UDC 636.234.082.2:612.017:636.09
DOI: https://doi.org//10.31073/abg.69.14

THE ABILITY OF HOLSTEIN BREED SIRES TO TRANSMIT A HIGH IMMUNE RESPONSE TO THEIR OFFSPRING IN CASE OF DISEASE

N. S. CHERNIAK*
Institute of Animal Breeding and Genetics nd. a. M.V. Zubets of NAAS (Chubynske, Ukraine)
https://orcid.org/0000-0002-240-7168 – N. S. Cherniak
irgt2017@ukr.net

Genomic selection allows animals to be selected based on their genetic information, which enables more accurate prediction of hereditary traits. This shortens the selection interval, improves reproductive efficiency, reduces the cost of raising unproductive individuals, and accelerates genetic progress in the population.

The research was conducted at the dairy production complex LLC "Ostriykivske," where 54 Holstein heifers were selected for genomic evaluation.

Genomic testing revealed significant differences in immune indicators among the daughters of different sires, confirming the genetic influence of the father on the health of his offspring. The highest Immunity+ index (105.67 ± 1.39) was recorded in the daughters of the sire Elkhart 3148929453, from the Elevation 1491007.65 lineage of the Holstein breed. These daughters inherit a high immune response to disease, as evidenced by a 7.86% lower incidence rate according to genomic testing. This indicates high genetic resistance to infectious diseases, which is a crucial factor for improving herd health and productivity.

In contrast, the sire Majordomo 13353511, which has a low Immunity Index, produces offspring that are more prone to diseases. This is supported by low immune resistance in his daughters, leading to increased cases of diseases such as paresis, retained placenta, and others. Using semen from sires with a high Immunity Index is an effective tool in breeding programs aimed at improving disease resistance in animals. Genomic evaluation enables the selection of sires with positive markers associated with immune response. The offspring of such animals show better health indicators, higher calf survival rates, and reduced veterinary costs. This is especially relevant in conditions of production intensification, when ensuring not only productivity but also animal welfare is critical.

Immunity+ (I) – bull semen with the property of transmitting strong immunity. This is an innovative technology in cattle breeding that enables the selection and use of semen from bulls with a high immune index. It aims to improve immune resistance in offspring, reduce morbidity, and enhance cow productivity. This opens new opportunities for selection and herd health improvement through the choice of sires with high immune status.

Keywords: **genomic evaluation, genomic selection, immune index, disease incidence, breeding bulls, offspring**

ВЛАСТИВІСТЬ БУГАЇВ-ПЛІДНИКІВ ГОЛШТИНСЬКОЇ ПОРОДИ ПЕРЕДАВАТИ НАЩАДКАМ ЗДАТНІСТЬ ДО ВИСОКОЇ ІМУННОЇ ВІДПОВІДІ У ВИПАДКУ ХВОРОБ

Н. С. Черняк
Інститут розведення і генетики тварин імені М.В. Зубця НААН (Чубинське, Україна)

Геномна селекція дає можливість здійснювати відбір тварин на основі їхньої генетичної інформації, що забезпечує більш точне прогнозування спадкових якостей. Це дозволяє

*Науковий керівник – Ю. В. Вдовиченко, доктор сільськогосподарських наук, старший науковий співробітник, член-кореспондент НААН

скоротити селекційний інтервал, підвищити ефективність відтворення, зменшити витрати на вирощування непродуктивних особин і прискорити генетичний прогрес у популяції.

Дослідження проводили на молочно виробничому комплексі ТОВ «Острійківське», для проведення геномної оцінки, було відібрано 56 теличок голштинської породи.

В результаті геномного тестування спостерігаються значні відмінності в імунних показниках у дочок різних бугаїв, що підтверджує генетичний вплив батьків на здоров'я їх нащадків. Найвищий показник Індексу імунітету Immunity+ (105,67 ± 1,39) відмічається у дочок бугая-плідника Елькгарта 3148929453 спорідненої групи Елевейшна 1491007.65 голштинської породи. Дочки бугая Елькгарта 3148929453 успадковують здатність до високої імунної відповіді у випадку хвороб, що підтверджується зниженим рівнем захворюваності на 7,86% за результатами геномного тестування. Це вказує на високу генетичну стійкість цих тварин до інфекційних захворювань, що є важливим фактором для підвищення здоров'я та продуктивності стада.

