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Main trends of dairy industry in Ukraine

Ruslana Stavetska*, Olena Babenko, Iryna Starostenko and Serhii Cherniak

Bila Tserkva National Agrarian University, Faculty of Biotechnological, 09107 Bila Tserkva, Kyiv region, Ukraine
**Corresponding author:* rstavetska@gmail.com

Abstract

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The paper analyzes the main trends in the dairy industry development in Ukraine over the past decades. During this period, there has been a fivefold reduction in the number of dairy cattle (2925.2 thousand heads in 2021) and a twofold increase in average milk yield (6101 kg in 2019). On the basis of crossing females of local breeds with bulls of Holstein, Swiss and some other breeds, four Ukrainian breeds of dairy cattle were created. Initially, there was a tendency to replace local breeds (Black-and-White, Simmental, Red Steppe, Lebedynska) with newly created breeds (Ukrainian Red-and-White dairy, Ukrainian Black-and-White dairy, Ukrainian Red dairy and Ukrainian Brown dairy). However, Holstein bulls are now widely used for insemination of cows and heifers (except Ukrainian Brown dairy). And today, these breeds are developing under absorbing crossbreeding and herds of Ukrainian dairy breeds are gradually becoming Holstein. In parallel with an increase in milk production, this has brought some negative elements associated with the use of high-yielding Holstein breed. In particular, these include the reducing of cow longevity, deteriorating of their reproduction ability and decreasing of replacement heifers' number. The searches for ways of solving the problem as well as the preservation of local breeds of dairy cattle are urgent tasks of dairy farming in Ukraine.

Keywords: dairy cattle; breed; productive and reproductive performance; replacement heifers

Introduction

The number of dairy cows in the world and their milk production is gradually increasing. According to the data of the US Department of Agriculture Foreign Agriculture Service, in 2018 the number of dairy cows in the world was 134.771 million, in 2021 p. – 138.721 million (USDA FAS, 2021). In 2020 the world milk production was more than 700 million tons (Bulletin of the International Dairy Federation, 2021). According to a calculation of Dairy Campus scientists at Wageningen University (Netherlands), the demands for milk and dairy products in the world by 2050 will increase 1.5 times – up to 1077 billion kg. Additional milk will be produced and consumed mainly in developing countries (Discover milk Georgia, 2017). In particular, in India for the period 2018-2021 the number of cows increased by 5518 thousand heads, in Brazil – by 100 thousand heads. In China and in the United States the number of cows has not changed significantly during this period. However, in the most countries there is a decrease in the number of dairy cows: in the European Union – by 761 thousand heads, in New Zealand – by 193 thousand heads, in Russia – by 315 thousand heads, in Ukraine – by 328 thousand heads (USDA FAS, 2021).

In Ukraine during the years of independence (since 1991) there has been a fivefold reduction in the number of dairy cattle. Structure of dairy cattle population has changed from mostly large-scale production (in 1990 74% of cows were kept in agricultural enterprises) to small-scale (now 75% of cows are kept in households). Leading scientists of Ukraine assume that current situation in the dairy sector of Ukraine has become a threat to the economic security of the state (Hladiy et al., 2021). Due to the systematic reduction of the

number of dairy cattle and the deterioration of their full-fledged fodder base (due to the reorientation of agricultural sector to more marginal crops), the gross production of raw milk and the provision of dairy plants with raw milk is reduced. On average, milk production in Ukraine decreases annually by 1.5% (Statistical Collection, 2021).

As of December 01, 2021 the number of dairy cattle in all categories of farms amounted to 2925.2 thousand heads, which is 6.9% less than in 2020. In particular there are 998.3 thousand heads in agricultural enterprises (0.6% less than in 2020) and 1926.9 thousand heads in households (9.8% less). The number of cows – 1610.7 thousand heads (6.8% less), of which in agricultural enterprises – 421.6 thousand heads (0.1% more), in households – 1189.1 thousand heads (9.0% less) (Ministry of Agrarian Policy and Food of Ukraine, 2021).

