings, and lactation stage (Chen et al., 2022).

In Armenia, clinical and hematological characteristics have been previously investigated in local breeds. The Caucasian Grey cattle have been studied by Hovhanisyan (2001) and Simonyan (2004), while research on the second planned Black Pied breed was conducted by Chitchyan (1984), Abovyan (1994), and Minasyan (2013), among others.

Although Holstein and Jersey breeds are widely studied in Western Europe and North America, data from the South Caucasus - especially under diverse climatic zones - are scarce. Thus, this study aims to fill a key research gap regarding the adaptability of elite dairy breeds in the South Caucasus under variable agro-climatic conditions.

In various regions of the Russian Federation, the reproductive abilities of Grey Swiss cows have been studied by Solovyova et al. (2016), Salakhov (2017), and Skoptsova & Popova (2018).

Good reproductive abilities of Holstein and Jersey cows have also been reported in the USA by Worman et al. (2009).

Kostomakhin et al. (2021) studied the reproductive abilities of Holstein cows in Kurgan Oblast, Russian Federation.

According to Khamiruev (2009), in the 'Baikalskoye' farm in the Republic of Buryatia, Russian Federation, the service period of Austrian-bred Simmental cows was 92.4 days, the dry period was 65.9 days, and the inter-calving period was 418.2 days.

According to Svyazhenina (2020), in the Tyumen region of the Russian Federation, the age at first calving for Simmental cows was 25.9–27.6 months, and the service period lasted 119–130 days.

The scientific and practical goal of this work is to conduct, for the first time, a comparative study of the milk productivity, reproductive capacity, and hematological and clinical indicators of Holstein, Brown Swiss (Schwyz), Simmental, and Jersey cattle breeds imported into the Republic of Armenia from various European countries in recent years, as well as of cows born and raised locally (local reproduction). The study is being carried out on two farms located in different agro-climatic zones of the Republic.

Based on the data obtained, it will be possible to present scientifically grounded conclusions regarding the adaptability of these breeds to the climatic conditions of Armenia and to make recommendations on the future importation and breeding of these animals in the country.

Action Plan

- Selection of Holstein, Brown Swiss (Schwyz), Simmental, and Jersey cows and formation of experimental groups on two farms
- Organization and implementation of research as outlined by the methodologies
- Regular visits to the farms and on-site supervision of ongoing work
- Collection, recording, and processing of data obtained from the research.

MATERIALS AND METHODS

Study Design and Location

The Republic of Armenia is a landlocked country in the South Caucasus, situated at the intersection of Eastern Europe and Western Asia. Its total surface area is approximately 29,743 km². Armenia's terrain is predominantly mountainous, with an average elevation of ~1,800 meters above sea level. The landscape features volcanic plateaus, high mountain ranges, and deep river valleys. The continental highland climate is characterized by hot, dry summers and cold, snowy winters, with significant regional variation. Annual precipitation ranges from less than 250 mm in arid zones to more than 1,000 mm in forested highlands.

Our research was conducted in the Tavush and Lori regions of the Republic of Armenia. Tavush, one of Armenia's ten administrative regions, is located in the northeastern part of the country. It covers 2,704 km² and is characterized by forested mountains, narrow valleys, and a relatively high proportion of biologically productive land. Tavush experiences a mildly humid climate influenced by prevailing westerly winds and orographic precipitation. Average annual precipitation ranges from 600 to 900 mm, with relatively warm, humid summers and moderate winters, particularly in lower altitudes. These conditions favor perennial grasses, forage crops, and natural pasturelands.

Lori, located immediately west of Tavush, spans approximately 3,799 km² and is topographically diverse, comprising uplands, river valleys, and subalpine zones. Its climate is temperate to moderately humid, with annual precipitation between 600 and 1,000 mm, and slightly cooler temperatures than Tavush due to elevation and exposure. Winter temperatures are lower, especially in higher altitudes, while summers remain relatively cool and moist.

The northeastern regions of Armenia, particularly Tavush and Lori, possess climatic and ecological conditions favorable for cattle farming. Key factors include:

- **Abundant precipitation and humidity:** Moderate to high rainfall supports lush pasturelands and diverse vegetation, enabling extended grazing seasons and reducing dependence on supplementary feed, which increases the cost-efficiency of extensive cattle rearing systems.
- **Cool summer temperatures:** Lower summer heat stress in highland regions like Lori contributes to higher milk yields and improved reproductive performance in cattle. Heat stress, a limiting factor in many semi-arid regions, is minimized here, especially for dairy breeds.
- **Availability of natural water resources:** Numerous rivers and springs in both regions provide reliable water supplies essential for livestock health and forage cultivation.
- **Longer vegetation periods:** Lower altitudes of Tavush allow multi-cut hay production and the growth of high-quality fodder crops such as clover, alfalfa, and mixed grasses.
- **Forest-pasture ecosystems:** Forest-steppe landscapes support agro-silvopastoral systems, enabling farmers to combine free-range grazing with woodland shelter, which improves animal welfare and productivity, especially in winter.