Бугай-плідник Мажордомо 13353511, який відзначається низьким Індексом імунітету, має нащадків, які більш схильні до захворювань. Це підтверджується низьким рівнем імунної стійкості у його дочок, що призводить до збільшення випадків хвороб, таких як парез, затримка посліду та ін.

Використання сперми бугаїв із високим імунним індексом є ефективним інструментом у селекційній роботі, спрямованій на підвищення стійкості тварин до захворювань. Завдяки геномній оцінці можливо відібрати бугаїв, які мають позитивні маркери, пов'язані з імунною відповіддю. Потомство таких тварин характеризується кращими показниками здоров'я, вищою виживаністю телят і зниженням витрат на ветеринарне обслуговування. Це особливо актуально в умовах інтенсифікації виробництва, де важливо забезпечити не лише продуктивність, а й добробут тварин.

Immunity+ (I) – сперма бугаїв з властивістю до передачі сильного імунітету. Це інноваційна технологія у селекції великої рогатої худоби, яка дозволяє відбирати та використовувати сперму бугаїв із високим імунним індексом. Вона спрямована на підвищення імунної стійкості потомства, зменшення захворюваності та покращення продуктивності корів. Це відкриває нові можливості для селекції та поліпшення здоров'я стада за рахунок вибору бугаїв з високим імунним статусом.

Ключові слова: **геномна оцінка, геномна селекція, імунний індекс, захворюваність, бугаї-плідники, потомство**

Introduction. The use of genomic evaluation of animals in cattle breeding is one of the most advanced directions in animal husbandry. This approach opens new opportunities for increasing productivity, improving animal health, and shortening the selection interval. The advantages and prospects of using genomic evaluation in cattle breeding are highlighted in the works of Birukova & Kopulova (2012), Ivanov et al. (2021). Due to genomic evaluation, breeders can assess the breeding qualities of animals at early developmental stages. This allows earlier decision-making about the feasibility of including specific individuals in breeding programs, significantly reducing the selection interval and improving breeding efficiency (Gladiy et al., 2018).

Dairy cattle productivity is ensured through the use of animals with high breeding value. The determination of breeding value is influenced by factors such as age at evaluation, economic efficiency of evaluation, and the realization of parental qualities in the offspring. Genomic evaluation allows breeding value to be assessed at an early age (Ruban & Kostenko, 2010). A developed and implemented methodology for predicting the breeding value of farm animals based on genome analysis has opened a new era of genetic improvement of breeds in the direction of enhancing economically beneficial traits such as productivity, health, reproduction, ease of calving, productive longevity, and more (Pryce & Hayes, 2012).

Genomic selection enables early evaluation and selection of potential breeding animals (bulls and heifers) with predicted values of economically important traits, which accelerates the genetic