What le to this situation? Mainly this is a series of social and economic changes that have been taken place in Ukraine in recent decades. It should be noted that breeds of dairy cattle in Ukraine have changed significantly. In the second part of the 20th century for milk production, as a rule, cows of domestic breeds were used: Black-and-White, Simmental, Red Steppe, Brown Carpathian, Lebedynska, and Ukrainian Whitehead. Beginning in the late 1970s, Ukrainian scientists and milk producers began to create new domestic breeds. Today, four breeds of dairy cattle have been created in Ukraine: Ukrainian Red-and-White dairy, Ukrainian Black-and-White dairy, Ukrainian Red dairy and Ukrainian Brown dairy breeds.

Ukrainian Red-and-White dairy – is first dairy breed in Ukraine. It was confirmed in 1993. The scheme of creating of Ukrainian Red-and-White dairy breed implied a reproductive crossing of Simmental cows with the Holstein Red-and-White bulls. According to this scheme, purebred cows and bulls were used to obtain half-blood offspring, and then half-blood offspring were mated with purebred Holstein bulls and provided getting 3/4-blooded animals. It was expected to breed these animals "in themselves" (Zubets & Kruhliak, 2010). This technique was used to create other breeds, the difference was only in the choice of initial breeds. In 2020 the average milk yield of Ukrainian of Ukrainian Red-and-White dairy cows on breeding farms was 7174 kg, milk fat yield – 3.80% / 272 kg, milk protein yield – 3.31% / 237 kg (State Register of Breeding Entities in Animal Husbandry in 2020).

Ukrainian Black-and-White dairy breed was confirmed in 1996. As a maternal breed were chosen Black-and-White and Ukrainian Whitehead breeds, as a paternal breed – Holstein Black-and-White breed. The scheme of its creation provided getting ¾ and 5/8-blooded animals with their subsequent breeding "in themselves"(Yefimenko et al., 2014). Today it is the most widespread breed of dairy cattle in Ukraine. In 2020, the average milk yield in breeding herds was 7737 kg, milk fat yield – 3.75% / 290 kg, milk protein yield – 3.29% / 254 kg (State Register of Breeding Entities in Animal Husbandry in 2020).

Ukrainian Red dairy breed was created by reproductive crossing of Red steppe cows with bulls of Angler, Danish Red and Holstein Red-and-White breeds. It was confirmed in 2005. This breed is common in the hot climate of southern Ukraine. Its feature is a high longevity. Under proper conditions of feeding and keeping its productive lifetime varies between four and seven lactations (Polupan, 2008). The average milk yield of cows in breeding herds – 6658 kg, milk fat yield – 3.91%/ 260 kg, milk protein yield – 3.26%/ 217 kg (State Register of Breeding Entities in Animal Husbandry in 2020).

Ukrainian Brown dairy breed was created by the method of reproductive crossing of Lebedynska breed (maternal basis) with Swiss breed of Western European and North American selection (paternal basis). The breed was confirmed in 2009 (Ladyka et al., 2011). Milk production of Ukrainian Brown dairy cows is lower compared to the production of other breeds: in 2020 milk yield of cows was 4498 kg, milk fat yield – 3.56%/ 160 кг, milk protein yield – 3.09%/ 139 kg (State Register of Breeding Entities in Animal Husbandry in 2020). However, the literature provides data on the potential of cows of this breed for milk yield 6-7 thousand kg with a fat content in milk of 3.9-4.0%, protein – 3.5% (Ladyka, 2000).

Ukrainian scientists report that Ukrainian breeds of dairy cattle are profitable under the following conditions: milk yield – 6.0 thousand kg, fat content in milk not less than 3.75%, protein content – not less than 3.05%, the age at first breeding of heifers – 16-18 months, live weight of heifers at first breeding – 380 kg and more, days from calving to conception – 120 days and less, calving percentage – 70-80% (Hladiy et al., 2021).

The purpose of the research was to study the main trends in the field of dairy industry in Ukraine over the past 30 years and identify the main ways and prospects for its development.