This study was conducted during 2022–2023 at two large commercial dairy farms in Armenia: 'Agroholding Armenia' LLC in Lori Province and the 'Himnatavush' Foundation in Tavush Province.

The farms housed fully grown Holstein, Brown Swiss, Simmental, and Jersey cows imported from various European countries, as well as locally born and raised first-lactation heifers derived from the same breeds. Each breed group included 10 clinically healthy cows. During the research period, the number of cows at the 'Agroholding Armenia' LLC farm ranged from 180 to 190, while at the 'Himnatavush' Foundation farm it was 80 to 90.

Both farms kept cows year-round in typical modern loose-box housing systems. Required zoo-hygienic standards were monitored and maintained in the barns. Cows were fed and milked twice daily, with mechanized milking performed in dedicated parlors equipped with appropriate milking units.

Loose-box housing was organized by grouping cows in separate barn sections, with individual boxes (resting/sleeping areas) prepared for each animal. Boxes were separated by metal bars and measured approximately 190–210 cm in length, 100–120 cm in width, and 100–110 cm in height (side bars). Boxes were elevated 15–20 cm above the barn floor, which was made of concrete or wooden planks and mostly covered with rubber mats. Bedding materials included wood shavings, peat, or chopped straw. Cows were fed in feeding troughs.

Milk yield was determined over a 305-day lactation period using test milking. Fat and protein content were measured using an 'Ekomilk' milk analyzer, and live weight was determined by weighing. The milk yield coefficient (milk yield to live weight ratio) was calculated based on these data.

Reproductive Performance Indicators

The following reproductive traits were evaluated using on-farm management records:

- Age at first calving
- Service period (interval from calving to successful conception)
- Calving interval (CI)
- Dry period (non-lactating period before calving)
- Reproductive capacity coefficient (RCC).

RCC was calculated according to Marmaryan (2001) using the formula:

$$\text{RCC} = \left(\frac{365}{\text{CI}}\right) \times 100$$

where 365 is the number of days in a year and CI is the calving interval in days.

Hematological Parameters

Measured hematological indicators included:

- Erythrocyte count (million mm^{-3})
- Leukocyte count (thousand mm^{-3})
- Hemoglobin concentration (g %)
- Total serum protein (g %)
- Alkaline reserve (mg %).

Blood samples were collected early in the morning from the jugular vein prior to feeding. Analyses were conducted at the 'Neolab' diagnostic laboratory (Yerevan), following standard veterinary hematology protocols.

Clinical Indicators

Clinical indicators were recorded seasonally (spring, summer, autumn, winter) to assess physiological adaptation:

- Body temperature, measured rectally with a digital veterinary thermometer
- Respiration rate, observed by thoracic movements per minute
- Pulse rate, measured at the coccygeal artery using a stethoscope.

These indicators reflect baseline metabolic activity and animals' physiological responses to seasonal climatic variations.

The data obtained from the studies were subjected to biometric processing (mean ± standard error, standard deviation, coefficient of variation) using the computer software 'Biostat'.

RESULTS AND DISCUSSION

Milk Productivity

Milk productivity was studied in cows of all breeds at two farms, focusing on first and third or higher lactations, including 305-day milk yield, milk fat and protein content, and live weight. Results are presented in Table 1.

As shown in Table 1, cows of all breeds demonstrated fairly high milk productivity. Generally, milk yield increased with age. An exception was observed among Brown Swiss and Simmental cows at 'Agroholding Armenia' LLC, where first-calf cows significantly outperformed mature cows in milk yield. Notably, first-calf Brown Swiss cows reached a record-high milk productivity of 8,523 kg, exceeding Holstein and Simmental counterparts by 223 kg (2.7%) and 610 kg (7.7%), respectively.

Among mature cows of these three breeds, Holsteins had the highest milk yield (8,887 kg), surpassing Brown Swiss and Simmental cows by 1,114 kg (14.3%) and 2,691 kg (43.4%), respectively. Brown Swiss cows in their third and higher lactations outperformed mature Simmental cows by 1,577 kg (25.4%).

The high milk productivity of locally raised first-lactation cows of these breeds is mainly attributed to the use of high-quality bulls, excellent feeding and care practices, and favorable rearing conditions during growth and development.

Milk fat content was relatively high, ranging from 3.9% to 4.33%. First-lactation Simmental cows had a fat content of 4.07%, 0.17% higher than Holsteins of the same lactation. Among mature cows, Holsteins exhibited the highest fat content (4.33%), while Brown Swiss cows showed relatively higher milk protein content.

Live weight increased predictably with age (Table 1). Simmental cows had the highest live weights (576 and 726 kg), significantly surpassing Holstein and Brown Swiss counterparts. However, Simmentals had lower milk yield coefficients. First-lactation cows exhibited higher milk yield coefficients (13.7–15.8) compared to mature cows.