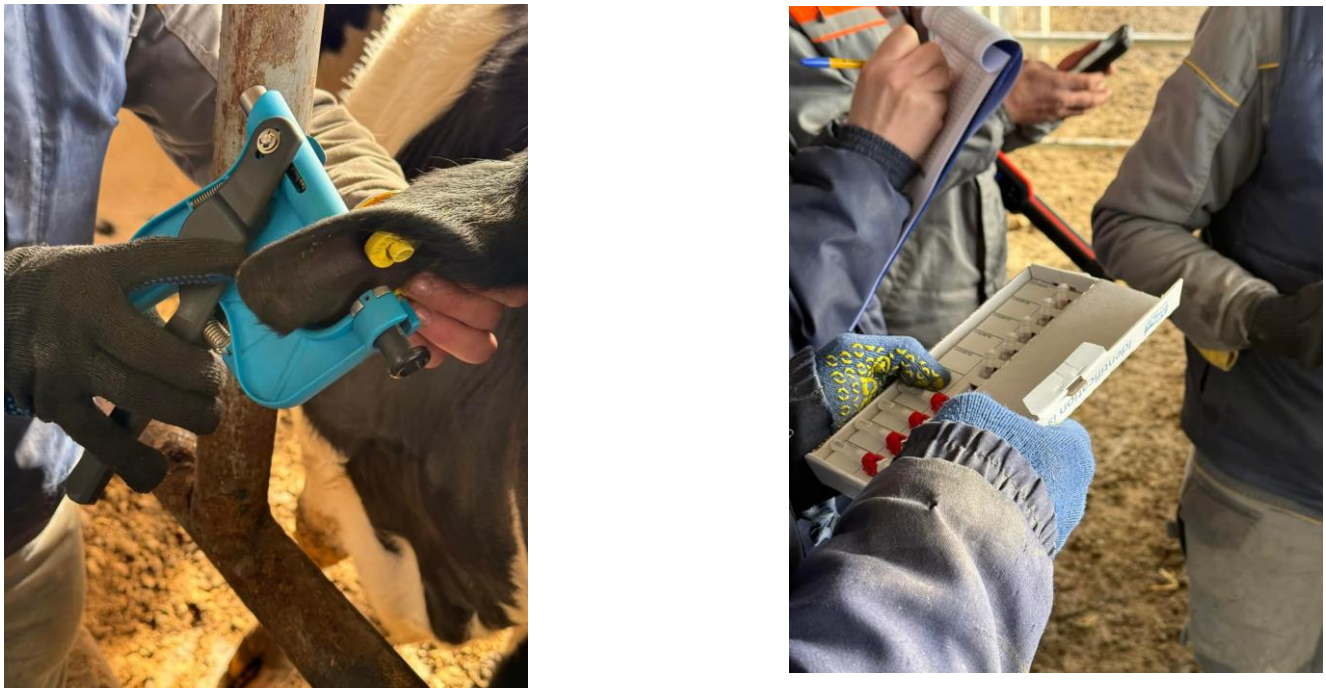
progress of breeds by increasing the number of improved traits and reducing the generation interval (Ruban et al., 2016; Schaeffer, 2006).

As with traditional genetic evaluations, Interbull plays an important role in the international comparison of genomic evaluations (Durr & Philipsson, 2012). However, genomic evaluations of breeding value must undergo validation tests to be internationally recognized (Mantysaari et al., 2010). Interbull has developed and continues to improve the genomic MACE (Multiple Across Country Evaluation) method for evaluating young Holstein bulls by country. Increasing attention has recently been paid to the prediction of breeding progress for productive traits. It is known that the effectiveness of selection is promoted by the high breeding value of sires. Methods that allow for early evaluation results are prioritized by breeders. Therefore, the issue of repeatability of breeding value assessments in successive generations and the use of this information for predictive breeding becomes relevant.

Objective. To study the ability of Holstein breed sires to transmit the capacity for a high immune response to their offspring in case of disease.

Materials and Methods. The research was conducted at the dairy production complex of LLC “Ostriykivske” in the Kyiv region, which has the status of a breeding reproducer for the Holstein breed. The farm uses loose housing technology. Advanced technologies are applied in the preparation, processing, and distribution of feed with the addition of mineral and vitamin supplements. For genomic evaluation, 54 Holstein heifers were selected. Evaluation was conducted during the first two weeks after birth.

