The purpose of the article is to carry out an evaluation of genetic resources of breeding dairy cattle Ukraine. The research was conducted on the observation materials of the State Statistics Service of Ukraine, the International Committee for Animal Recording, the State Register of subjects of breeding business in livestock breeding by using statistical methods. The breed of cows is an important factor in the economic efficiency of dairy cattle-breeding. Due to the long intensive selection work on cattle breeds, the milk productivity of cows in developed livestock countries has reached levels of 8.0–10.0 thousand kg and more for 305 days of lactation. The number of cows in breeding farms in Ukraine for 2006–2019 has decreased by 38 thousand head or by 22%. In the breeding structure of pedigree dairy cattle, animals of Ukrainian Black and White Dairy (49.9%), Holstein breeds (25.2%) and Ukrainian Red and White Dairy (14.4%) prevail.

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Introduction. Dairy cattle breeding is one of the most important and promising sectors of world livestock breeding. According to FAO (the Food and Agriculture Organization of the United Nations) statistics, the share of cow's milk production in the global milk production structure is 82.7% [1]. There are about 133 million farms in the world, where there are more than 264 million dairy cows producing more than 650 million tons of milk each year [2, 3]. According to the International Dairy Federation (IDF), the largest cow's milk is produced in the Asian region — 29% of the world's total, 28 European countries — 24, countries of North and Central America — 18, South America — 10%. The share of dairy production in other countries of Europe, Africa and Oceania is 9; 5; 5% respectively [3].

According to Dairy Campus scientists' researches at the University of Wageningen (the Netherlands), the demand for milk and dairy products in the world by 2050 will increase 1.5 times – to 1077 billion kg. Additional volumes will be produced and consumed, mainly in developing countries. So, there were countries on the market, milk production growth rates in which over the past 15 years exceeded world figures. Among them – India and Pakistan (production leaders in the informal segment), Russia (plans to satisfy their own needs for milk in 5–10 years), China (invests not only in its own production, but also in the dairy business of Russia, Australia, New Zealand), Belarus, Uzbekistan (an increase in the production of raw milk by 2.5 times in 15 years), Tajikistan, Kyrgyzstan, Armenia, Azerbaijan, Turkey, Iran [4, p. 2].

At the present stage, the development of dairy farming needs to focus on increasing the livestock population with high productive indicators in the large-scale sector. In the period from 2000 to 2020, the number of cows in Ukraine decreased by 2.8 times (from 4958.3 thousand heads on 01.01.2001 to 1788.5 thousand heads on 01.01.2020), and in agricultural enterprises – by 4.2 times (from 1851.0 to 438.6 thousand heads respectively) [5]. An important factor in the growth of the large-scale sector should be the revival of the national selection system. Therefore, the issue of scientific substantiation of the organizational principles of effective management of breeding dairy cattle breeding is now of particular urgency.

Materials and methods of research. The purpose of the article is to carry out an evaluation of genetic resources of breeding dairy cattle Ukraine. The research was conducted on the observation materials of the State Statistics Service of Ukraine, the International Committee for Animal Recording, the State Register of subjects of breeding business in livestock breeding by using statistical methods.

Research results. Cattle breeds differ according to economic indicators of useful traits of animals, including the level of productivity, which significantly influences the economic efficiency of production. According to ICAR (The International Committee for Animal Recording), cows of the Holstein breed remain the leaders, whose productivity for the 305 days of lactation is at the level of 9–11 thousand kg of milk (Table 1). Such achievements are the result of a long intensive breeding work aimed at increasing milk production.
Among other breeds, which cow's productivity approaches the animals Holstein breed, Ayrshire (up to 9.0 thousand kg), Braunvieh, Montbeliarde, Fleckvieh, Norwegian Red, Swedish Red, Jersey (7.0–8.0 thousand kg) are next (Table 2). A number of breeds are distinguished by qualitative features of dairy productivity. For example, the fat content in milk of cows of the Jersey breed of Canadian breeding is 5.1% [6]. The milk productivity of these breeds is lower than Holstein dairy cows. But they have significant benefits in functional traits such as high reproductive capacity, extended duration of economic use, high payment of feed by the resulting products, which increases their competitiveness to the level of animals of the Holstein breed.