Table 1. Milk productivity, milk composition, live weight, and milk yield coefficient of Holstein, Brown Swiss, Simmental, and Jersey cows by lactation and farm

Milk productivity indicators of different cow breeds in the farms of 'Agroholding Armenia' LLC and 'Himnatavush' Foundation (n = 10)									
Breed	Lactation	Biometric parameters	Milk yield in 305 days, kg	Milk fat content, %	Milk protein content, %	Milk fat, kg	Milk protein, kg	Live weight, kg	Milk yield coefficient
'Agroholding Armenia' LLC									
Holstein	I	M±m	8,300 ± 566	3.9 ± 0.05	3.04 ± 0.02	324 ± 21.7	252 ± 16.2	553 ± 19.7	15.0 ± 1.0
		C_v	21.6	3.9	2.4	21.2	20.4	11.3	20.8
	III and higher	M±m	8,887 ± 445	4.33 ± 0.13	3.04 ± 0.02	385 ± 16.3	270 ± 13.1	683 ± 12.4	13.0 ± 0.7
		C_v	15.8	9.7	2.6	13.5	15.3	5.8	18.1
Swiss	I	M±m	8,523 ± 530	3.9 ± 0.05	3.11 ± 0.04	332 ± 22.3	265 ± 18.0	540 ± 19.0	15.8 ± 0.9
		C_v	19.7	3.8	3.6	21.2	21.5	11.1	18.5
	III and higher	M±m	7,773 ± 338	4.3 ± 0.04	3.22 ± 0.05	334 ± 15.6	250 ± 10.8	660 ± 10.0	11.8 ± 0.5
		C_v	13.7	3.1	4.7	15.0	14.1	4.8	14.8
Simmental	I	M±m	7,913 ± 419	4.07 ± 0.09	3.14 ± 0.03	322 ± 16.2	248 ± 14.2	576 ± 16.5	13.7 ± 0.9
		C_v	16.7	6.8	3.0	15.9	18.0	9.1	21.6
	III and higher	M±m	6,196 ± 565	4.23 ± 0.08	3.1 ± 0.02	262 ± 19.5	192 ± 16.7	726 ± 9.0	8.5 ± 0.8
		C_v	28.8	5.8	2.4	21.7	27.7	3.9	29.2
'Himnatavush' Foundation									
Jersey	I	M±m	3,345 ± 147	5.82 ± 0.13	3.9 ± 0.05	195 ± 7.4	130 ± 6.2	440 ± 14.2	7.6 ± 0.3
		C_v	13.9	7.2	4.0	12.1	15.1	10.2	10.7
	III and higher	M±m	4,040 ± 182	5.4 ± 0.13	3.82 ± 0.04	218 ± 13.6	154 ± 7.2	485 ± 12.8	8.3 ± 0.5
		C_v	14.2	7.7	3.4	19.6	14.6	8.3	17.5
Simmental	I	M±m	3,670 ± 205	4.0 ± 0.06	3.18 ± 0.02	147 ± 7.2	117 ± 5.9	560 ± 10.5	6.6 ± 0.3
		C_v	17.7	4.9	2.5	15.7	16.1	5.9	14.8
	III and higher	M±m	5,115 ± 243	3.95 ± 0.05	3.15 ± 0.03	202 ± 8.7	161 ± 6.4	655 ± 11.4	7.8 ± 0.4
		C_v	15.1	3.7	2.7	13.7	12.7	5.5	14.7

At the 'Himnatavush' Foundation farm, Jersey and Simmental cows showed fairly high milk productivity increasing with age. Simmentals outperformed Jerseys in milk yield for both lactation groups but lagged in milk fat and protein content. Jerseys, known for their high milk fat globally, had fat contents of 5.82% and 5.4% for first and third or higher lactations, respectively.

Simmental cows at this farm had higher live weights (560 and 655 kg) than Jerseys but lower milk yield coefficients.

In summary, Holstein, Brown Swiss, Simmental, and Jersey cows - both imported and locally born, first-calf and mature - showed milk productivity typical for their breeds and quite high under Armenian conditions.

Similar positive results for these breeds have been reported in other countries:

- At 'Agroholding Armenia' LLC, milk yields for local reproduction Holstein, Swiss, and Simmental cows were 9,040, 8,450, and 9,313 kg, respectively (Minasyan et al., 2023b).
- At 'Himnatavush' Foundation, first lactation Jersey cows produced 2,532 kg milk with 5.79% fat, and third/higher lactations produced 3,132 kg with 5.28% fat (Chitchyan, 2017).
- In Kazakhstan, imported Holstein cows at 'Almati' farm yielded 7,598 kg (Muratova, 2021).
- In Russia, first-lactation Holsteins at 'Agrofirma Pakhma' farm produced 8,615 kg (Tyapugin et al., 2021); in Moscow's 'Avdeyevskoye' farm, first and third lactations yielded 7,297 and 8,773 kg respectively (Lepekhina et al., 2022).
- Simmental cows in Russia's Tyumen region produced 6,903 kg (first lactation) and 7,360 kg (mature) (Svyazhenina, 2020).

These data demonstrate consistently high milk productivity of the studied breeds under favorable feeding and management conditions.