Material and Methods

A systematic analysis of dairy industry Ukraine during its independence (since 1991 to the present) has been conducted. In particular, the dairy cattle population dynamics, production structure of dairy industry, Ukrainian dairy breeds and the current course of their improvement, results of bull using

have been studied. The results of absorbing crossbreeding of Ukrainian dairy breeds with Holstein were analyzed.

Analytical studies of livestock dynamics and performance of dairy cattle were performed based on statistical materials (Statistical Collection, 2021; Statistical Yearbook, 2020). Breeds and production dynamics of dairy cows have been studied on the basis of data from the State Register of Breeding Entities in Animal Husbandry (2021). Efficiency of bull using has been studied on the basis of data from the Bull catalogue of dairy and dual-purpose breeds allowed for insemination of females (2021).

The bull using of Ukrainian Black-and-White dairy and Holstein breeds and the share of Holstein heredity in their daughters was studied in five breeding herds of Ukrainian Black-and-White dairy breed in Kyiv region (ALC "Terezyne", APC nd. a. Shchors, LLC "Sukholiske», LLC AF "Matiushi", LLC AF "Glushky"). The replacement heifers' number and their culling reason were studied in three herds (ALC "Terezyne", APC nd. a. Shchors, and LLC AF "Glushky"). The study included 1323 calves. All replacement heifers were reared on the farms.

Results and Discussion

Over the past 30 years the average milk yield of cows in Ukrainian enterprises have more than doubled and in this period newly created breeds have played a significant role. In households the growth of milk yield of cows over the years is much lower due to worth housing conditions, unbalanced diets, using for insemination of cows semen of sires with unknown origin (Figure 1).

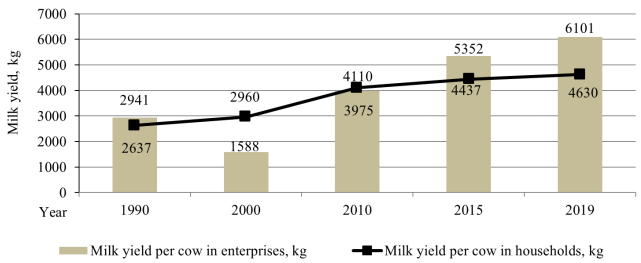

Fig. 1. Annual average milk yield per cow in enterprises and households in Ukraine

Source: Animal production of Ukraine 2019. Statistical yearbook, 2020

As a result in 2019 p the average milk yield of cows in enterprises was higher by 1471 kg (31.8%) compared to households.

The milk yields of dairy cows on the best farms of Ukraine exceed the average milk yield in enterprises by 1.5-2.0 times. According to the results of the rating «Dairy records of Ukraine – 2021», the average milk yield in the TOP-10 dairy farms ranges from 10,350 to 11,764 kg (Association of Milk Producers, 2021). The number of dairy cows on this farm is 800-1700, the breed – Holstein or Ukrainian Black-and-White dairy with a high Holstein share heredity (close to 100%).

Despite the annual decrease in milk yield of Ukrainian cows, the number of breeding herds of dairy cattle is declining (Table 1).

Table 1. Number of dairy herds with breeding status

Breed	2007	2020
Ukrainian Red-and-White dairy	152	60
Ukrainian Black-and-White dairy	349	169
Ukrainian Red dairy	44	14
Ukrainian Brown dairy	7	2
Red Steppe	38	6
Lebedynska	8	3
Brown Carpathian	10	0
Ukrainian Whitehead	1	1
Holstein	35	67

Source: State Register of Breeding Entities in Animal Husbandry, 2020

It should be noted that the number of cows in the active pert of population (controlled certified breeding herds) is extremely insufficient. This is 26.5% of the cows kept in agricultural enterprises (Kruhliak, 2018). For example, in Israeli The Israeli Herd-book includes more than 90% of the population (Pankratova, 2014), in Sweden – 86% (Lindhé, 2017) and in Canada – 70% (Canadian Dairy Genetics).