### 1. Main economic traits of recorded Holstein Black and White cows in some countries of the world in 2019

| Country       | Milk per cow in 305 days (kg) | Percent fat content (%) | Percent protein content (%) | Calving interval (days) |
|---------------|------------------------------|-------------------------|-----------------------------|-------------------------|
| USA           | 11629                        | 3.82                    | 3.31                        | ...                     |
| Canada        | 10909                        | 3.98                    | 3.27                        | ...                     |
| Finland       | 10590                        | 4.22                    | 3.52                        | 409                     |
| South Korea   | 10352                        | 3.92                    | 3.21                        | 460                     |
| Czech Rep.    | 10253                        | 3.86                    | 3.39                        | 400                     |
| Estonia       | 10193                        | 3.79                    | 3.35                        | 409                     |
| Slovak Republic * | 9762                        | 3.78                    | 3.26                        | 412                     |
| Belgium       | 9681                         | 4.11                    | 3.46                        | 406                     |
| Germany       | 9393                         | 4.05                    | 3.44                        | 409                     |
| Norway        | 9381                         | 4.2                     | 3.42                        | 397                     |
| Denmark       | 9294                         | 4.09                    | 3.51                        | ...                     |
| France        | 9048                         | 3.94                    | 3.31                        | 421                     |
| Austria       | 8972                         | 4.06                    | 3.32                        | ...                     |
| **Ukraine**   | **8965**                     | **3.91**                | **3.40**                    | ...                     |
| Switzerland   | 8960                         | 3.99                    | 3.25                        | 412                     |
| New Zealand   | 3846                         | 4.45                    | 3.76                        | ...                     |

*2018 y...: No information. Source: The International Committee for Animal Recording [6].

### 2. Main economic traits of recorded dairy cows in some countries of the world in 2019

| Breed         | Country       | Milk per cow in 305 days (kg) | Percent fat content (%) | Percent protein content (%) | Calving interval (days) |
|---------------|---------------|------------------------------|-------------------------|-----------------------------|-------------------------|
| Braunvieh     | Canada        | 8982                         | 4.22                    | 3.55                        | ...                     |
|               | **Ukraine**   | **8877**                     | **3.83**                | **3.60**                    | **407**                |
|               | Germany       | 7565                         | 4.25                    | 3.62                        | 416                     |
|               | Austria       | 7527                         | 4.15                    | 3.51                        | ...                     |
|               | Switzerland   | 7235                         | 4.09                    | 3.30                        | 392                     |
|               | Finland       | 9529                         | 4.49                    | 3.57                        | 406                     |
|               | Canada        | 8159                         | 4.15                    | 3.41                        | ...                     |
|               | USA           | 6974                         | 4.00                    | 3.37                        | ...                     |
|               | **Ukraine**   | **6369**                     | **3.95**                | **3.10**                    | **428**                |
| Ayrshire      | Switzerland   | 6080                         | 3.97                    | 3.35                        | 383                     |
|               | USA           | 8701                         | 4.17                    | 3.63                        | ...                     |
|               | Austria       | 7734                         | 4.15                    | 3.43                        | ...                     |
|               | Germany       | 7725                         | 4.19                    | 3.54                        | 393                     |
|               | France        | 6654                         | 3.99                    | 3.52                        | 398                     |
|               | **Ukraine**   | **6211**                     | **4.00**                | **3.22**                    | **...**                |
| Fleckvieh     | Switzerland   | 7025                         | 4.08                    | 3.42                        | 393                     |
|               | France        | 6669                         | 4.19                    | 3.61                        | 407                     |
|               | **Ukraine**   | **6211**                     | **4.00**                | **3.22**                    | **...**                |
| Normande      | Switzerland   | 7025                         | 4.08                    | 3.42                        | 393                     |
|               | France        | 6669                         | 4.19                    | 3.61                        | 407                     |
|               | **Ukraine**   | **6211**                     | **4.00**                | **3.22**                    | **...**                |
| Montbeliarde  | Czech Rep.    | 8361                         | 4.05                    | 3.55                        | 384                     |
|               | Switzerland   | 7607                         | 3.78                    | 3.37                        | 395                     |
|               | France        | 7286                         | 3.85                    | 3.45                        | 401                     |
|               | **Norwegian Red** | **Switzerland** | **7705**                | **4.32**                  | **3.47**                | **379**                |
|               | **Swedish Red** | **Sweden**       | **7648**                | **4.36**                  | **3.62**                | **392**                |
| Pinzgauer     | Austria       | 5069                         | 3.92                    | 3.34                        | ...                     |
|               | Canada        | 7106                         | 5.13                    | 3.87                        | ...                     |
In Ukraine, the highest milk productivity is Holstein (8965 kg), Fleckvieh (8877 kg), Ukrainian Black and White Dairy (7486 kg) and Ukrainian Red and White Dairy (6997 kg). Currently, in 344 breeding herds, 137.8 thousand cows are kept, which is one third less than 10 years ago (Table 3). The most numerous is the Ukrainian Black and White Dairy – 68.829 purebred cows, or 49.9% in the structure of dairy cattle breeding herds. The share of Holstein – 25.2%, Ukrainian Red and White Dairy is 14.4%.