Reproductive Performance

The comparative assessment of reproductive traits among Holstein, Brown Swiss, Simmental, and Jersey cows - both imported and locally born - indicated satisfactory adaptation and reproductive efficiency under Armenian agro-climatic conditions.

Data presented in Table 2 show that the age at first calving among locally bred first-lactation cows ranged from 24.6 to 28.0 months. Jersey cows exhibited the earliest calving (24.6–25.0 months), characteristic of early-maturing breeds. In contrast, Holstein, Brown Swiss, and Simmental cows calved at 27.0–28.0 months, consistent with medium-maturing breeds.

The service period exceeded the recommended 80–90 days in all groups. Locally bred cows showed shorter service periods (105.7 days on average) than imported ones (113.8 days), suggesting improved reproductive efficiency. The calving interval (CI) ranged from 374.4 to 393.3 days, and the reproductive capacity coefficient (RCC) varied between 92.9 and 97.3. Jersey cows had the highest RCC values (96.6–97.3), reflecting superior reproductive performance.

Dry periods ranged from 61.4 to 85.2 days - above the standard 45–60 days - but remained within acceptable physiological limits.

These findings align with prior studies conducted in Armenia (Minasyan, 2010; Navasardyan, 2015) and other regions (Abdullayev et al., 2021; Muratova, 2021; Kanev et al., 2024), which describe similar reproductive traits in continental climates.

Table 2. Reproductive performance indicators (mean ± SD) in imported and locally bred cows by breed and farm

Reproductive Performance Indicators of Different Breeds of Cows in the Farms of 'Agroholding Armenia' LLC and 'Himnatavush' Foundation (n = 10)								
Breed	Lactation	Biometric parameters	Age at first calving (months)	Service period duration (days)	Gestation period duration (days)	Calving interval duration (days)	Dry period duration (days)	Reproductive capacity coefficient (RCC)
'Agroholding Armenia' LLC								
Holstein	I	M±m	27.3 ± 1.23	103.4 ± 4.12	277.3 ± 1.3	380.8 ± 5.53	61.4 ± 3.47	95.8 ± 0.92
		C_v	14.3	12.6	1.5	2.9	17.9	3.0
	III and higher	M±m	28.6 ± 1.16	113.0 ± 3.83	275.4 ± 1.2	388.5 ± 7.96	61.9 ± 4.87	94.0 ± 0.96
		C_v	12.8	10.7	1.4	3.2	24.9	3.2
Swiss	I	M±m	27.7 ± 0.81	106.5 ± 4.26	275.2 ± 1.1	381.8 ± 4.6	64.7 ± 4.7	95.7 ± 1.17
		C_v	9.2	12.7	1.23	3.84	23.1	3.85
	III and higher	M±m	30.6 ± 0.86	112.8 ± 4.1	274.2 ± 0.92	387.0 ± 4.35	68.7 ± 4.35	94.4 ± 1.1
		C_v	8.9	11.5	1.1	3.6	20.0	3.7
Simmental	I	M±m	27.3 ± 0.78	107.0 ± 4.12	278.5 ± 1.23	385.6 ± 4.2	69.0 ± 4.55	94.8 ± 1.0
		C_v	9.0	12.2	1.4	3.45	20.9	3.4
	III and higher	M±m	29.0 ± 1.24	115.6 ± 3.83	277.0 ± 1.3	393.3 ± 4.5	70.7 ± 4.5	92.9 ± 1.1
		C_v	13.5	10.5	1.5	3.6	20.1	3.7
'Himnatavush' Foundation								
Jersey	I	M±m	25.0 ± 0.66	97.5 ± 5.0	280.3 ± 0.8	378.0 ± 5.3	81.3 ± 4.7	96.6 ± 1.3
		C_v	8.4	16.0	0.9	4.4	18.2	4.3
	III and higher	M±m	24.6 ± 1.0	93.8 ± 7.5	281.6 ± 1.2	374.4 ± 7.2	85.2 ± 5.4	97.3 ± 1.9
		C_v	12.8	25.3	1.3	6.1	19.9	6.1
Simmental	I	M±m	27.0 ± 0.8	102.0 ± 3.85	279.1 ± 1.2	381.0 ± 4.2	65.0 ± 2.7	95.9 ± 1.0
		C_v	9.8	11.9	1.3	3.5	13.2	3.5
	III and higher	M±m	28.0 ± 0.63	105.7 ± 4.1	278.8 ± 1.2	384.5 ± 4.1	71.0 ± 2.8	95.0 ± 1.0
		C_v	7.1	12.4	1.3	3.4	12.5	3.3

Note: CI – calving interval; RCC – reproductive capacity coefficient.