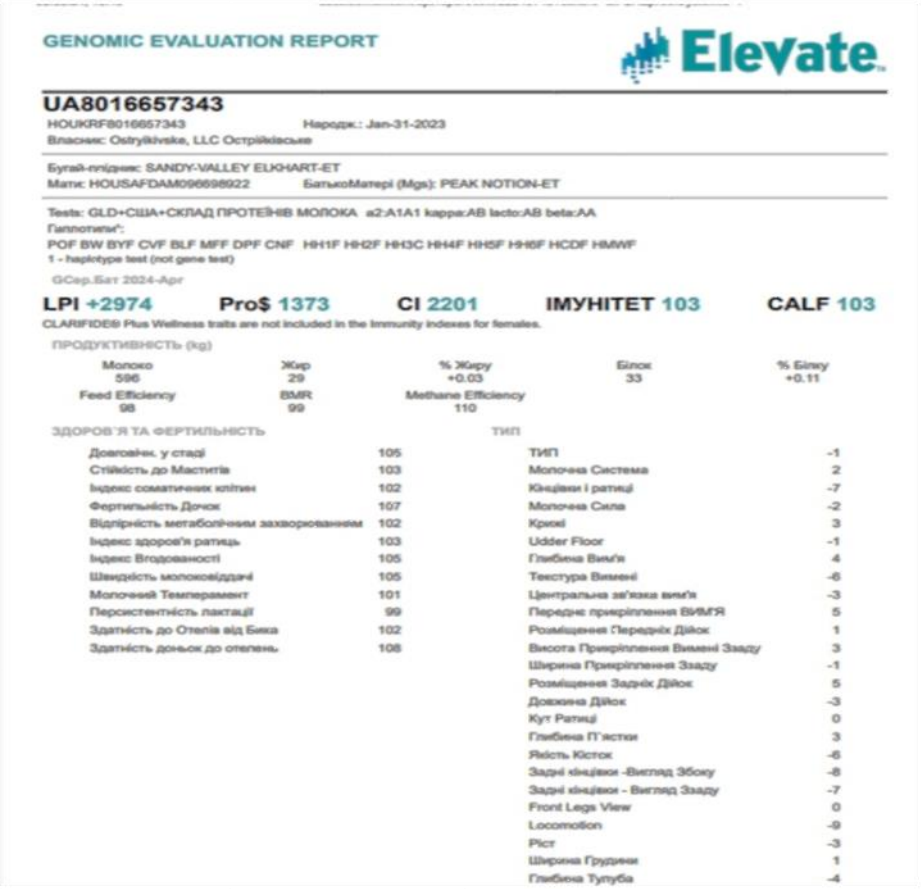
Sample collection was carried out using ear notching (Pic. 1). For genomic evaluation, the collected samples were sent to the NeoGen laboratory in the USA. Information on the animal and its pedigree was provided as required.



Picture 1. **Sample collection for genomic evaluation.**

Based on the results of the genomic evaluation, information about the genetic makeup inherited by the heifer was obtained at the early stages of rearing. This includes not only the Immunity Index but also key indicators related to health, longevity, type traits, milk productivity, reproductive performance, and the presence of genetic defects (Pic. 2).

Thus, genomic evaluation enables an accurate prediction of the economic viability of keeping the animal in the herd. It allows for a precise assessment of the potential economic benefits of using the animal in both breeding programs and milk production.



GENOMIC EVALUATION REPORT

Elevate

UA8016657343

HOUKRF8016657343 Народж.: Jan-31-2023
Власник: Ostryikivske, LLC Острійківське

Бугай-плідник: SANDY-VALLEY ELKHART-ET
Мати: HOUSAFDAM096698922 БатькоМатері (Mgs): PEAK NOTION-ET

Tests: GLD+США+СКЛАД ПРОТЕЇНІВ МОЛОКА a2:A1A1 kappa:AB lacto:AB beta:AA
Гаплотипи*:
POF BW BYF CVF BLF MFF DPF CNF HH1F HH2F HH3C HH4F HH5F HH6F HCDF HMWF
1 - haplotype test (not gene test)

GCep.Бат 2024-Apr

LPI +2974 **Pro$ 1373** **CI 2201** **ІМУНІТЕТ 103** **CALF 103**

CLARIFIDE® Plus Wellness traits are not included in the Immunity indexes for females.

ПРОДУКТИВНІСТЬ (kg)

Молоко	Жир	% Жиру	Білок	% Білку
596	29	+0.03	33	+0.11
Feed Efficiency	BMR	Methane Efficiency		
98	99	110		

ЗДОРОВ'Я ТА ФЕРТИЛЬНІСТЬ

Довголіття, у стаді	105
Стійкість до Маститів	103
Індекс соматичних клітин	102
Фертильність Дочок	107
Відпірність метаболічним захворюванням	102
Індекс здоров'я ратиць	103
Індекс Вгодованості	105
Швидкість молоковіддачі	105
Молочний Темперамент	101
Персистентність лактації	99
Здатність до Отелів від Бика	102
Здатність доньок до отелень	108