In 13 years (2007-2020) the number of herds of Ukrainian Red-and-White dairy breed decreased by 60%, Ukrainian Black-and-White dairy – 52%, Ukrainian Red dairy – 68%, Ukrainian Brown dairy breed – by 71%. Of the breeds of dairy cattle, which were used in Ukraine 50 years ago (Red Steppe, Lebedynska, Ukrainian Whitehead) only few herds remain. Genetic material of Ukrainian Whitehead, Lebedynska, Brown Carpathian and Ukrainian Grey breeds is stored in Animal Genetic Resources Bank at Institute of Animal Breeding and Genetics nd.a. M.V. Zubets of National Academy of Agrarian Science of Ukraine. 19.5 thousand semen doses from 27 bulls of above-mentioned breeds are stored there (Vyshnevskyi et al., 2017). The Institute has started work on preservation of gene pool of Ukrainian Grey and Ukrainian Whitehead breeds using method of obtaining embryos in vivo and further embryopreservation (Hladiy et al., 2018).

It should be noted that the improvement of Ukrainian breeds of dairy cattle is a slightly different way than that

which was planned during their creation. It was assumed that bulls of these breeds would by widely used for insemination of cows and heifers and just some part of females would be inseminated with semen of original parent breed. Such bulls were bred in every breed, but for insemination of heifers and cows the semen of imported bulls is increasingly used: for Ukrainian Red-and-White and Ukrainian Black-and-White dairy breeds Holstein bulls are used, for Ukrainian Red dairy breed – Holstein, Angler, Danish Red and Norwegian Red bulls, For Ukrainian Brown dairy breed – Swiss bulls Holstein.

A typical situation with using of Holstein bulls in the herds of Ukrainian Black-and-White dairy breed is shown in Figure 2.

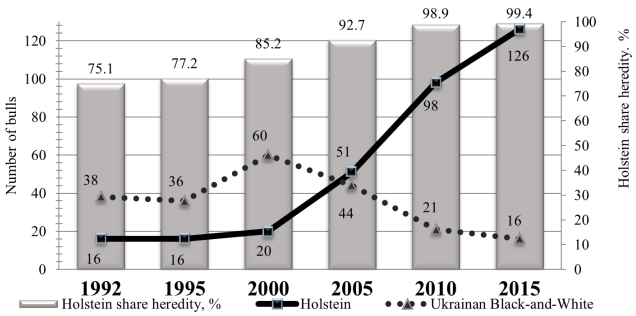

Fig. 2. Holstein share heredity (%) depending on Holstein and Ukrainian Black-and White dairy bulls by year

Source: Own calculations

In 1992, in five breeding herds of Ukrainian Black-and-White dairy breed in Kyiv region about 2800 cows were daughters of 38 bulls of Ukrainian Black-and-White dairy breed (70%) and 16 Holstein bulls (30%). In 2015 about 2600 were kept in these herds, they were daughters of 16 bulls of Ukrainian Black-and-White dairy breed (11%) and 126 Holstein bulls (89%). In 2017 only one bull of Ukrainian Black-and-White dairy breed was used in one of the herds. Starting from 2018 cows and heifers in these herds were inseminated with purebred Holsteins. This change in the ratio of Ukrainian Black-and-White dairy and Holstein bulls affected the Holstein share heredity of cows, which increased from 75.1% in 1992 to 99.4% in 2015. In 2021 in these five herds the Holstein share heredity of heifers and cows reached almost 100%. That is the herds of Ukrainian Black-and-White dairy breed are gradually becoming Holstein. This situation is typical for many dairy herds in Ukraine.

This trend is confirmed by the number of bulls allowed for use in Ukraine in 2021 (Table 2).

In 2021, 1,566 dairy and dual-purpose bulls were allowed for insemination in Ukraine. The majority of bulls were Holstein – 74.3%, bulls of Ukrainian breeds – only 9.8%. Biriukova (2012) reports that the number of bulls of Ukrainian dairy breeds which used for insemination of females is steadily declining, in particular, during 2009-2011 their number decreased by 45%.