Table 3. Hematological parameters in different cattle breeds (mean ± SD) measured during the study

Hematological Indicators of Mature Cows of Different Breeds in the Farms of 'Agroholding Armenia' LLC and 'Himnatavush' Foundation (n = 10)						
Breed	Biometric parameters	Erythrocyte count, mln/1mm³	Leukocyte count, thous./1mm³	Hemoglobin, g%	Total protein, %	Blood alkaline reserve, mg%
'Agroholding Armenia' LLC						
Holstein	M±m	7.1 ± 0.10	10.6 ± 0.48	11.0 ± 0.35	6.3 ± 0.11	424.0 ± 9.4
	C_v	4.4	14.3	10.1	5.7	7.0
Swiss	M±m	6.7 ± 0.14	8.8 ± 0.54	11.8 ± 0.37	6.4 ± 0.11	430.5 ± 7.0
	C_v	6.9	19.3	9.9	5.4	5.2
Simmental	M±m	7.2 ± 0.18	9.4 ± 0.52	12.0 ± 0.14	6.3 ± 0.12	433.1 ± 9.3
	C_v	7.8	17.4	3.6	5.9	6.8
'Himnatavush' Foundation						
Jersey	M±m	5.2 ± 0.18	7.5 ± 0.3	9.5 ± 0.2	6.3 ± 0.08	430.2 ± 9.5
	C_v	10.9	12.6	6.5	4.3	7.0
Simmental	M±m	7.1 ± 0.23	9.2 ± 0.6	11.6 ± 0.18	6.1 ± 0.1	424.1 ± 7.9
	C_v	10.2	20.3	4.9	4.7	5.9

Note: All values are within physiological ranges. Sample size n = 10 per group.

Table 4. Seasonal variation in clinical indicators in cows of different breeds

Clinical Indicators of Holstein, Swiss, and Simmental Breed Cows from the 'Agroholding Armenia' LLC Farm and Jersey and Simmental Breed Cows from the 'Himnatavush' Foundation Farm (n = 10)

Breed	Lactation	Spring			Summer			Autumn			Winter		
		Body temperature, °C	Respiratory rate, per min	Pulse rate, per min	Body temperature, °C	Respiratory rate, per min	Pulse rate, per min	Body temperature, °C	Respiratory rate, per min	Pulse rate, per min	Body temperature, °C	Respiratory rate, per min	Pulse rate, per min
'Agroholding Armenia' LLC													
Holstein	I	38.2	34.3	72.2	38.3	34.8	72.8	38.2	34.5	72.3	38.2	34.7	71.7
	III and higher	37.6	31.8	66.1	37.7	33.1	69.0	37.7	32.0	66.2	37.7	33.1	67.6
Swiss	I	38.3	34.4	73.1	38.4	34.8	73.8	38.3	34.3	73.3	38.2	34.2	73.4
	III and higher	37.8	33.4	72.0	37.8	33.8	72.7	37.8	33.4	71.8	37.7	33.3	71.0
Simmen-tal	I	38.8	32.7	68.8	38.8	33.6	69.6	38.6	33.1	69.0	38.5	32.5	69.0
	III and higher	38.1	33.0	70.0	38.0	33.5	71.1	38.0	32.9	70.2	38	32.6	70.4
'Himnatavush' Foundation													
Jersey	I	38.7	33.0	64.0	38.7	33.8	65.4	38.8	32.2	64.9	38.0	32.5	64.4
	III and higher	38.8	32.2	65.0	38.7	33.6	65.7	38.6	32.4	65.0	38.3	33.0	64.8
Simmen-tal	I	38.7	32.0	69.0	38.6	33.0	70.0	38.6	32.6	69.1	38.5	32.3	68.5
	III and higher	38.2	33.1	71.0	38.2	33.8	71.7	38.3	33.3	70.5	38.0	33.0	70.2

Note: Measurements recorded in spring, summer, autumn, and winter. Units: temperature (°C), respiration (breaths min^{-1}), pulse (beats min^{-1}).

Hematological Indicators

Table 3 shows hematological profiles of study cows. All values fell within physiological norms. At 'Agroholding Armenia' LLC, Holstein and Simmental cows had slightly higher erythrocyte and leukocyte counts than Brown Swiss cows, while hemoglobin, total protein, and alkaline reserve were stable across breeds.

At 'Himnatavush' Foundation, Jersey cows exhibited higher total serum protein and alkaline reserve levels compared to Simmental cows, suggesting enhanced metabolic activity and heat adaptability. Simmental cows showed elevated erythrocyte and hemoglobin levels, possibly reflecting robust oxygen transport capacity.

These results align with previous breed-specific hematological findings reported by Gaidukova (2011), Shevkhuzhev et al. (2014) and Chitchyan (2017).

Clinical Indicators

Seasonal clinical monitoring (Table 4, Figs 1 and 2) showed body temperatures within the normal physiological range (37.6–38.8 °C). Respiratory and pulse rates varied slightly by season, ranging from 31.8 to 34.8 breaths per minute and 64.0 to 73.8 beats per minute, respectively.

Slight increases during summer were most pronounced in Jersey cows, likely due to higher metabolic activity and environmental sensitivity.

These values are consistent with species-specific norms described by Kudryavtsev & Kudryavtseva (1974), confirming the animals' health and good adaptation to local climatic variations.