| Breed                        | Number of recorded herds | Number of recorded cows |
|------------------------------|--------------------------|-------------------------|
|                              | 2007 | 2012 | 2017 | 2020 | 2007 | 2012 | 2017 | 2020 |
| Ukrainian Black and White Dairy | 358  | 206  | 177  | 169  | 91546 | 75535 | 68181 | 68829 |
| Ukrainian Red and White Dairy | 161  | 98   | 68   | 59   | 37905 | 31920 | 25340 | 19825 |
| Ukrainian Red Dairy          | 42   | 29   | 17   | 16   | 13348 | 9309  | 6489  | 5127  |
| Holstein                     | 35   | 34   | 44   | 64   | 10504 | 14211 | 18467 | 34752 |
| Fleckvieh                    | 56   | 28   | 18   | 15   | 9372  | 5181  | 4916  | 4322  |
| Red Steppe                   | 40   | 15   | 6    | 6    | 8832  | 4135  | 1642  | 1436  |
| Lebedynska                   | 8    | 6    | 3    | 3    | 1433  | 1122  | 713   | 648   |
| Ukrainian Brown Dairy        | 7    | 4    | 2    | 2    | 1008  | 479   | 170   | 170   |
| Brown Carpathian             | 10   | 1    | –    | –    | 863   | 146   | –     | –     |
| Polish Red                   | 5    | 3    | 1    | 1    | 662   | 509   | 136   | 116   |
| Angler                       | 3    | 3    | 3    | 3    | 352   | 333   | 251   | 266   |
| Ayshire                      | 2    | 2    | 2    | 2    | 322   | 513   | 523   | 533   |
| Ukrainian Whiteheaded        | 1    | 1    | 1    | 1    | 160   | 320   | 300   | 300   |
| Braunvieh                    | 1    | 1    | 2    | 3    | 128   | 100   | 1101  | 1457  |
| Pinzgauer                    | 2    | –    | –    | –    | 60    | –     | –     | –     |
| Total                        | 731  | 431  | 344  | 344  | 176495| 143813| 128229| 137781|

– There were no phenomena. Source: The State Register of pedigree animal husbandry [7].

It should be noted the extremely insufficient number of cows of the active part of the livestock (breeding stock-rearing farms that are certified as subjects of the tribal affairs and conduct breeding records) – 29.5% of the number of cows kept in agricultural enterprises, and 7.7% – at farms all categories. For example, in Israel (the world leader in the cows’ milk productivity in level about 12 thousand kg per cow) it is more than 90%. In other countries with a developed dairy industry, this figure is at 90% – in Denmark [8], 86% in Sweden [9], and 70% in Canada [10]. The low proportion of the recorded dairy livestock in Ukraine greatly complicates the process of improving high-yielding herds.