Most Holstein bulls estimated by genome come from the United States (64.3%), Canada (24.0%), France and the Netherlands (together 9.1%); by offspring type and productivity – from the United States (60.3%), Germany, Canada and France (together 28.6%). In evaluation by offspring productivity and by origin, the primacy belongs to bulls with Ukrainian origin – 64.0% i 72.3%, respectively.

More than 90% of Simmental bulls with genomic evaluation and with evaluation by offspring type and productivity have French and Czech origin, Jersey bulls are from the United States, Red bulls (Ayrshire, Angler, Norwegian Red and Danish Red are from Norway and Denmark.

Table 2. The use of bulls of different breeds in Ukraine in 2021

Breed	Number of bulls	Type of evaluation by:						
		genomic		offspring type and productivity		offspring productivity		origin
		n	SI	n	SI	n	SI	n
Holstein	1164	536	+1408	411	+831	116	+420	101
Ukrainian Black-and-White	61	–	–	–	–	37	412	24
Ukrainian Red-and-White	33	–	–	–	–	19	+385	14
Ukrainian Red dairy	21	–	–	2	+541	14	+620	5
Ukrainian Brown dairy	39	10	+1008	6	+325	5	+223	18
Simmental	77	25	+686	23	+472	20	+586	9
Jersey	57	31	+1030	21	+680	–	–	5
Red breeds	80	5	+1478	5	+1028	19	+584	51
Other	34	–	–	13	+1169	12	+516	9

Source: Bull catalogue of dairy and dual-purpose breeds allowed for insemination of females in 2021

The value of selection index (SI) of bulls depends on the type of evaluation. In our study the average value of selection index the bulls with genomic evaluation is +1353, with evaluation by offspring type and productivity +811, by offspring productivity +455.

Simultaneously with advantages of the extensive use of Holstein bulls for insemination of Ukrainian dairy cows and heifers (higher milk production, better type of cows) a number of weakness was revealed. In particular, in many Holstenized dairy herds difficulties have arisen regarding less number of calves, rearing and survival of replacement heifers and shortening the average longevity of cows. This problem is especially acute given the current calving percentage and average productive lifetime of cows.

The State Statistics Service of Ukraine reports that in 2019 the calving percentage in agricultural enterprises was 64% which is 9% less than in 2010 (Statistical Yearbook, 2020). Deterioration of dairy cows reproduction ability is typical not only for Ukraine but also in fact for all countries where this industry is highly developed. Low fertility in the dairy cow industry annually courses farmers more than $0.5 billion damages to the milk losses, reducing cow numbers, increasing herd replacement cost, veterinary and treatment costs (Krzyzewski et al., 2004). Productive lifetime of cows of Ukrainian breeds is up to 3-4 lactations, in Holsteins – up to 1.8-2.0 lactations (Bashchenko et al., 2017). With increasing of Holstein share heredity in Ukrainian dairy herds, the longevity of cows tends to decrease (Klopenko & Stavetska, 2015; Mazur et al., 2018). However, there is opposite result of research, which reports that with the increasing of Holstein share heredity the productive lifetime of cows is prolonged and their lifetime production increases (Polupan et al., 2021).

Deterioration of dairy cows reproduction ability is due to:

• one-sided selection for high yield. Breeding programmes have focused on selecting for increased milk production, however, fertility in dairy cows has decreased strongly over the last decades as milk production per cow increased significantly (Walsh et al., 2011; Cassandro, 2014; Kgari et al., 2020). Because of the antagonistic relationship between fertility and milk production which is associated with pleiotropic effects of alleles for production and fertility (Glaze, 2011). The increase in the genetic potential of dairy cattle in Ukraine leads to a deterioration in reproduction ability of cows (Kuziv & Fedorovych, 2015). In particular, an increase in milk yield per lactation by 1000 kg is accompanied by an increasing in days from calving to conception by 16-28 days (Piddubna, 2014);

• unsatisfactory performance of artificial insemination techniques: about 70% of females may be temporarily infertile for this reason (Kharuta et al., 2009);