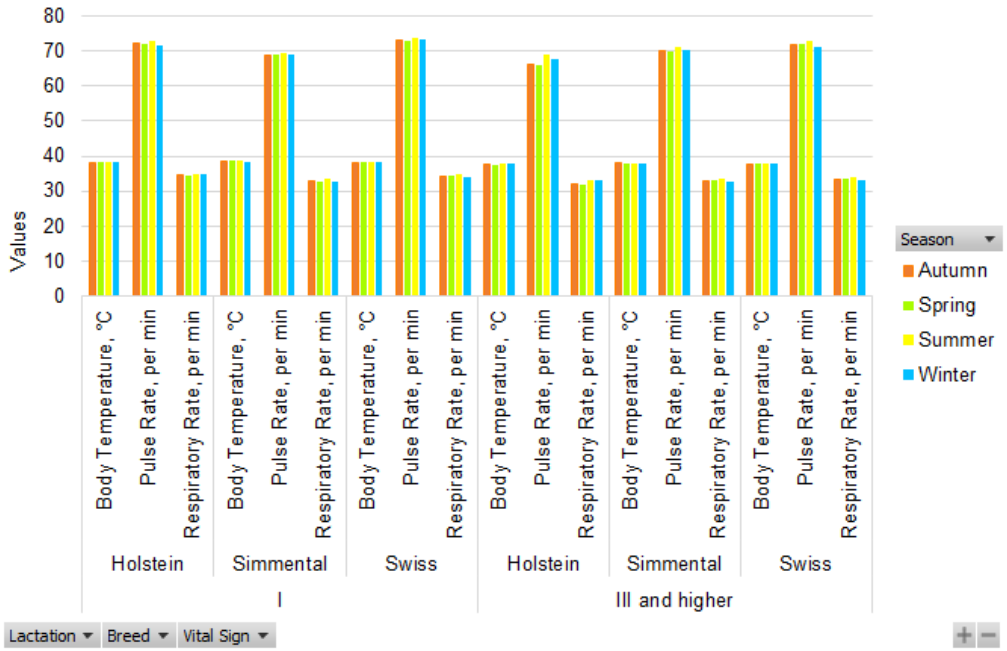

Figure 1. Clinical Indicators of Holstein, Swiss, and Simmental Breed Cows from the 'Agroholding Armenia' LLC Farm.

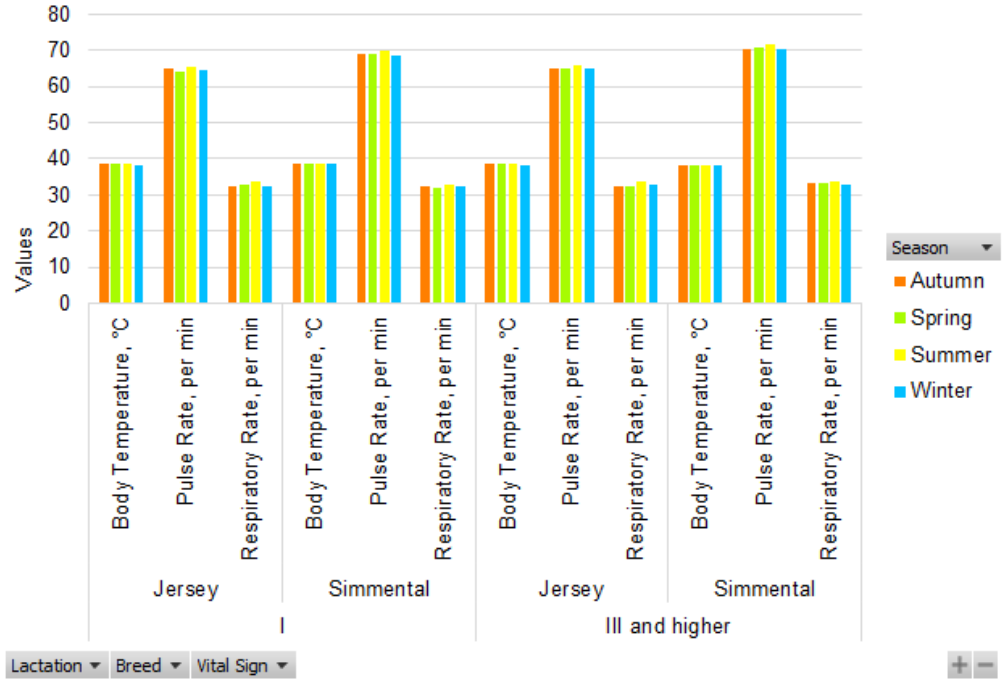

Figure 2. Clinical Indicators of Jersey and Simmental Breed Cows from the 'Himnatavush' Foundation Farm.

CONCLUSIONS

The findings of this study demonstrate that Holstein, Brown Swiss, Simmental, and Jersey cows – both imported and locally bred – exhibit satisfactory milk productivity, reproductive performance, and physiological adaptation under the diverse agro-climatic conditions of Armenia.