ТИП

ТИП	-1
Молочна Система	2
Кінцівки і ратиці	-7
Молочна Сила	-2
Крижі	3
Udder Floor	-1
Глибина Вим'я	4
Текстура Вимені	-6
Центральна зв'язка вим'я	-3
Переднє прикріплення ВИМ'Я	5
Розміщення Передніх Дійок	1
Висота Прикріплення Вимені Заду	3
Ширина Прикріплення Заду	-1
Розміщення Задніх Дійок	5
Довжина Дійок	-3
Кут Ратиці	0
Глибина П'ястки	3
Якість Кісток	-6
Задні кінцівки -Вигляд Збоку	-8
Задні кінцівки - Вигляд Заду	-7
Front Legs View	0
Locomotion	-9
Ріст	-3
Ширина Грудини	1
Глибина Тулуба	-4

Photo 2**. Results of the genomic evaluation.**

Research Results. It was observed that among the daughters of different sires of the same breed, there are statistically significant differences in the Immunity Index. This indicates a substantial paternal influence on the transmission of immune traits to offspring, which depends on the genetic characteristics of a particular sire.

According to the results of the genomic test, the highest Immunity+ Index (105.67 ± 1.39) was recorded in the daughters of the Holstein sire Elkhart 3148929453, from the Elevation 1491007.65 lineage (Table 1).

This suggests a high genetic resistance of these animals to infectious diseases, which is an important factor in improving the health and productivity of the herd.

The Immunity Index in the daughters of sires Bosa 3139112680 (Elevation 1491007.65 lineage) and Pinball 13353753 (Chief 1427381.62 lineage) is almost identical, ranging from 100.90 to 100.92.

This indicates similar genetic characteristics of these sires in terms of immune resistance, which may be important for planning future breeding strategies.

1. The Influence of the Sire on the Immunity Index of Daughters

Name	Related group	Immunity Index Bull (I)	Number of daughters, h	Immunity Index (I)	σ	Cv, %
Bosa US3139112680	Elevation 1491007.65	103	10	100,90 ± 1,50	4,75	4,71
Pinball CA13353753	Chief 1427381.62	101	13	100,92 ± 1,09	3,95	3,91
Starjack US3138498788	Chief 1427381.62	100	11	99,64 ± 0,92	3,04	3,05
Elkhart US3148929453	Elevation 1491007.65	106	9	105,67 ± 1,39	4,07	4,03
Password CA13638215	Chief 1427381.62	100	7	100,29 ± 1,27	3,35	3,34
Majordomo CA13353511	Elevation 1491007.65	99	4	98,5±0,87	1,73	1,76

A relatively low Immunity Index was observed in the daughters of the sire Majordomo 13353511 (Elevation 1491007.65 lineage), at 98.5 ± 0.87. This suggests lower resistance to infections in the offspring of this sire compared to others, which was confirmed by the genomic testing results. In terms of immune indicators, the daughters of Elkhart 3148929453 showed a statistically significant advantage over the offspring of Majordomo 13353511 ($P < 0.001$). The daughters of Elkhart had a notably higher Immunity Index, confirming the high level of immune resistance in their progeny.

The influence of the sire on the Immunity Index of daughters is an important aspect of selection, as the genetic characteristics of sires directly determine the level of immune resistance in their offspring.

Genomic testing has revealed significant differences in immune indicators among the daughters of different bulls, confirming the genetic impact of sires on the health of their progeny. Thus, the daughters of the sire Elkhart 3148929453 inherit the ability to mount a strong immune response in the case of disease, as evidenced by a 7.86% lower morbidity rate based on the results of genomic testing (Table 2).