• embryonic mortality – termination of pregnancy due to embryonic death from 1 to 60 days. According to Guidelines for veterinarians (Kharuta et al., 2009), first service fertility rate can reach 85-100%, but embryonic mortality is often quite high. In particular, embryonic loss in Holstein cows in 44 herds in France and determined the rates of early and late embryonic mortality after the first artificial insemination to be 31.6% and 14.7%, respectively (Humblot, 2001);

• the breed influence, the origin of both maternal and paternal sides, Holstein share Heredity. In dairy herds with high Holstein share heredity deterioration of the main indicators of reproduction ability is noted (Stavetska & Rudyk, 2012; Khmelnychyi & Vechorka, 2018);

• using of inbreeding: selection for high milk yield is accompanied by an increase in inbreeding. For example, in the USA between 1976 and 1999, inbreeding in Jersey herds increased from 1.3% to 6.0%, and in Holstein from 0.7% to 4.6% (Washburn et al., 2002). There is evidence that a 1% increase in inbreeding coefficient increased number of services by 0.17 and reduced conception rate by 3.3 (Hermas et al., 1987);

• poor nutrition, housing of cattle and microclimate conditions, etc.

One of the negative consequences of dairy cows low fertility is reduction of number of replacement heifers. If the number of replacement heifers in the herd is limited, than all available animals are used for herd replacement without going through of selection. This reduces the rate of herd improvement by the desirable traits. The size of group of primiparous cows, which must be introduced into a herd every year, depends on the intensity of replacement heifers culling. It was found that in the researched herds of Ukrainian Black-and-White dairy breed an average 74.7% of heifers remain for herd replacement (Figure 3).

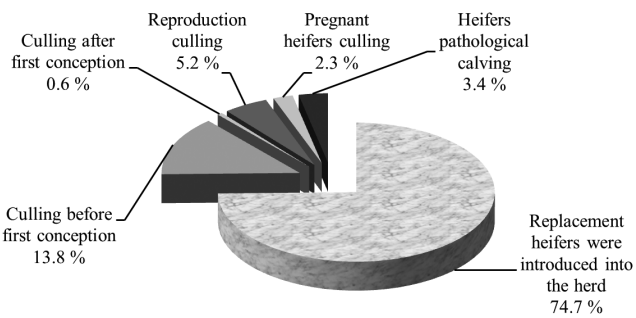

Fig. 3. Perspective replacement heifers and t culling reason, %
Source: Own calculations

Most of the heifers were culling before first conception – 13.8%. Much of heifers culling due to reproduction failure – 5.2%, in particular, underdeveloped of reproductive organs, ovarian hypofunction, infectious diseases. Such heifers don't come into heat or their insemination is ineffective. If in these herds the number of services per conception of heifers is 1.6-1.9, than heifers of this group have 6-8 services per conception. At the same time, a large part of heifers cull in connection with injuries, diseases (2.3%) and pathological calving (3.4%), primarily due to dystocia – some calves reach 50 kg and more.

Thus, thorough analysis of culling reasons of replacement heifers in dairy herds allows identifying of their rearing weakness and involuntary culling reasons. Eliminating these shortcomings or minimizing them will increase the survival of replacement heifers.

Given the problematic issues in the field of dairy industry, leading Ukrainian scientists have identified the main directions of development of dairy farming until 2025 (Bashchenko et al., 2017). They emphasize the focus on expanding milk production on large farms, which is positive in terms of modern intensive technologies using, economic efficiency of milk production and investment attractiveness in dairy farming.

Conclusions

The dairy industry in Ukraine is currently experiencing challenging times due to the systematic reduction in livestock numbers and gross milk production. Through omissions in organization of the selection process, Ukrainian dairy breeds gradually become Holstein or acquire the status of endangered and need of preservation. One positive development is an increase in milk yield of cows both in agricultural enterprises and in households, as well as the introduction of new modern dairy farming technologies. It is obvious that dairy industry in Ukraine needs to be regulated by the state or relevant institutions in order to slowdown the reduction in livestock numbers, to regulate the market of imported semen, to control the improvement of newly created Ukrainian breeds of dairy cattle and to preserve endangered local breeds.

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