At the 'Agroholding Armenia' LLC farm, first-calf Brown Swiss cows produced 8,523 kg of milk, exceeding their Holstein and Simmental counterparts by 223 kg (2.7%) and 610 kg (7.7%), respectively. Among mature cows of these breeds, Holsteins had the highest milk yield (8,887 kg), surpassing Brown Swiss and Simmental cows by 1,114 kg (14.3%) and 2,691 kg (43.4%), respectively. Brown Swiss cows also outperformed Simmentals by 1,577 kg (25.4%).

These three breeds showed relatively high milk fat content, ranging between 3.9% and 4.33%. Live weights increased proportionally with age, with Simmental cows having the highest values (576 kg and 726 kg), significantly surpassing Holstein and Brown Swiss counterparts.

At the 'Himnatavush' Foundation farm, milk yields of Simmental cows were 3,670 kg and 5,115 kg for first and third or higher lactations, respectively; Jersey cows produced 3,345 kg and 4,040 kg. Jersey cows demonstrated characteristically high milk fat content – 5.82% and 5.4%, respectively.

Although service and dry periods slightly exceeded standard recommendations, reproductive efficiency indicators such as the reproductive capacity coefficient (92.8–97.2) remained within acceptable thresholds. Locally bred cows outperformed imported ones in several reproductive traits, indicating successful genetic adaptation and effective herd management.

Hematological indicators showed no significant differences among mature cows of all breeds at both farms, with all values within physiological norms. Clinical parameters including body temperature (37.6–38.8°C), respiration rate (31.8–34.8 breaths min^{-1}), and pulse rate (64.0–73.8 beats min^{-1}) were stable and within normal ranges throughout the study.

Hematological and clinical parameters confirm the absence of pathological stress. Jersey cows exhibited slightly better reproductive efficiency and protein metabolism indicators, while Simmental cows showed enhanced erythrocyte and hemoglobin profiles.

These results support the continued importation and selective breeding of Holstein, Brown Swiss, Simmental, and Jersey cattle in Armenia. Their adaptability, reproductive viability, and physiological stability suggest strong potential for improving the sustainability, productivity, and genetic advancement of the national dairy sector.

Further longitudinal studies under varying feeding regimes are recommended to fully exploit the genetic potential of these breeds in Armenia's evolving dairy industry.

ACKNOWLEDGEMENTS. The authors sincerely thank the management and staff of 'Agroholding Armenia' LLC and the 'Himnatavush' Foundation for providing access to research animals and valuable farm records. The support of the 'Center for Agricultural Research and Certification' SNCO and the 'Scientific Center for Risk Assessment and Analysis in Food Safety Area' was instrumental for conducting fieldwork and laboratory analyses. The authors also acknowledge the diagnostic services provided by 'Neolab' Laboratory, Yerevan, Armenia.

REFERENCES

Abdullayev, K.Sh., Saniyazova, A.Zh. & Sultanbayeva, G.K. 2021. Selection status in the dairy cattle industry in southern Kazakhstan. In *Collection of Scientific Works of the Kazakh National Agrarian Research University*, Almaty, pp. 71–75.

Abovyan, Yu.H. 1994. *Influence of genotypic characteristics and paratypical factors on the development and manifestation of natural resistance in cattle*. Doctoral dissertation in biological sciences, Yerevan, 40 pp.

Chen, H., Yu, B., Liu, C., Cheng, L., Yu, J., Hu, X. & Xiang, M. 2022. Hematology Reference Intervals for Holstein Cows in Southern China: A Study of 786 Subjects. *Vet Sci.* **9**(10), 565.

Chitchyan, Zh.T. 1984. *Economic and biological traits of imported Black Pied cattle in Armenia's mountainous zones*. Abstract of thesis for Candidate of Agricultural Sciences. 06.02.04, Krasnodar, 23 pp.

Chitchyan, Zh.T. 2017. Biological and productive traits of imported Jersey cows in the northeast of Armenia. PhD dissertation, Yerevan, 23 pp.

Eidrigievich, E.V. & Raevskaya, V.V. 1978. *Conformation of Farm Animals*. Moscow: Kolos, 255 pp.

Gaidukova, E.V. 2011. Correlation between milk productivity and reproductive qualities of cows depending on breed in breeding farms in Kaluga region. *Zootechny* **12**, 8–10.

Hovhanisyan, A.O. 2001. Economic-biological characteristics of the Caucasian Brown cattle breed and the development and application of new selection parameters for breed improvement in the Republic of Armenia. Abstract of doctoral dissertation in agricultural sciences. 06.02.01, Yerevan, 37 pp.

Kanev, P.N., Gorelik, O.V. & Kharlap, S.Yu. 2024. Association of productive traits in Holstein dairy cattle. *Agrarian Science* **3**, 92–97.

Khamiruev, T.N. 2009. Simmental cattle of Austrian selection under the conditions of the Baikalskoye enterprise, Republic of Buryatia. In *Agrarian Science for Agricultural Production in Kazakhstan, Siberia, and Mongolia. Proceedings of the 12th International Scientific-Practical Conference (Shymkent, April 16–17, 2009)*, Vol. II, Almaty, pp. 64–67.