In particular, a reduction in the incidence of the following diseases was recorded:

- Mastitis – by 2.38%
- Ketosis – by 1.92%
- Metritis – by 1.87%
- Displaced abomasum – by 0.72%
- Retained placenta – by 0.79%

These data indicate that the offspring of Elkhart 3148929453 inherit an enhanced immune response, resulting in improved overall animal health and reduced need for veterinary intervention. The sire Majordomo 13353511, who has a low Immunity Index, produces offspring that are more susceptible to disease. This is evidenced by the lower level of immune resistance observed in his daughters, leading to increased incidence of conditions such as paresis and retained placenta. Using semen from bulls with a low immunity index in breeding is undesirable, as such animals have lower genetic potential to develop a strong immune response. Their offspring may be more vulnerable to infectious diseases and show higher mortality rates at an early age, requiring additional veterinary expenses and reducing overall farm efficiency.

2. The Influence of the Sire on the Disease Resistance of Daughters ($\bar{x} \pm S.E.$)

Bull's name	Head Count	Diseases, %																	
		mastitis			metritis			ketosis			displaced abomasum			retained placenta			paresis		
		M ± m	σ	Cv, %	M ± m	σ	Cv, %	M ± m	σ	Cv, %	M ± m	σ	Cv, %	M ± m	σ	Cv, %	M ± m	σ	Cv, %
Elkhart 3148929453	9	2,38 ± 0,42	1,26	3,00	1,87 ± 0,13	0,48	3,69	1,92 ± 0,11	0,34	3,10	0,72 ± 0,09	0,27	3,00	0,79 ± 0,1	0,40	3,07	0,00 ± 0,01	0,05	5,00
Majordomo 13353511	4	0,57 ± 0,37	1,24	3,18	0,90 ± 0,12	0,41	3,42	0,66 ± 0,17	0,55	3,23	0,30 ± 0,11	0,37	3,36	-0,21 ± 0,1	0,27	2,45	-0,05 ± 0,02	0,08	4,00
Pinball 13353753	13	1,14 ± 0,28	0,99	3,54	1,76 ± 0,13	0,45	3,46	0,81 ± 0,15	0,50	3,35	0,18 ± 0,07	0,26	3,68	0,69 ± 0,1	0,38	3,48	-0,4 ± 0,03	0,09	3,07
Bosa 1339112680	10	1,95 ± 0,39	0,78	2,00	0,98 ± 0,22	0,43	1,95	1,25 ± 0,23	0,46	2,00	0,68 ± 0,08	0,15	1,88	-0,03 ± 0,1	0,25	1,92	0,025 ± 0,04	0,08	2,07
Password 13638215	7	0,29 ± 0,31	0,89	2,85	1,56 ± 0,23	0,62	2,67	0,78 ± 0,17	0,47	2,91	0,53 ± 0,09	0,26	2,87	0,46 ± 0,1	0,38	2,69	0,04 ± 0,05	0,13	2,64
Starjack 3138498788	11	0,83 ± 0,26	0,79	3,03	0,67 ± 0,15	0,46	3,05	1,19 ± 0,12	0,35	3,08	0,29 ± 0,08	0,26	3,18	0,21± 0,1	0,24	2,99	-0,04± 0,02	0,07	3,30

Advantages of bulls with a high Immunity Index:

- **Reduced disease incidence in offspring**
  Offspring of such sires exhibit greater resistance to infectious diseases, decreasing the frequency of illnesses such as mastitis, and metritis.
- **Improved overall herd health**
  Animals with a high Immunity Index possess an increased ability to combat pathogens, reducing the need for medical intervention and improving the general health status of the herd.
- **Lower veterinary costs**
  A lower disease burden means reduced expenses for treatment and preventive measures, increasing the economic efficiency of livestock farming.
- **Improved calf survival**
  Calves sired by bulls with a high Immunity Index demonstrate better early-life survival, positively influencing farm productivity.
- **Increased productivity**
  Thanks to their robust health, animals with strong immune systems show better performance in milk yield, meat production, and growth.
- **Genetic optimization of the herd**
  High immunity in sires contributes to the transmission of disease resistance not only to immediate offspring but also to future generations, providing long-term benefits.