Over the past ten years, the number of breeding stock-rearing farms in Ukraine has doubled. Among them there was a tendency for livestock consolidation. Average number of cows in herds the breeding stock-rearing farms was: in 2007 – 241 heads, in 2012 – 334, in 2017 – 373, in 2019 – 401 (Table 2). In 2007–2019, as a result of ongoing concentrations of livestock, the average size of a purebred dairy herd increased almost one and a half times, which, due to the scale effect, made it possible for enterprises to reduce production costs per unit.

The average milk yield of purebred cows in industrial enterprises increased from 4606 kg in 2007 to 7653 kg in 2019, or almost one and a half times (Table 4). Due to the effect of the factor of natural biological antagonism on the milk productivity and reproductive capacity of cows, the raising of productivity with an increase in the heredity of the Holstein breed has led to a decrease in the calving output of 100 cows, and a decrease in the length of the commercial use of cows. This trend is also characteristic of all newly created dairy breeds. In particular, from Ukrainian Black and White Dairy cows the calving output per 100 cows decreased from 82.8 heads in 2006 to 77.4 in 2019; Ukrainian Red and White Dairy respectively from 82.2 to 69.5 calves; Ukrainian Red Dairy, where the proportion of the heredity of the Holstein breed is slightly lower than the first two, the calving rate dropped at lower pace.

According to the results of dairy cattle recording, among the domestic breeds the highest milk productivity is in the Ukrainian Black and White Dairy cows – 7364 kg with a fat content of 3.74%, protein 3.22%; Ukrainian Red and White Dairy – respectively 6989; 3.78; 3.27; Ukrainian Red Dairy
– 6549; 3.90; 3.26 (Table 5). Domestic breeds on genetic potential are at the level of the best European analogues, and according to indicators of reproduction and health they prevail them.

4. Economically important traits recorded purebred cows in Ukraine

| Breed                        | Milk per cow in 305 days (kg) | Exit calves per 100 cows (heads) |
|------------------------------|-------------------------------|----------------------------------|
|                              | 2006 | 2011 | 2016 | 2019 | 2006 | 2011 | 2016 | 2019 |
| Ukrainian Black and White Dairy | 4708 | 5413 | 6732 | 7486 | 82.78 | 80.35 | 76.81 | 77.44 |
| Ukrainian Red and White Dairy | 4654 | 5601 | 6627 | 6997 | 82.22 | 80.90 | 79.22 | 69.55 |
| Ukrainian Red Dairy          | 4277 | 4883 | 5834 | 6284 | 82.86 | 79.42 | 80.61 | 80.05 |
| Holstein                     | 6006 | 7223 | 8071 | 8965 | 68.15 | 70.18 | 73.90 | 76.92 |
| Fleckvieh                    | 3850 | 5030 | 6959 | 6211 | 87.06 | 82.36 | 91.81 | 79.40 |
| Red Steppe                   | 3526 | 3607 | 4052 | 3910 | 83.58 | 77.95 | 78.64 | 71.92 |
| Lebedynska                   | 4018 | 3783 | 5236 | 4671 | 76.36 | 86.53 | 93.03 | 95.69 |
| Ukrainian Brown Dairy        | 4347 | 5579 | 3892 | 4743 | 44.88 | 86.22 | 73.68 | 81.18 |
| Brown Carpathian             | 2591 | 2991 | –    | –    | 70.18 | 40.32 | –    | –    |
| Polish Red                   | 3099 | 3398 | 1842 | –    | 71.16 | 67.38 | 89.09 | 30.94 |
| Angler                       | 4112 | 3965 | 4461 | 4345 | 85.07 | 75.08 | 82.43 | 75.81 |
| Ayrshire                     | 4353 | 5922 | 6269 | 6369 | 84.40 | 69.92 | 67.30 | 63.07 |
| Ukrainian Whiteheaded        | 3344 | 3838 | 4988 | 4850 | 88.34 | 88.12 | 86.00 | 91.67 |
| Braunvieh                    | 3789 | 2356 | 8380 | 8877 | 87.50 | 88.00 | 57.76 | 85.35 |
| Pinzgauer                    | 2379 | –    | –    | –    | 80.36 | –    | –    | –    |
| **Average**                  | 4606 | 5506 | 6785 | 7653 | 81.93 | 79.55 | 78.62 | 77.93 |

There were no phenomena. Source: The State Register of pedigree animal husbandry [7].