Kostomakhin, N.M., Voronova, O.A. & Gabedova, M.A. 2021. Milk productivity and reproductive capacity of cows with different Holstein blood levels. *Bulletin of Kurgan State Agricultural Academy* **3**(39), 43–50.

Kozlo, N.E. 1984. *Animal Reproduction*. Moscow, 224 pp.

Kudryavtsev, A.A. & Kudryavtseva, L.A. 1974. Clinical Hematology of Animals. Moscow: Kolos, 339 pp.

Lepekhina, T.V., Bakay, F.R. & Avdeeva, E.V. 2022. Milk productivity of Holstein cows in the Moscow region. *Zootechny* **5**, 5–7.

Mao, V.G., Vang, Z.P. & Jhi, X.K. 2010. Effect of the age of first mating on reproductive performance of Chinese Holsteins. *Chinese Journal of Animal Science* **46**, 52–54.

Marmaryan, Yu.G. 2001. *Fundamentals of Animal Husbandry*, Yerevan, 433 pp.

Meyer, M.J., Everett, R.W. & Van Amburgh, M.E. 2004. Reduced age at first calving: Effects on lifetime production, longevity, and profitability. In Stevenson, J.S. (ed.): *Dairy Day 2004*, Kansas State University, Tempe, AZ, pp. 42–52.

Minasyan, L.M. 2010. Reproductive abilities of Black Pied cows in the mountainous zones of the Republic of Armenia. *AgroScience*, 9–10, 409–412.

Minasyan, L.M. 2013. *The Black Pied cattle breed and ways to improve its efficiency in the Republic of Armenia*. Abstract of doctoral dissertation in agricultural sciences. 06.02.01, Yerevan, 45 pp.

Minasyan, L.M., Chitchyan, T.Zh. & Chitchyan, Zh.T. 2023a. Milk Productivity of Holstein Cows Imported from Germany Under the Conditions of the 'Smart' Barn at 'Depi Agro' Farm in the Armavir Region of Armenia. *Agroscience and Technology of the Armenian National Agrarian University* **3**, 273–277.

Minasyan, L.M., Simonyan, A.Kh., Chitchyan, T.Zh. & Chitchyan, Zh.T. 2023b. Results of a comparative study of milk productivity indicators in Holstein, Brown Swiss, and Simmental cows of local reproduction under the conditions of Armenia. *Effective Animal Husbandry* **1**(183), Krasnodar, 74–75.

Minasyan, L.M., Markosyan, T.H., Vardanyan, H.R., Simonyan, L.L., Shahazizyan, N.A. & Simonyan, A.Kh. 2024. *Bulletin on the Number of Farm Animals and Livestock Production in the Republic of Armenia*. Author's Edition, Yerevan, 45 pp.

Muradyan, A.M., Solovyeva, O.I., Minasyan, L.M., Chitchyan, Zh.T. & Ruzanova, N.G. 2022. Changes in the Milk Productivity Dynamics of Locally Bred Brown Swiss Cows in Armenia. *Agricultural Science* **365**(12), Moscow, 41–42.

Muratova, M.A. 2021. Specifics of milk productivity in Holstein cows under southeastern Kazakhstan conditions. *Collection of Scientific Works of the Kazakh National Agrarian Research University*, Almaty, pp. 109–114.

Navasardyan, D.S. 2015. *Biological and economic characteristics of Holstein, Brown Swiss, and Simmental cows*. PhD abstract, Yerevan, 24 pp.

Salakhov, F.D. 2017. *Comparative characterization of economically valuable and adaptive traits in Holstein and Brown Swiss cows under industrial milk production technology*. Dissertation for Candidate of Agricultural Sciences. Ufa, 133 pp.

Shevkhuzhev, A.F., Smarkuev, D.R. & Meremshaova, E.A. 2014. Morphological and biochemical blood indicators in Simmental cows. *Dairy and Meat Cattle Breeding* **4**, 29–32.

Simonyan, Kh.M. 2004. *Cattle breeds raised in Armenia and methods for their improvement*. Yerevan, 558 pp.

Skoptsova, T.I. & Popova, S.A. 2018. Milk productivity of first-calf Brown Swiss cows depending on their lineage. *Proceedings of Velikolukskaya State Agricultural Academy* **3**, Velikiye Luki, 28–32.

Solovyova, O.I., Ruzanova, N.G., Khramtsev, A.V., Levinkova, V.P. & Listrapenkova, V.I. 2016. Productive and reproductive qualities of Brown Swiss and Sychevka breed cows depending on mating type. *Dairy and Meat Cattle Breeding* **3**, 38–40.

Svyazhenina, M.A. 2020. Simmental cattle of the Tyumen region. *Proceedings of the Omsk State Agrarian University* **4**(84), 283–286.

Tyapugin, S.E., Meshcherov, R.K. & Dunin, M.I. 2021. Breeding characteristics of Holstein cattle from Northern European countries. *Dairy and Beef Cattle Breeding* **6**, 2–4.

Worman, H.D., Wright, J.R. & Hubbard, S.M. 2009. Reproductive status of Holstein and Jersey cows in the United States. *Journal of Dairy Science* **92**, 3517–3528.