Disadvantages of bulls with a low Immunity Index:

- **Increased disease incidence in offspring**
  Offspring of bulls with a low immunity index are more susceptible to infectious diseases like mastitis, and metritis, decreasing overall herd productivity.
- **Lower calf survival**
  Calves from such sires exhibit higher early-life mortality due to weak immune systems, leading to significant production losses.
- **Greater need for veterinary intervention**
  Animals with lower immunity require more intensive veterinary oversight, treatments, and preventive care, raising maintenance costs.
- **Reduced economic efficiency**
  Frequent illnesses and the resulting treatment expenses lower the profitability of the herd, as these costs are not offset by increased productivity.
- **Deterioration of overall herd health**
  A high disease burden can weaken the overall health status of the herd, affecting its efficiency and reducing product quality.
- **Risk of genetically transferring weak immunity**
  If such bulls are used for reproduction, their poor immunity may be passed on to offspring, potentially weakening immune resilience in future generations.

Conclusions.

The highest Immunity+ index (105.67 ± 1.39) was recorded in the daughters of the sire Elkhart 3148929453, from the Elevation 1491007.65 lineage of the Holstein breed. These daughters inherit a high immune response to disease, as evidenced by a 7.86% lower incidence rate according to genomic testing.

Genomic selection allows farmers and breeders to select animals with the highest genetic potential even before they reach productive age, significantly improving key performance indicators such as milk yield, meat productivity, disease resistance, and other essential traits.

Through genetic testing, it is possible to identify bulls that transmit strong immunity to their offspring. Genomic evaluation provides accurate identification of animals with high immune traits, which significantly reduces disease risk among progeny and raises the overall health level of the herd.

The use of semen from bulls with a high Immunity Index is a crucial step in breeding for improved disease resistance and overall productivity, contributing to reduced veterinary expenses and ensuring stable production levels.

In contrast, using bulls with a low Immunity Index poses substantial risks to herd health and the economic efficiency of the farm. This highlights the importance of carefully selecting sires based on their immune status.

REFERENCES

Ivanov, I. A., Markhaichuk, Yu. S., & Shcherbyna, O. V. (2021). Generational repeatability of breeding value of Holstein sires of German selection. *Bulletin of Sumy National Agrarian University. Animal Husbandry*, 2 (45), 83–87. https://doi.org/10.32845/bsnau.lvst.2021.2.12 [In Ukrainian].

Biriukova, O. D., & Kopylova, K. V. (2012). Applied aspects of genomic selection use in the herd of Ukrainian Red-and-White dairy breed. *Collected Scientific Works of Podilsky State Agrarian and Technical University*, 2012, 20, 23–25. [In Ukrainian].

Ruban, S. Yu., Danshyn, V. O., Fedota, O. M., Mitioghlo, L. V., & Turchyn, V. Ya. (2016). Global experience and prospects for the use of genomic selection in dairy cattle breeding. *The Animal Biology*, 18 (1), 117–125. [In Ukrainian].

Ruban, S. Yu., & Kostenko, O. I. (2010). Evaluation of the efficiency of traditional and genomic breeding schemes in dairy cattle. *Technology of Production and Processing of Livestock Products*, 3 (72), 135–139. [In Ukrainian].

Hladii, M. V., & Polupan, Yu. P. (Eds.) (2018). *Selektsiini, henetychni ta biotekhnolohichni metody udoskonalennia i zberezhennia henofondu porid silskohospodarskykh tvaryn* [Breeding, genetic and biotechnological methods for improving and preserving the gene pool of farm animal breeds]. Tekhservis. [In Ukrainian]. https://iabg.org.ua/images/poltava_2018.pdf.

Durr, J., & Philipsson, J. (2012). International cooperation: the pathway for cattle genomics. *Animal Frontiers*, 2 (1), 16–21.

Mantysaari, E., Liu, Z., & VanRaden, P. (2010) Interbull validation test for genomic evalutions. *Interbull Bulletin*, 41, 17–21.

Schaeffer, L. R. (2006) Strategy for applying genome-wide selection in dairy cattle. *J. Anim. Breed. Genet.*, 123 (4), 218–223.

Pryce, J., & Hayes, B. (2012). A review of how dairy farmers can use and proft from genomic technologies. *Anim. Prod. Sci.*, 52, 180–184.

Одержано редколегією 25.04.2025 р.
Прийнято до друку 14.05.2025 р.