5. The characteristic of dairy herds Ukraine in 2011–2019, according to the results of the dairy cattle recording

| Year | Number of herds | Number of bonitized cows | Milk per cow (kg) | Productivity (for 305 days last completed lactation) |
|------|----------------|--------------------------|-------------------|----------------------------------------------------|
|      |                |                          | percent content   | percent content (%)                                 |
|      |                |                          | fat               | protein                                           |
|      |                |                          | 2006              | 2011      | 2016              | 2019      | 2006              | 2011      | 2016              | 2019      |
|      |                |                          | 2018              | 2017      | 2016              | 2015      | 2014              | 2013      | 2012              | 2011      | 2010              |
| Ukrainian Black and White Dairy | 59   | 14901          | 6989              | 264.49       | 257.24           | 240.59       | 223.41           | 207.83       | 192.07           | 177.54       | 164.54           |
| Ukrainian Red and White Dairy | 58   | 17589          | 6791              | 257.24       | 240.59           | 223.41       | 207.83           | 192.07       | 177.54           | 164.54           |
| Ukrainian Red and White Dairy | 57   | 18465          | 6640              | 250.70       | 238.78           | 226.39       | 214.87           | 194.57       | 176.22           | 158.94           |
| Ukrainian Red and White Dairy | 56   | 18814          | 6357              | 238.78       | 226.39           | 214.87       | 194.57           | 176.22       | 158.94           | 144.26           |
| Ukrainian Red and White Dairy | 55   | 20285          | 6368              | 242.22       | 224.90           | 207.83       | 192.07           | 177.54       | 164.54           | 151.94           |
| Ukrainian Red and White Dairy | 54   | 21494          | 6236              | 234.90       | 224.90           | 207.83       | 192.07           | 177.54       | 164.54           | 151.94           |
| Ukrainian Red and White Dairy | 53   | 21983          | 6091              | 232.19       | 226.87           | 200.26       | 184.57           | 176.22       | 158.94           | 144.26           |
| Ukrainian Red and White Dairy | 52   | 23964          | 6093              | 231.07       | 217.85           | 197.78       | 179.57           | 164.54           |
| Ukrainian Red and White Dairy | 51   | 25751          | 5588              | 210.55       | 192.17           | 182.77       | 164.54           | 151.94           |
| Ukrainian Red and White Dairy | 50   | 27173          | 5430              | 203.05       | 177.51           | 157.02       | 138.57           | 126.22           |

Source: author calculations on the basis of data from the The State Register of pedigree animal husbandry [7].
**Conclusions.** Consequently, the breed of cows is an important factor in the economic efficiency of dairy cattle-breeding. Due to the long intensive selection work on cattle breeds, the milk productivity of cows in developed livestock countries has reached levels of 8.0–10.0 thousand kg and more for 305 days of lactation.

The number of cows in breeding farms in Ukraine for 2006–2019 has decreased by 38 thousand head, or by 22%. The average milk yield of purebred cows in industrial enterprises increased from 4606 kg in 2007 to 7653 kg in 2019, or almost one and a half times. But the extremely insufficient number of cows of the active part of the livestock greatly complicates the process of improving high-yielding herds.

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**BIBLIOGRAPHY**

1. The Global Dairy Sector: Facts. FAO: вебсайт. URL: https://www.fil-idf.org/wp-content/uploads/2016/12/FAO-Global-Facts-1.pdf (дата звернення: 02.08.2020).
2. Statistics: Dairy cows. Compassion in world farming : вебсайт. URL: https://www.ciwf.org.uk/media/5235182/Statistics-Dairy-cows.pdf (дата звернення: 08.08.2020).
3. 2016 World Dairy. Situation Report. Bulletin of the International Dairy Federation. The International Dairy Federation : вебсайт. URL: http://www.idfa.org/docs/default-source/d-news/world-dairy-situationsample.pdf (дата звернення: 03.08.2020).
4. The DairyNews. Discover milk Georgia. Dairynews : вебсайт. URL: http://www.dairynews.ru/news-image/2017/January/20170117/Dairy%20Olympics%202017%20Feb.pdf (дата звернення: 10.08.2020).
5. Державна служба статистики : вебсайт. URL: http://www.ukrstat.gov.ua (дата звернення: 02.09.2020).
6. Milk recording surveys on cow, sheep and goats. The International Committee for Animal Recording (ICAR) : вебсайт. URL: https://www.icar.org/survey/pages/tables.php (дата звернення: 01.09.2020).
7. Державний реєстр суб’єктів племінної справи у тваринництві / Інститут розведення і генетики тварин імені М. В. Зубця НААН : вебсайт. URL: http://animalbreedingcenter.org.ua/derjplemreestr (дата звернення: 27.08.2020).
8. Available breeds. Selectsires : вебсайт. URL: http://www.selectsires.com/dairy/crossbreeding_available.html?version=20170404 (дата звернення: 15.08.2020).
9. Lindhe B. Two competing Swedish breeds with different profiles but of equal size. Milkproduction : вебсайт. URL: http://www.milkproduction.com/Library/Scientific-articles/Reproduction/Two-competing-Swedish/ (дата звернення: 12.08.2020).
10. Canadian dairy genetics. A century of improvement breeds. Government of Canada : вебсайт. URL: http://www.agr.gc.ca/resources/prod/Internet-Internet/MISB-DGSIM/ATS-SEA/PDF/4663-eng.pdf (дата звернення: 18.08.2020).

**REFERENCES**

1. The Global Dairy Sector: Facts. [online] Mode of access: https://www.fil-idf.org/wp-content/uploads/2016/12/FAO-Global-Facts-1.pdf (Accessed 02.08.2020) (in English).
2. Statistics: Dairy cows. [online] Mode of access: https://www.ciwf.org.uk/media/5235182/Statistics-Dairy-cows.pdf (Accessed 08.08.2020) (in English).
3. 2016 World Dairy. Situation Report. Bulletin of the International Dairy Federation. [online] Mode of access: http://www.idfa.org/docs/default-source/d-news/world-dairy-situationsample.pdf (Accessed 03.08.2020) (in English).
4. The DairyNews. Discover milk Georgia. [online] Mode of access: http://www.dairynews.ru/news-image/2017/January/20170117/Dairy%20Olympics%202017%20Feb.pdf (Accessed 10.08.2020) (in English).
5. Derzhavna služba statystyky – The State Statistics Service. Download Table [online] Mode of access: http://www.ukrstat.gov.ua (Accessed 02.09.2020) (in Ukrainian).

6. Milk recording surveys on cow, sheep and goats. Download Table [online] Mode of access: https://www.icar.org/survey/pages/tables.php (Accessed 01.09.2020) (in English).

7. Derzhavnyy reyestr sub"yektiv pleminnoi spravy u tvarynnystvi – The State Register of pedigree business animal husbandry. Download Table [online] Mode of access: http://animalbreedingcenter.org.ua/derjplemreestr (Accessed 27.08.2020) (in Ukrainian).

8. Available breeds. [online] Mode of access: http://www.selectsires.com/dairy/crossbreeding_available.html?version=20170404 (Accessed 15.08.2020) (in English).

9. Lindhé B. Two competing Swedish breeds with different profiles but of equal size. [online] Mode of access: http://www.milkproduction.com/Library/ Scientific-articles/Reproduction/Two-competing-Swedish/ (Accessed 12.08.2020) (in English).

10. Canadian dairy genetics. A century of improvement breeds. [online] Mode of access: http://www.agr.gc.ca/resources/prod/Internet-Internet/MISB-DGSIM/ATS-SEA/PDF/4663-eng.pdf (Accessed 18.08.2020) (in English).